September 30, 2015

CITY OF PINOLE

Project Manual for:

The Pinole-Hercules Water Pollution Control Plant Upgrade

Part 2 - Technical Specifications

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Final Version

City of Pinole

Pinole-Hercules Water Pollution Control Plant Upgrades

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Table of Contents

PART 2 – TECHNICAL SPECIFICATIONS

DIVISION 01 - GENERAL REQUIREMENTS

01010	CONSTRUCTION AND SCHEDULE CONSTRAINTS
01060	SPECIAL CONDITIONS
01062	MAJOR EQUIPMENT SUPPLIERS
01200	REQUESTS FOR INFORMATION (RFI)
01320	CONSTRUCTION PROGRESS SCHEDULE
01340	SUBMITTALS
01342	OPERATION AND MAINTENANCE MANUALS
01560	ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS
01600	PRODUCT DELIVERY, STORAGE, AND HANDLING
01601	JOB CONDITIONS
01640	PRODUCT SUBSTITUTIONS
01650	FACILITY START-UP, SEQUENCING AND CONSTRAINTS
01710	CLEANING
01800	OPENINGS AND PENETRATIONS IN CONSTRUCTION
01900	SOIL INVESTIGATION DATA

DIVISION 02 - SITE WORK

02072	DEMOLITION, CUTTING AND PATCHING
02110	SITE CLEARING
02155	TEMPORARY BYPASS PUMPING SYSTEMS
02200	EARTHWORK
02220	CONTROLLED LOW STRENGTH MATERIAL
02221	TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES
02260	TOPSOILING AND FINISHED GRADING
02270	SOIL EROSION AND SEDIMENT CONTROL
02315	TUBEX GROUT-INJECTION PILES
02316	TORQUE-DOWN STEEL PILES
02317	PRECAST AND PRESTRESSED CONCRETE DRIVEN PILING
02444	CHAIN LINK FENCE AND GATES
02513	ASPHALTIC CONCRETE VEHICULAR PAVING
02515	PRECAST CONCRETE MANHOLE STRUCTURES

DIVISION 03 - CONCRETE

03030	HYDRAULIC STRUCTURE TESTING
03108	FORMWORK
03151	ANCHORAGE TO CONCRETE
03208	REINFORCEMENT
03308	CONCRETE, MATERIALS AND PROPORTIONING
03311	CONCRETE MIXING, PLACING, JOINTING, AND CURING
03348	CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS
03350	TESTING
03431	PRECAST CONCRETE
03510	LOW DENSITY CELLULAR CONCRETE FILL (LDCCF)
03740	CONCRETE CRACK REPAIR INJECTION

DIVISION 04 - MASONRY

04050	COLD AND HOT WEATHER MASONRY CONSTRUCTION
04110	CEMENT AND LIME MORTARS
04155	MASONRY ACCESSORIES
04210	BRICK MASONRY AND VENEER
04220	CONCRETE MASONRY
04510	MASONRY CLEANING

DIVISION 05 - METALS

05120	STRUCTURAL STEEL
05131	STRUCTURAL ALUMINUM
05211	STEEL JOISTS
05313	METAL DECK
05505	METAL FABRICATIONS
05522	ALUMINUM RAILINGS

DIVISION 06 - WOOD AND PLASTICS

06100	ROUGH CARPENTRY
06610	FIBERGLASS REINFORCED PLASTIC FABRICATIONS

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07101	PVC SHEET LINER FOR CONCRETE PIPE AND STRUCTURES
07120	FLUID APPLIED WATERPROOFING
07176	LIQUID WATER REPELLENT
07412	METAL ROOFING
07900	JOINT SEALANTS

DIVISION 08 - DOORS AND WINDOWS

08110	HOLLOW METAL DOORS AND FRAMES
08305	ACCESS DOORS
08332	STEEL ROLLING OVERHEAD DOORS
08600	ALUMINUM ACCESS HATCHES
08700	FINISH HARDWARE

DIVISION 09 - FINISHES

09201	METAL FURRING AND LATHING
09905	PAINTING AND PROTECTIVE COATINGS

DIVISION 10 - SPECIALTIES

10200	LOUVERS AND VENTS
10400	IDENTIFICATION DEVICES
10441	WARNING SIGNS
10520	FIRE EXTINGUISHER AND CABINETS
10731	CANOPIES

DIVISION 11 - EQUIPMENT

11005	EQUIPMENT: BASIC REQUIREMENTS
11060	PUMPING EQUIPMENT: BASIC REQUIREMENTS

11061 PUMPING EQUIPMENT: NON-CLOG CENTRIFUGAL
11063 PUMPING EQUIPMENT: SAMPLING PUMPS
11065 PUMPING EQUIPMENT: SUMP
11068 PUMPING EQUIPMENT: VORTEX (TORQUE-FLOW)
11069 PUMPING EQUIPMENT: PROGRESSING CAVITY
11073 PUMPING EQUIPMENT: VERTICAL TURBINE PUMPS
11076 PUMPING EQUIPMENT: SUBMERSIBLE NON-CLOG
11081 HIGH SPEED TURBO AERATION BLOWER
11084 SUBMERSIBLE PROPELLER PUMPS
11088 AERATION EQUIPMENT: FINE BUBBLE TYPE
11089 AERATION EQUIPMENT: COARSE BUBBLE TYPE
11093 PERFORATED PLATE SCREENS
11094 SCREENINGS WASHER/COMPACTOR
11095 AUTOMATIC SELF-CLEANING STRAINERS
11096 FORCED VORTEX GRIT REMOVAL SYSTEM
11120 PRIMARY CLARIFIER AND GRAVITY THICKENER: CIRCULAR GENERAL REQUIREMENTS
11125 SLUDGE COLLECTION: CIRCULAR SUCTION-TYPE
11142 ROTARY DRUM THICKENING SYSTEM
11150 SECONDARY CLARIFIER FLOCCULATION BAFFLES, WEIR PLATES AND SCUM BAFFLES
11151 PRIMARY CLARIFIER SLUDGE PROTECTOR BAFFLES, WEIR PLATES AND SCUM BAFFLES
11152 GRAVITY THICKENER WEIR PLATES AND SCUM BAFFLES
11153 FLOW SPLIT TARGET BAFFLES
11322 GRIT CYCLONES AND CLASSIFIERS
11364 DEWATERING CENTRIFUGE
11373 SUBMERSIBLE MIXERS
11376 ROTARY-LOBE BLOWERS
11651 SHOP AND STORAGE EQUIPMENT
11923 LIQUID POLYMER BATCHING SYSTEM
11932 PUMPING EQUIPMENT: CHEMICAL METERING PUMPS
11947 INDUCTION MIXING EQUIPMENT
11980 COMPRESSED AIR SYSTEM
11982 SAMPLING AND MONITORING EQUIPMENT

DIVISION 13 - SPECIAL CONSTRUCTION

13121 METAL BUILDING SYSTEMS
13123 REINFORCED FIBERGLASS ENCLOSURE
13206 COVERS: FIBERGLASS
13211 HYDROPNEUMATIC (SURGE) TANK
13420 CHEMICAL STORAGE TANKS
13440 INSTRUMENTATION FOR PROCESS CONTROL: BASIC REQUIREMENTS
13441 CONTROL LOOP DESCRIPTIONS
13442 PRIMARY ELEMENTS AND TRANSMITTERS
13446 CONTROL AUXILIARIES
13448 CONTROL PANELS AND ENCLOSURES
13500 PROGRAMMABLE LOGIC CONTROLLER (PLC) CONTROL SYSTEM
13502 COMPUTER NETWORK AND HUMAN MACHINE INTERFACE (HMI) SYSTEM
13504 CONFIGURATION REQUIREMENTS: HUMAN MACHINE INTERFACE (HMI) AND REPORTS
13900 PACKAGED METERING MANHOLE

DIVISION 14 - CONVEYING SYSTEMS

14301	HOISTS, TROLLEYS, AND MONORAILS
14305	BRIDGE CRANES
14551	SHAFTLESS SCREW CONVEYORS

DIVISION 15 - MECHANICAL

15060	PIPE AND PIPE FITTINGS: BASIC REQUIREMENTS
15061	PIPE: STEEL
15062	PIPE: DUCTILE
15063	PIPE: COPPER
15064	PIPE: PLASTIC
15065	DOUBLE CONTAINMENT PIPING SYSTEM
15067	PIPE: STAINLESS STEEL
15072	ASBESTOS CEMENT PIPE REMOVAL
15090	PIPE SUPPORT SYSTEMS
15097	SEISMIC RESTRAINTS FOR PIPING
15100	VALVES: BASIC REQUIREMENTS
15101	GATE VALVES
15102	PLUG VALVES
15103	BUTTERFLY VALVES
15104	BALL VALVES
15106	CHECK VALVES
15114	MISCELLANEOUS VALVES
15115	WATER CONTROL GATES
15150	SPECIALTY VALVES
15183	PIPE, DUCT AND EQUIPMENT INSULATION
15440	PLUMBING FIXTURES AND EQUIPMENT
15605	HVAC: EQUIPMENT
15885	ODOR CONTROL SYSTEM
15890	HVAC: DUCTWORK
15970	INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS
15990	HVAC SYSTEMS: BALANCING AND TESTING

DIVISION 16 - ELECTRICAL

16010	ELECTRICAL: BASIC REQUIREMENTS
16012	SEISMIC BRACING SYSTEMS
16060	GROUNDING
16080	ACCEPTANCE TESTING
16120	WIRE AND CABLE: 600 VOLT AND BELOW
16121	MEDIUM VOLTAGE CABLE
16130	RACEWAYS AND BOXES
16135	ELECTRICAL: EXTERIOR UNDERGROUND
16140	WIRING DEVICES
16230	ENGINE GENERATOR: DIESEL
16265	VARIABLE FREQUENCY DRIVES: LOW VOLTAGE
16410	SAFETY SWITCHES
16411	TRANSFER SWITCHES
16412	SEPARATELY MOUNTED CIRCUIT BREAKERS
16440	SWITCHBOARDS
16441	PANELBOARDS
16442	MOTOR CONTROL EQUIPMENT
16460	DRY-TYPE TRANSFORMERS
16490	OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

16491 LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)
16492 ELECTRICAL METERING DEVICES
16493 CONTROL EQUIPMENT ACCESSORIES
16500 INTERIOR AND EXTERIOR LIGHTING

SECTION 01010
CONSTRUCTION AND SCHEDULE CONSTRAINTS

PART 1 - GENERAL

1.1 SUMMARY

A. The wastewater treatment facility must be kept in continuous operation throughout the construction period. No interruption will be permitted which adversely affects the normal facility operation. The Contractor shall provide all temporary facilities and make all temporary modifications as necessary to keep the existing facilities in operation during the construction period. Any temporary facilities, materials, equipment and labor required to achieve this objective shall be provided by the Contractor and included in the original bid price. At the completion of work, all such temporary facilities, materials, and equipment remaining shall be removed from the site.

B. Work shall be scheduled, sequenced, and performed in a manner which minimizes disruption to the operation and maintenance of the existing facilities.

C. The Contractor is solely responsible for developing a detailed sequence of work that accomplishes the tasks shown and specified with the minimum possible interruption to the existing facilities and that complies with all limitations and restrictions specified herein.

D. The Contractor shall incorporate the construction and schedule constraints of this Section into the construction schedule(s) required under Section 01320. The schedules shall include the Contractor's activities necessary to satisfy all the constraints of the Contract Documents.

E. Some temporary facilities are shown schematically on the drawings. The Contractor may propose alternate temporary facilities. Temporary facilities shall comply with the requirements in Section 02155.

F. Flow varies based on season. "Dry weather season" is defined as the period of May 1 through October 31. "Wet weather season" is defined as the period of November 1 through April 31.

G. The Contractor's schedule must minimize the number and duration of power outages. Contractor shall provide standby generators and all labor and fuel needed during periods of power outage to keep generator(s) fueled. The Owner's existing generator(s) may be utilized to supply power during construction activities. Total hours utilized per calendar year shall not exceed 25 hours. Plant will supply the fuel used for the plant's generator. Contractor is not allowed to modify existing standby generator power distribution system.

H. All existing instrumentation must remain in service at all times unless specifically noted otherwise on drawings or in specifications.

I. All existing utilities must remain in service during modifications unless specifically noted otherwise on drawing or in specifications.

J. Temporary lighting, controls, instrumentation, alarms, security devices, ventilation, and all required safety devices shall be provided by the Contractor whenever the work, or interruption due to the work, affects the operation of existing facilities.

K. 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. The Contractor shall provide adequate temporary pumping and piping facilities to clear the work areas as necessary of water, sewage, sludge, grit or miscellaneous items commonly found in municipal sewage.

L. The Contractor shall drain and clean all work areas, including tanks and basins, as required to perform work. Contractor shall provide all temporary pumps and piping required, and dispose of all waste materials generated. Contractor to coordinate all draining/cleaning work with Owner.

M. Construction activities that interfere with the operation of or access to the existing facilities shall be thoroughly planned in advance. All required equipment, materials, and labor shall be on hand at the time of the undertaking.

N. The Contractor shall provide appropriate staff (including subcontractors, equipment suppliers, etc.) for 2 hours following system resumption after all shutdowns to monitor and ensure the proper operation of affected systems.

O. Facility Access:
   1. Safe access to all areas of the WPCP shall be provided and maintained by the Contractor at all times for the Owner's operations and maintenance personnel.
   2. Access for large vehicles, e.g. chemical delivery, diesel, and sludge hauling trucks shall be maintained at all times. An access plan detailing internal plant routes shall be submitted by the Contractor for approval by the Owner for each major construction stage.
   3. Maintain access at all times to fuel dispensing station near main entrance gate.
   4. Maintain access to diesel storage adjacent to Generator building at all times outside of Stage I work. It is understood that access during Stage I work will be limited however Contractor must make every reasonable effort to maintain a minimum level of access for generator fueling as required to maintain backup power.
   5. The Contractor may have no more than 40 FT of open trench open at any one time unless greater lengths specifically identified and approved as part of work area access plan.

P. Operation of Existing Equipment:
   1. Operational functions or shutdown of the existing facilities and/or systems required to facilitate Contractor's operations will be performed by Owner's personnel only. This includes operation of all electrical and instrumentation facilities, gates, valving and pumps.
   2. While work is being performed, the Contractor shall provide access to all operating equipment for both routine and emergency operation and maintenance by Owner's personnel.

Q. If in the opinion of the Construction Manager, any of the Contractor's proposed work will unduly impact the Owner's operations then the Construction Manager may require the Contractor to revise and resubmit its plan.

1.2 CONSTRUCTION STAGING

A. Due to the extent of the modifications to be undertaken and the necessity to maintain all secondary systems in operation during wet weather months, the work under this contract has been planned as stages to be executed in over multiple wet and dry seasons.

B. The capacity of the existing Water Pollution Control Plant (WPCP) is limited by the secondary treatment systems including the aerations basins, secondary clarifiers, and associated equipment. All available secondary process tanks must be on-line and operational during wet weather months to insure discharge permit compliance.

C. Each stage must be complete before the follow stage may begin to insure sufficient treatment capacity is maintain at all times.
   1. Stage I:
      a. Stage I includes the following primary work elements:
         1) construction of new Headworks facilities,
         2) construction of new solids management facilities,
         3) modifications to the existing effluent pump station, and
         4) modifications to existing Primary Clarifiers 1 and 2.

b. The construction of the new headworks facility will allow for demolition of the existing headworks facilities and the construction of relocated Primary Clarifier 3 under Stage II work.
c. The construction of the new solids management facilities will allow for the demolition of the existing solids facilities and construction of additional aeration basins under Stage II work.
d. The construction of the ferric chloride dosing facilities under Stage I will allow the plant to execute a Chemically Enhanced Precipitation Treatment (CEPT) strategy to improve the performance of the remaining operational primary clarifiers and therefor allow the plant to operate on a reduced number of primary clarifiers during the wet weather months prior to the construction of new Primary Clarifier 3.
e. The 30 IN Bypass pipe from the new Headworks to the Primary Effluent Junction Box must be operational before the beginning of the wet weather season as this pipe is intended carry wet weather flows above 12 mgd around the primary clarifier system.

2. Stage II:
   a. Stage II includes the following primary work elements:
      1) demolition of the existing headworks facilities and construction of Primary Clarifier 3,
      2) construction of new sodium hypochlorite and bisulfite systems,
      3) demolition of existing Primary Clarifier 3 and Secondary Clarifier 2 to allow for construction of new larger Secondary Clarifier 2,
      4) demolition of the existing solids facilities and construction of additional aeration basins,
      5) modifications to the existing aeration basins process air supply systems, and
      6) demolition and replacement of the existing Mixed Liquor Splitter Box.
   b. This work requires the WPCP to operate with a pair of primary clarifiers and four existing secondary clarifiers through the wet weather months.
3. Stage III:
   a. Stage III includes the following primary work elements:
      1) demolition and replacement of Secondary Clarifier 1 and
      2) construction of additional chlorine contact basins.
   b. At the completion of Stage III the project will be complete.

1.3 GENERAL CONSTRUCTION CONSTRAINTS

A. The following constraints are applicable to all three stages of construction.

B. All scheduling constraints or special conditions may not have been identified. This list shall not substitute for the Contractor's sole responsibility for planning and coordination for completion of the work in accordance within the Contract Documents.

C. The Contractor shall perform the work in accordance with the following constraints:
   1. Dry weather season flows range between 2 mgd (minimum flow) and 6 mgd (peak hourly flow).
   2. Wet weather season flows range between 2 mgd (minimum flow) and 20 mgd (peak hourly flow).
   3. Bypass pumping of any kind is not allowed during wet weather months due to the potential for significant flows from storms.
   4. Park access must be maintained at all times. Work within the park area, including fencing and path relocation must be complete before Contractor staging area established.
   5. Interruptions to flow in the influent sewers shall not be allowed. Any flow stoppage, regardless of duration, must include provisions for temporary bypass pumping provided in accordance with Section 02155.
   6. All work associated with the influent sewers shall be performed during the dry weather season.

7. Rising water levels in the existing influent pump station, due to flow stoppage or system failure of the existing pump station, will result in flooding of existing RAS Pump Stations and other low level plant structures due to backflow through the existing plant drain system. The Contractor shall exercise caution to insure existing facilities are not inadvertently flooded during construction.
8. Influent screening must be performed at all times. No unscreened wastewater may enter the treatment basins.
9. The 24 IN bypass piping from the Primary Effluent Sampling Box to the influent channel of aeration basin Train 2 can only be used in the dry weather season.
10. When bypass pumping to facilitate modifications to the PE pipe between the Primary Effluent Junction Structure and the Aeration Basins provide shutoff valves at all active aeration basins.
11. Interruptions to process air flow to the aerations basins, for any reason, shall be limited to a maximum of 3 hours in length in any one day and only between the hours of midnight and 6 am.
12. The existing DO probes at the existing aeration basins are utilized for information only. Provide temporary wiring as required to maintain existing DO probe operation until new DO probes operational.
13. The effluent pump station may be taken off-line for up to 5 weeks, by utilizing the shallow water outfall, to complete modifications and upgrades at the station. Provide temporary pumping to supply 4W water throughout shutdown.
14. Interruptions to the power supply for the existing Digester Control Building shall be limited to a maximum of 8 hours for electrical system modifications.
15. Interruptions to the power supply for the Solids Handling System shall be limited to a maximum of 8 hours for electrical system modifications.
16. Maintain plant drainage system as required throughout construction to facilitate ongoing operations as well as regular maintenance events.
17. Sludge generated by the existing treatment plant must be processed (dewatered) for off-hauling at least 5 days per week, 8 hours per day. Plant Operations can, with adequate notification, shut down sludge processing and accumulate solids in the treatment process. The maximum solids handling shutdown duration varies based on conditions and is less than 4 days under all circumstances.
18. Interruptions to the 1W water system for connections and modifications must be limited to 2 hours in duration. Contractor to provide isolation valves as required to connect to existing 1W supply piping to provide water for construction activities.
19. Interruptions to the 2W water system for connections and modifications must be limited to 2 hours in duration.
20. The 3W water system is critical for many plant functions including but not limited to pump packing flushing, chemical carrier water, analyzers, and washdown. Provide temporary piping as required to maintain the existing 3W pump system in service at the existing Chlorine Contract Basins as required to construct the new basins. Both 3W supply pumps are utilized at all times. A single pump may be removed temporarily from service for piping modifications at a time with prior notification to Plant Staff. The entire 3W system may be off-line for a maximum of 2 hours but only between the hours of midnight and 6 am for modifications.
21. The 4W water system is critical for many plant functions including but not limited to pump packing flushing, chemical carrier water, analyzers, and washdown. Provide temporary piping as required to maintain the existing 4W pump system in service at the existing Chlorine Contract Basins as required to construct the new basins. Both 4W supply pumps are utilized at all times. A single pump may be removed temporarily from service for piping modifications at a time with prior notification to Plant Staff. The entire 4W system may be off-line for a maximum of 2 hours but only between the hours of midnight and 6 am for modifications.
22. Paving and repaving activities shall only take place after all major structural are complete at the end of Stage 3. Provide temporary AB to ensure driving surfaces are operational throughout construction.

23. Effluent metering is critical to bisulfite and chlorine dosing control. If metering at effluent pump station is off line longer than an 8 hours working day control system must be temporarily reconfigured to allow for influent metering to pace chemical dosing. Contractor to return control to effluent meter after modifications complete.

1.4 ADDITIONAL CONSTRUCTION CONSTRAINTS BY STAGE

A. Construction Constraints Stage I:
   1. The new headworks including but not limited to the screens, grit, pumps, ferric facilities, odor control, electrical building and miscellaneous facilities must be tested and fully operational before modifications to the secondary treatment systems may begin except as specifically noted elsewhere.
   2. The clarifier mechanisms and sludge pumps for Primary Clarifiers 1 and 2 must be replaced before existing Primary Clarifier 3 may be taken off-line for demolition. A minimum of two Primary Clarifiers must be on-line and operational at all times except as specifically noted elsewhere.
   3. The new Gravity Sludge Thickener and Solids Handling System must be operational before the existing Gravity Sludge Thickener and Solids Handling System may be taken off-line for demolition to allow for the aeration basin expansion. The existing motor control center and centrifuge LCP in existing polymer building must remain operational until Solids Handling Building and MCC-N construction is complete.
   4. Existing chlorination/dechlorination chemical systems (Sodium Hypochlorite and Sodium Bisulfite) must be temporary relocated, but remain fully operational, to allow for other construction activities. Provide complete temporary facilities for these chemicals.
      a. Provide temporary power to temporary bisulfite tank heaters.
      b. Bisulfite dosing must be maintained at no less than two locations (Effluent Pump station and chlorine contact basins).
      c. Hypochlorite must be maintained at the Chlorine Contract Basins.
      d. Systems to be located as allows by Contractors construction sequencing however must be accessible for chemical deliveries.
      e. Storage tank(s) shall be no less than 7,000 gallons for each chemical. Tanks and pumps purchased for this project may be utilized for temporary system. Tanks must have seismic anchorage and automated level indication.
      f. Pumps must be paced as currently configured.
      g. Provide eyewash stations.
      h. All temporary piping shall be double contained.
   5. A minimum two (2) Primary Clarifiers must be on-line and operational at all times except as specifically noted otherwise.
   6. All Primary Clarifiers may be bypassed for a maximum of 48 hours at any one time using the 30 IN Bypass pipe from the new headworks to allow for modifications in the Primary Influent Distribution Box. Allow for no less than 2 weeks recover of treatment system between complete Primary clarifier bypasses events.
   7. No less than two existing blowers or one new blower must be in service at all times. Provide temporary blow off valves, with silencers, as required to keep blowers above minimum surge flow rates throughout construction. Under no circumstances may new and existing blowers be operational into a single common header. Contractor must supply all air blowoff valves with silencers required to keep blowers above minimum flow rates (existing blower minimum 900 scfm, new blower minimum 2000 scfm).
   8. Wasting of solids (WAS) from the process cannot be off-line for more than two consecutive days during transition to new solids thickening and management facilities. This will allow Plant staff to manage solid inventory within the process tanks.
   9. The 24 IN SE pipe from SC 5 passes through the worksite for new SC 2. Provide temporary piping as required around the worksite. Note that temporary facilities, of the Contractor's choosing, will be required to isolate the 24 IN SE from the main 42 IN SE pipe for installation of the temporary piping.

10. Provide temporary pipe and/or pumps as required to maintain the drains from the existing Gravity Sludge Thickener to plant drain system until new thickening facilities are operational.
11. Maintain all utilities including power, network cable, and telephone service to the existing Public Works Building (AKA Corporation Yard Building) throughout construction. Temporarily reroute utilities as required around construction. Interruptions to service may take place only outside normal business hours and must be limited to a maximum of 4 hours at any one time.
12. Existing polymer dosing system must be temporary relocated, but remain fully operational, to allow for other construction activities. Provide a complete temporary facility for polymer storage and dosing.
13. The Sodium Hydroxide (NaOH) system may be off-line until the new facilities are constructed under Stage III. Sodium Hydroxide is currently not used or stored at the site.
14. Contractor to provide temporary pump and piping as required to maintain drainage system in operation through out construction. Temporary pumping within the drainage system must allow for wet weather season stormwater drainage.
15. Pave new access path around Contractor laydown area to maintain public assess.
16. Off site piping, work shown on C6C101 shall be coordinated with work at effluent pump station to minimize interruptions to effluent flow.

B. Construction Constraints Stage II:
1. The Stage I construction activities associated with the new headworks must be complete before the existing headworks, maintenance shop building, and hypochlorite system may be demolished to allow for the construction of Primary Clarifier 3.
2. The Stage I construction activities associated with the new headworks must be complete before existing Secondary Clarifier 2 and existing Primary Clarifier 3 may be demolished to allow for construction of new Secondary Clarifier 2. The 24 IN SE pipe from Secondary Clarifier 5 must be temporarily rerouted around the construction of Secondary Clarifier 2.
3. The Stage I construction activities associated with the new Gravity Sludge Thickener and solids handling system must be complete before the existing Gravity Sludge Thickener and solids handling system may be demolished to allow for the construction of the aeration basin expansion.
4. Because the bypass piping from the Primary Effluent Sample Box to the influent channel of the aeration basins are inadequate to pass the wet weather season flows, the PE/ML splitter box construction must be complete within a single dry weather season.
5. A minimum two (2) Primary Clarifiers must be on-line and operational at all times.
6. No less than four (4) Secondary Clarifiers must be on-line and operational at all times except as specifically noted elsewhere.
7. No less than four (4) Aeration Basins must be on-line and operational at all times. This may take the form of two existing basins paired with two new basins. The aerations basins must be configured in a manner to allow for the construction of the new PE/ML Splitter box.
8. Provide temporary measures as required to prevent flow from short circuiting through Internal ML Recycle pump when operating aeration trains from zone E to zone A (i.e. reverse flow).
9. The discharge from all RAS pumps must be combined, either with temporary or permanent piping, before modifications to the aeration basins may begin to allow operational flexibility between secondary clarifier operation and RAS discharges. RAS flow meters must be maintained operational. Temporary RAS piping may not block access stairs.
10. Once RAS piping combined into a single pipe, RAS pumping may not be off-line at more than one operating secondary clarifier at a time unless specifically allowed elsewhere. RAS pumping interruptions may not exceed 4 hours maximum and only between midnight and 8am.
11. RAS pump electrical modifications:
    a. May drop to just one RAS pump per clarifier for RAS pump electrical cutover.

b. Design anticipates a single RAS pump servicing each secondary clarifier on constant speed to allow for electrical modifications. Plan MCC layout and provide constant speed motor starters as required. Maximum 21 days.
c. Maintain automatic control of RAS pumps throughout electrical modifications.
d. RAS flow meters must be operational for all operational RAS pumps.

C. Construction Constraints Stage III:
1. New Secondary Clarifier 2, must be on-line and operational before existing Secondary Clarifier 1 may be demolished to allow for construction of new Secondary Clarifier 1.
2. The Secondary Effluent pipe from Secondary Clarifier 5 must be rerouted to the new Secondary Effluent Junction box to allow for the construction of the new Chlorine Contact Basin.
3. Except as noted elsewhere, both sides of the existing Chlorine Contact Basin must remain in service until the new CCB is ready to be placed service. Once the new basins are ready to be placed in service no less than both sides of the existing CCB or one new half and one existing half of the CCBs must be maintained in service at all times.
4. One half of the existing Chlorine Contract Basin may be taken off-line for up to 6 hours between the hours of midnight and 6 am in the dry weather season for short term shutdowns.
5. Temporary pumping from within the existing Chlorine Contract Basin must maintain a minimum water depth of 3 FT within the basins at all times.
6. The scum piping from the Chlorine Contact Basins scum skimmers may be demolished as required to allow for construction of the new Chlorine Contract Basin however the scum skimmers must remain in place until the new basins are complete. Scum skimming will be manual by plant staff.
7. The Flare system may be offline for up to 3 hours to allow the existing flare to be relocated to the new locations. It is understood that the Plant Staff will operate the flare in manual mode as the flare control system is relocated. The control system must be relocated within XX hours.
8. Repave access path on western edge of WPC parking after construction at chlorine contact basin complete.
9. Install public restrooms for park as access permits in Stage 3.
10. Equipment specified in Section 11652 , Section 11653, and Section 11654 shall be provided only at the end of Stage 3 construction.

1.5 STAGE II CONSTRUCTION SEQUENCE

A. Due to the complexity of the process constraints associated with the upgrades to the secondary system the following general sequence has been provided to aid in general planning.

B. This general sequence is intended to show how the various constraints can be complied with while construction activities are undertaken. This general sequence is NOT intended as a step by step procedure in which all constraints are identified and addressed. The Contractor shall develop his own detailed plan for performing the work in accordance with all requirements whether noted or not.

C. The following physical constraint on construction are noted:
1. Two of the four existing ML lines from the existing Aeration Basins to the existing Mixed Liquor Splitter Box pass through the area where the new PE/ML Splitter box will be constructed.
2. The existing channel at the east end of the existing Aeration Basins must be demolished to allow for the construction of the new Aeration Basins.
3. The new ML lines from the new ML Splitter Box to Secondary Clarifiers 1, 2 and 4 pass through the location of the existing ML Splitter Box.
4. The new 18 IN RAS header passes through the location of the existing ML Splitter Box.

STEP	ACTIVITY/DESCRIPTION	NOTES
1.	Request Ops Staff operate existing AB in parallel and shut gates at east end to allow for demo of east end channel.	Relocate wiring for DO probe prior to channel demolition.
2.	Reroute low pressure air piping as required around AB construction.	Connection will require a short shutdown of entire air system. Do not block stair to digester.
3.	Excavate and construct new AB tanks.	
4.	Combine all RAS flows into a single header with flows split evenly between the operating aeration basins. Provide plug valves for shutoff at active basins.	
5.	Install and test diffusers in new aeration basin oxic zones 2C and 2D. Hydrotest tank.	Connection will likely require a short shutdown of entire air system.
6.	Request Ops Staff transfer a portion of the MLSS to AB Train 2 through temporary RAS piping.	
7.	Request Ops Staff open valve on 30 IN PE bypass from PE Splitter Box to existing influent channel and modify existing gate positions to bring basins 2A through 2E into service.	Note that the flow within the basins will be enter at 2E and exit only from the most southern existing ML line from zone 2A.
8.	Allow Ops Staff to operate system for one week with flow split between existing AB 3 and 4 and partially modified AB Train 2.	Required to maintain activated sludge process stability.
9.	Request Ops Staff close 42 IN valve in PE Sampling Box to take existing AB 3 and 4 out of service and route all RAS to AB Train 2.	Not allowed before May 1st (start of dry season)
10.	Pump contents of off-line aeration basins to influent sewer to allow for rescreening and grit removal.	
11.	Make modifications to AB Train 1 and construct the PE/ML Splitter Box Structure.	All flow will be treated by partially modified AB Train 2
12.	Fill AB tanks with clean water and test diffusers in AB Train 1.	Will likely require a short shutdown for process air connections.
13.	Request Ops Staff allow PE and RAS to feed newly modified AB Train 1.	Note that the flow within the basins will enter at 1E and exit only from the most northern existing ML line from zone 1A.
14.	Allow Ops Staff to operate system for one week with flow split between partially modified AB Train 2 and newly modified AB Train 1.	Required for process stability.
15.	Set up bypass pumping from the SC Junction Box to SE chlorination Box.	
16.	Request Ops Staff stop PE and RAS flows to AB Train 2. Continue process aeration in AB Train 2.	
17.	Make temporary connection from existing 24 ML at the south side of AB Train 2 around existing Secondary Clarifier 1, to new Secondary Clarifier 2.	
18.	Request Ops Staff allow PE and RAS to enter AB Train 2. MLSS will pass through the temporary piping to Secondary Clarifier 2.	Bypass pumping from the SC Junction Box will begin.

STEP	ACTIVITY/DESCRIPTION	NOTES
19.	Request Ops Staff isolate Secondary Clarifier 1 to allow for installation of temporary SE connection from Secondary Clarifier 1 to Secondary Clarifier JB. Return SC 1 to service.	Bypass pumping from the SC JB continues.
20.	Request Ops Staff isolate SC 5 to allow for final SE connection to SC Junction Box. Return Secondary Clarifier 5 to service.	Bypass pumping from the SC Junction Box continues.
21.	Request Ops Staff isolate SC 3 and 4 to allow for final SE connections to SE JB and SE pipe near CCB. Return Secondary Clarifier 3 and 4 to service.	Bypass pumping from SE Junction Box may end once all SE piping modifications complete.
22.	Request Ops Staff isolate Secondary Clarifier 5 to allow for final ML piping connections to the new ML Splitter Box.	
23.	Request Ops Staff isolate Secondary Clarifier 4 to allow for final ML connections to new ML Splitter Box.	
24.	Request Ops Staff modify gates within AB Train 1 to reverse flow to final flow direction.	Reversing flow in AB Train will route ML to SC 4 and 5 from the newly constructed ML Splitter Box and stop flow to the existing ML Splitter Box and therefore to Secondary Clarifier 1 and 3.
25.	Dewater and demo existing ML Splitter Box.	
26.	Connect final ML piping to Secondary Clarifier 3 and bring clarifier on-line	
27.	Demo interfering portions of Secondary Clarifier 1 to allow for installation of 24 IN ML to Secondary Clarifier 2.	
28.	Request Ops Staff stop PE and RAS flows to AB Train 2 to allow temporary ML bypass piping to be removed. Connect Secondary Clarifier 2 to new ML Splitter Box.	Plant will be down to 3 Secondary Clarifier for this step.
29.	Pump contents of AB Train 2 to influent sewer to allow rescreening and grit removal.	
30.	Make remaining modifications to AB Train 2 including replacing all remaining existing diffusers.	
31.	Fill AB Train 2 with clean water and test diffusers.	
32.	Request Ops Staff allow PE and RAS flow to AB Train 2 to bring on-line.	Flow will be from zone A to zone E.
33.	Make any remaining minor channel modifications required.	

1.6 OUTAGE PLANS AND REQUESTS

A. Modifications to existing facilities, the construction of new facilities, and the connection of new to existing facilities will require the temporary outage or bypass of existing treatment processes or facilities. In addition to the construction schedule required under Section 01320, the Contractor shall submit a detailed outage plan and time schedule for all construction activities which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, structure, road or other facilities from service. All outage plans shall be approved by the Owner.

B. The outage plans shall be submitted for the Owner's review and acceptance a minimum of three (3) weeks in advance of the time that such outages are required. A System Outage Request form, included at the end of this section, shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of this Section. The outage plans shall describe the Contractor's method for preventing bypassing of other treatment units; the length of time required to complete said operation; any necessary temporary power, controls, instrumentation or alarms required to maintain control, monitoring and alarms for the treatment plant processes; and the manpower, plant, and equipment which the Contractor shall provide in order to ensure proper operation of associated treatment units.

C. The Owner shall be notified in writing at least one week in advance if the schedule for performing any outage has changed, or if revisions to the outage plan are required. The owner has the option to reschedule any outages due to plant operations and flows at no additional cost. Prior to the outage, the Contractor and Owner shall meet to review outage plan, inventory of parts, Contractor's emergency back-up plan, and safety program. Outage request shall be rescheduled at no cost to Owner if Owner determines that the Contractor is unprepared to safely conduct the outage.

D. The Contractor shall provide written confirmation of the shutdown date and time two working days prior to the actual shutdown.

E. The Contractor shall observe the following outage requirements:
   1. Systems or individual equipment items shall be isolated, dewatered, decommissioned, de-energized, or depressurized in accordance with the detailed outage plan and schedule.
   2. Whenever the construction work requires dewatering or bypassing portions of the facilities, the Contractor shall provide the necessary pumping and bypassing facilities to maintain the water flow.
   3. Whenever temporary relocation of existing facilities is required for execution of the work, the Contractor shall provide the necessary labor and temporary piping and wiring as required.
   4. Any temporary facilities and equipment not required after completion of the final work shall be promptly removed.
   5. The Contractor shall not begin an alteration until specific permission has been granted by the Construction Manager in each case. The Construction Manager will coordinate the Contractor's planned procedure with the operation of the system. The making of connections to existing facilities or other operations that interfere with the operation of the existing equipment shall be completed as quickly as possible and with as little delay as possible.
   6. The Construction Manager will be the sole judge of when the Contractor's operations are causing interference with existing water and wastewater facilities, and the Construction Manager's orders and instructions shall be carried out without delay.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

Pinole-Hercules Water Pollution Control Plant Upgrades Project

System Outage Request

File No. _____

Date Prepared	Project Title	Request No.
Requested by:	Contractor	

Anticipated Shutdown	System(s) to be Shutdown
Date _____ Time _____ Duration _____	

Description of Work to be Performed	Work to be Done
Work by Others	☐ Welding/Burning ☐ Electrical ☐ Trenching ☐ Confined ☐ Space Entry ☐ Other

Possible Considerations to be Noted: ☐ Pure Oxygen Present ☐ CL_2 Present

☐ Combustible Gas Present ☐ SO_2 Present ☐ Hazardous Atmosphere

	Name/Phone	
Utilities Maintenance		☐ Work is on Critical Path ☐ Regulatory Agency Notification Required ☐ "Dry Run" Required ☐ Maintenance Approval of Start-up Required
Utilities Maintenance ICE		APPROVED
Utilities Operations		Utilities Engineer Date
Utilities Water Quality		Construction Manager Date

City Comments:

SECTION 01060
SPECIAL CONDITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for:
      a. Preconstruction Conference.
      b. Project signs.
      c. Contractor's Superintendent's Field Office.
      d. Engineer's Field Office.
      e. Drawings and Contract Documents for Contractor use.
      f. Project photographs.
      g. Testing and Special Inspections.
      h. Schedule of Values.
      i. Project meetings.
      j. Special considerations related to adjacent properties and facilities.
      k. Historical and archaeological finds.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Building code:
      a. California Building code (CBC):
         1) 2013 Edition.

1.3 PRECONSTRUCTION CONFERENCE

A. A preconstruction conference shall be held at Pinole City Hall after award of Contract.
   1. Engineer will notify the Contractor as to the date and time of the conference two (2) weeks in advance of the proposed date.
   2. Contractor's Project Manager and Project Superintendent and Contractor's Subcontractor Representatives shall attend.

1.4 PROJECT SIGNS

A. Engineer's Sign:
   1. Furnish and install 4 FT x 8 FT plywood backboard with support legs and bracing.
   2. Securely mount Engineer-furnished sign to backboard.

B. SRF Sign:
   1. Furnish and install 4 FT x 8 FT plywood backboard with support legs and bracing for each sign.
   2. Furnish and install commercially produced regulatory agency sign(s) conforming to Exhibit(s) “A” attached to this Specification Section.
      a. Color sample of Exhibit(s) will be provided at Pre-Construction Conference.
      b. Sign(s) may be professionally painted on backboard on site.

C. Contractor's standard company sign.
   1. Restricted to: 4 FT x 8 FT.

D. Coordinate sign locations with Owner.

E. Signs not listed in this Specification Section permitted only upon approval of Owner.

1.5 CONTRACTOR'S SUPERINTENDENT'S FIELD OFFICE

A. Establish at site of Project.

B. Equipment: Telephone, telecopy, mailing address, and sanitary facilities.

C. Assure attendance at this office during the normal working day.

D. At this office, maintain complete field file of Shop Drawings, posted Contract Drawings and Specifications, and other files of field operations including provisions for maintaining "As Recorded Drawings."

E. Remove field office from site upon acceptance of the entire work by the Owner.

1.6 DRAWINGS AND CONTRACT DOCUMENTS FOR CONTRACTOR USE

A. Refer to General Conditions.

B. Contractor shall pick up all "no-charge" documents within 10 days from date of Notice to Proceed.

C. Additional documents after "no-charge" documents will be furnished to Contractor at cost.

1.7 PROJECT PHOTOGRAPHS

A. At least once each month during construction of the Work, provide progress pictures as directed by Engineer.
   1. Pictures shall be digital and provided on disk with thumbnail index.
   2. Provide number of photographs as follows:
      a. Twenty-four (24) ground level color photos per month.
      b. Three (3) color aerial photos taken at each of the following:
         1) At 0 percent complete.
         2) At **three (3)** month intervals after initial set.
         3) At 100 percent complete.
   3. Contractor shall schedule and coordinate photographer with Engineer's Field Representative.
   4. Photographically impose a site plan key map on each photograph in the upper right hand corner and show by arrow the subject and the direction from which the photograph was taken.
      a. Date all photographs.

1.8 TESTING AND SPECIAL INSPECTIONS

A. Definitions:
   1. Service Provider: Agency hired by the Owner to perform testing and Special Inspections which are defined in the Contract Documents to be provided by the Owner.
   2. Contractor's Testing Agency: Agency hired by the Contractor to perform prequalification and field-testing which are defined in the Contract Documents to be provided by the Contractor.
   3. Special Inspections: Inspections required by the Building Code to verify that materials are properly installed.

B. General:
   1. Testing and Special Inspection Services (Services) are required for portions of this Project to verify Contract Document compliance of materials, installation, fabrication, erection or placement of components and mechanical connections.
      a. The following paragraphs define the division of responsibilities between the Owner and Contractor as related to these Services.
      b. Because the nature of these Services is broad, these Services may be provided by more than one Service Provider for the Owner or more than one Testing Agency for the Contractor.
         1) The terminology "Owner's Testing Agency" used throughout the Contract Documents is synonymous and refers to the Owner's Service Provider(s).
      c. The Service Provider(s) responsible for Owner-provided Services shall be selected after Contract award.

C. Product Production Testing:
   1. This testing category addresses all factory and fabrication plant testing required to certify that materials meet Contract Document requirements.
   2. Examples of this category of testing include steel mill tests, structural steel and weld testing, establishment of mix designs, etc.
   3. Documentation requirements may include definition of factory test procedures, testing reports, certificates or other forms as applicable.
   4. Costs associated with all phases of securing satisfactory product production testing information required by the Contract Documents are the full responsibility of the Contractor.
   5. Owner's Testing and Inspection:
      a. Owner may, at its discretion, have its service provider travel to fabricator's production facilities to perform Special Inspections as required under this Specification.

D. Field Testing:
   1. Strength/condition of materials testing:
      a. This testing category addresses all testing required to verify strength of materials or conditions of subgrade during construction.
      b. Examples of this subcategory of testing include concrete testing, structural steel and weld testing.
      c. Owner will hire Service Provider for this testing.
      d. Costs associated with first time tests will be paid by the Owner. Costs of corrective action and costs of retesting are the sole responsibility of the Contractor.

E. Special Inspections:
   1. Owner will hire a Service Provider for Special Inspections if Special Inspections are required by local codes.
      a. Examples include inspection of reinforcing prior to placement of concrete, inspection of field welding, etc.
      b. Contractor shall notify Owner a minimum of 24 HRS in advance of any required Special Inspections. Work to be inspected should be complete at time of inspector's arrival on-site.
      c. Payment for Special Inspection services will be in accordance with the following:
         1) After Contractor notification, Service Provider arrives at site and performs inspection within the timeframe defined below. If inspection determines work is satisfactory, Owner pays all costs associated with this inspection.
         2) After Contractor notification, Service Provider arrives at site and performs inspection within the timeframe defined below. If inspection determines work is deficient, Contractor corrects deficiencies within timeframe defined below. Work is re-inspected and, if work is satisfactory, Owner pays all costs associated with this inspection.
         3) After Contractor notification, Service Provider arrives at site and work is not ready for inspection. Service Provider will remain on-site for a maximum of 1 HR awaiting the completion of the work. If work is not ready for inspection at the end of this period, Service Provider will be dismissed until Contractor requests re-inspection. All costs associated with this inspection trip will be charged to the Contractor.
         4) After Contractor notification, Service Provider arrives at site and performs inspection within the timeframe defined above. Inspection reveals work is deficient. Contractor attempts to correct deficiencies within 1 HR timeframe and calls for re-inspection. Work is re-inspected and found to still be deficient. Service Provider will be dismissed. All costs associated with this inspection trip will be charged to the Contractor.
   2. Contractor shall provide timely access to construction to allow Special Inspections and shall provide a schedule of work every two weeks to coordinate with the Owner such that Service Provider may be made available as required.

F. Service Provider is not authorized to revoke, alter, relax, enlarge or release any requirements of the Contract Documents.

G. Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiency in the work.

H. Owner retains the responsibility for ultimate rejection or approval of any portion of the work.

I. Payment for Soil, Concrete and Other Testing:
   1. Soils and concrete testing:
      a. The Owner will pay for "Passing" soils and "Passing" concrete tests on the Project.
      b. Costs of corrective action, costs of "Failing" soils and concrete tests, and cost of testing associated with establishment of mix design are the sole responsibility of the Contractor.
   2. Other testing: Required testing, testing procedures, reports, certificates, and costs associated with all phases of securing required satisfactory test information which may be required by individual Specification Sections or Drawings are the full responsibility of the Contractor.

1.9 SCHEDULE OF VALUES

A. Where a Contract is awarded on a lump sum basis, the Contractor shall file with the Engineer a balanced price segregation of the lump sum bid into items similar to the various subdivisions of the general and detailed specifications, the sum of which shall equal the lump sum bid.
   1. The cost of various materials shall be furnished upon request of the Engineer, and such data will then be used as a basis for making progress estimates.
   2. Breakdown costs, itemized by Specification Section and trade, and distribute cost to individual applicable units and structures.
   3. Where structures, units, equipment or other components are identified by a specific series or, identification number, utilize said designation throughout cost breakdown.
   4. Provide detailed breakdown for individual yard piping or conduit runs and identify approximate quantities involved to satisfaction of the Engineer.
   5. Provide separate breakdown for change order items requested.
   6. Provide an additional breakdown sheet, equivalent to the Stored Material Summary of EJCDC document C620, showing the tabulation format for stored materials.
   7. Submit this sheet each month with Contractor's pay request breakdown.
   8. The detail and format of cost breakdown and stored materials tabulation sheet shall be fully approved by Engineer.

B. A reasonable allocation of the Contract Price to the component parts of the Work will be approved if component parts of the Work have values assigned to them that are well-balanced with respect to relative values for similar work established by published estimating guides.
   1. Unless otherwise agreed to at the Preconstruction Conference, Means Estimator Guide or other similar nationally recognized estimating guide shall be used for resolving differences between Engineer's and Contractor's opinions of allocation of values.
   2. Consent of Surety: If Contractor and Engineer cannot mutually agree on a Schedule of Values, Engineer will approve a Schedule of Values approved by the Surety providing the Performance Bond.

C. Contractor's costs shall not govern the allocation of values when application of Contractor's costs to a component part of the Work results in any other component part or combination of component parts being under-valued in relation to conventional estimating guides.

D. Schedule of Values shall be agreed upon prior to first Application for Payment.

1.10 PROJECT MEETINGS

A. Construction Meetings:
   1. The Engineer will conduct construction meetings involving:
      a. Contractor's project manager.
      b. Contractor's project superintendent.

c. Owner's designated representative(s).
d. Engineer's designated representative(s).
e. Contractor's subcontractors as appropriate to the Work in progress.
f. Owner's Construction Quality Control Consultant.

2. Meetings will be conducted every two (2) weeks.
3. The Engineer will take meeting minutes and submit copies of meeting minutes to participants and designated recipients identified at the Preconstruction Conference.
   a. Corrections, additions or deletions to the minutes shall be noted and addressed at the following meeting.
4. The Engineer will schedule meetings for most convenient time frame.
5. The Engineer will have available at each meeting full chronological files of all previous meeting minutes.
6. The Contractor shall have available at each meeting up-to-date record drawings.

B. Pre-Installation Conferences:
   1. Coordinate and schedule with Resident Project Representative and Engineer for each material, product or system specified.
      a. Conferences to be held prior to initiating installation, but not more than two (2) weeks before scheduled initiation of installation.
      b. Conferences may be combined if installation schedule of multiple components occurs within the same two (2) week interval.
      c. Review manufacturers recommendations and Contract Documents Specification Sections.
   2. Contractor's Superintendent and individual who will actually act as foreman of the installation crew (installer), if other than the Superintendent, shall attend.

1.11 SPECIAL CONSIDERATIONS RELATED TO ADJACENT PROPERTIES AND FACILITIES

A. Contractor shall be responsible for negotiations of any waivers or alternate arrangements required to enable transportation of materials to the site.

B. Maintain conditions of access road to site such that access is not hindered as the result of construction related deterioration.
   1. Provide daily sweeping of hard-surface roadways to remove soils tracked onto roadway.

1.12 HISTORICAL AND ARCHAEOLOGICAL

A. If during the course of construction, evidence of deposits of historical or archeological interest is found, the Contractor shall cease operations affecting the find and shall notify Owner.
   1. No further disturbance of the deposits shall ensue until the Contractor has been notified by Owner that Contractor may proceed.
   2. Owner will issue a notice to proceed after appropriate authorities have surveyed the find and made a determination to Owner.
   3. Compensation to the Contractor, if any, for lost time or changes in construction resulting from the find, shall be determined in accordance with changed or extra work provisions of the Contract Documents.
   4. The site has been previously investigated and has no known history of historical or archaeological finds.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

SECTION 01062
MAJOR EQUIPMENT SUPPLIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. A listing of the equipment for the Project, which is considered to be major equipment.
   2. A listing of the approved suppliers of said major equipment.
   3. Certain instructions concerning the bidding of major equipment.

1.2 DEFINITIONS

A. Manufacturers or suppliers, as used in the context of "approved manufacturers or suppliers of major equipment," shall mean the manufacturers or suppliers listed in the ACCEPTABLE MANUFACTURERS OF MAJOR EQUIPMENT Article of this Specification Section.

1.3 INSTRUCTIONS FOR BIDDING MAJOR EQUIPMENT

A. Furnish, for base bid, equipment by any of the suppliers listed in the ACCEPTABLE MANUFACTURERS OF MAJOR EQUIPMENT Article of this Specification Section, or as added to the ACCEPTABLE MANUFACTURERS OF MAJOR EQUIPMENT Article of this Specification Section by addendum.

B. Name only one (1) of said suppliers in the schedule of major equipment suppliers found in the Proposal.

C. Proposal shall be considered irregular and subject to rejection if the Bidder:
   1. Fails to list an approved supplier for each item.
   2. Lists more than one approved supplier for each item.

D. If the Bidder fails to list an approved supplier, the Owner has the sole right to select one (1) of the suppliers from the list of manufacturers in the ACCEPTABLE MANUFACTURERS OF MAJOR EQUIPMENT Article of this Specification Section.

E. If the Bidder lists more than one (1) approved supplier, the Owner has the sole right to select one (1) of the suppliers so listed.

F. Requests for prequalification of equipment to be listed in the ACCEPTABLE MANUFACTURERS OF MAJOR EQUIPMENT Article of this Specification Section must comply specifically with applicable provisions of the Contract Documents.

1.4 ACCEPTABLE MANUFACTURERS OF MAJOR EQUIPMENT

A. Major Equipment and Acceptable Manufacturers:

END OF SECTION

SECTION 01200
REQUESTS FOR INFORMATION (RFI)

PART 1 - GENERAL

1.1 SUMMARY

A. This Specification Section specifies administrative and procedural requirements for handling and processing Requests for Information (RFI).

B. RFI is intended for requesting clarifications and interpretations of Contract Documents due to apparent inconsistencies, errors or omissions in Contract Documents, and due to unanticipated existing conditions.

C. RFI is not intended for general communication, requesting substitutions, Contractor's proposed changes, resolution of nonconforming work, or coordination between contractors or for general questions not related to Contract Documents.

D. RFI process is intended to be a cooperative effort between Engineer and Contractor to expedite responses to RFIs and maintain progress of Work without utilizing other lengthy procedures.

E. Any other proposed method of processing RFIs other than indicated within this Specification Section shall be evaluated by Engineer for potential impact on Engineer's services.
   1. If Engineer agrees to utilize another proposed method, Engineer will be reimbursed for any special training, usage fees, extra time required to implement, maintain, utilize and administer such a system.

1.2 RFI SUBMITTAL PROCEDURE

A. All RFIs shall be submitted on the form attached to this Specification Section, or on mutually agreeable forms to be provided at the preconstruction meeting, and shall include all backup information.
   1. Backup information shall include, but not be limited to Contractor verified field measurements, quantities, dimensions, installation requirements, materials, catalog number, and any other information that will assist the Owner in reviewing the RFI.

B. Within ten (10) working days of receipt of RFI, Engineer will either return a response to the RFI or notify Contractor when a response will be issued.

1.3 COMMENCEMENT OF RFI-RELATED WORK

A. No portion of the work requiring instruction from the Engineer shall begin until RFI has been reviewed by the Engineer and returned to Contractor with instruction or with notation indicating Engineer response is not necessary.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 REQUESTS FOR INFORMATION

A. Review of Contract Documents and Field Conditions:
   1. Before starting each portion of Work, Contractor shall carefully study and compare various Drawings, Specifications and other Contract Documents, coordination drawings, Shop Drawings, prior correspondence or documentation relative to that portion of Work, as well as information furnished by Owner.
   2. Contractor and Subcontractors shall evaluate and take field measurements of conditions related to that portion of Work and shall observe any conditions at site affecting it.

3. These obligations are for purpose of facilitating coordination and construction by Contractor.
4. Any errors, inconsistencies or omissions discovered in Contract Documents shall be reported promptly to Engineer as a properly prepared and timely RFI.

B. Contractor's and Subcontractor's Responsibilities:
1. When interpretation, clarification or explanation of portion of Construction Documents is needed by Contractor, Subcontractor, Vendor or Supplier, the request shall be processed through Contractor.
   a. Review request for completeness, quality, proper referencing to Drawing or Specification Section and reason submitted.
   b. If request is not acceptable, it shall be returned to submitter with comments regarding reason for being returned.
   c. Make every attempt to validate, resolve or respond to RFI by thoroughly researching and reviewing Contract Documents and field conditions.
   d. Respond to RFI accordingly if review of RFI discloses a response or is related to coordination of construction or other issue not related to Contract Documents.
   e. If unable to respond to request, it shall be restated in clear, concise, correct, complete and easily understood manner, and rewritten if necessary, additional information included if necessary, and only then submitted to Engineer for response.
2. Follow these procedures in developing an RFI:
   a. List specific Contract Documents researched when seeking information being requested.
   b. Reference all applicable Contract Drawings by sheet number, section, detail, room number, door number, etc., Specifications by section and paragraph number, and reference any other relevant documents.
   c. The field titled "Regarding" on attached RFI form must be clear for future reference in reports or correspondence.
   d. Clearly state request and provide Contract Document references and any additional information needed so request can be fully understood, including sketches, photos or other reference material.
   e. Fully assess issues, suggest any reasonable solutions and include various factors, including potential costs, schedule impacts, if any, and recommendations which will aid in determining a solution or response.
      1) If a reasonable solution can not be suggested, a statement to that effect should be so stated.
   f. Indicate reason request is being submitted.
   g. Any critical RFI's requiring a rapid response shall clearly indicate such with an explanation as to why RFI is critical.
   h. Priority for responses shall be indicated when multiple RFI's are submitted within short period of time.
3. Copies of responses to RFI's shall be distributed to all parties affected.
4. A response to RFI shall not be considered a notice to proceed with a change that may revise the Contract Sum or Contract Time, unless authorized by Owner in writing.
5. If response to RFI is determined incomplete, it shall be resubmitted with reason response is unacceptable and any necessary additional information within five (5) days of time of receipt of response to RFI.

C. RFI Submittal Numbering:
1. RFI's shall be assigned unique numbers in sequential order (1, 2, 3, 4, etc.).
2. A resubmitted RFI or a previously answered RFI requiring revising or further clarification shall be submitted using original RFI number proceeded by ".1" to indicate revision one of RFI (i.e.: RFI No. 34.1 for revision 1 to RFI No. 34).
3. Engineer may return RFI without response for following reasons:
   a. Request is unclear or incomplete.
   b. Detailed information not provided.

c. Is related to construction means, methods or techniques.
d. Is related to health or safety measures.
e. Is due to Contractor’s lack of adequate coordination.
f. Is for coordination between Subcontractors.
g. Is considered a "Substitution Request."
h. Is considered a "Contractor Proposed Change."
i. Is due to non-conformance.
j. Response is required by another party.

END OF SECTION

REQUEST FOR INFORMATION FORM

Contractor's RFI No. _____ Engineer's RFI No. _____

Contract: _____

Contractor: _____

Owner: _____ Owner's Contract No._____

Engineer **HDR Engineering, Inc.** Engineer's Contract No._____

THIS REQUEST BY:_____ cc to:_____
(Name of the Contractor's Representative)

REFERENCE: DIVISION _____ SECTION _____ PLAN SHEET NO. _____

_____

_____

_____

_____

_____

ATTACHMENTS _____

INTERPRETATION BY: _____Date: _____, 20____
(Name of the Engineer's Representative)

_____

_____

_____

_____

_____

ATTACHMENTS_____

The General Conditions specifies that once the Engineer provides a response to a Contractor's RFI, that determination shall be final and binding on the Contractor unless the Contractor delivers to the Owner written notice of a change in the work within a certain period of time of receipt of that determination. See the GCs for further clarification.
cc to: _____
_____

SECTION 01320
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Specific requirements for the preparation, submittal, updating, and status reporting of the construction Progress Schedule.

B. Review of the CPM Schedule.
   a. In so far as the Contractor is solely responsible for its means and methods and the CPM schedule represents in part its means and methods, the review of the CPM schedules (preliminary, baseline, updates, revisions, etc.) is for compliance with the requirements as defined in the contract documents.
   b. The review of the CPM schedule is not intended to be complete or exhaustive or check every activity and its relation to the work.
   c. The Construction Manager (CM) will provide comments on the CPM schedule compliance with those contract requirements and anomalies that might appear to the CM.
   d. If the Contractor fails to include contract requirements (e.g. specified cure times, commissioning periods) in the CPM schedule, or the CM fails to notify the Contractor of anomalies the Contractor is not relieved of the contract requirements.
   e. Acceptance of the CPM schedule does not imply that the Owner has approved or accepted the Contractor's means and methods or sequence for performing the work to construct the project.
   f. If the Contractor has questions or concerns about comments, the Contractor and CM shall meet to resolve those issues prior to issuance of future updates or revisions.

1.2 QUALITY ASSURANCE

A. The person preparing, updating and revising the construction Progress Schedule shall be experienced in the preparation of schedules of similar complexity.

1.3 DEFINITIONS

A. The following definitions shall apply to this Specification Section:
   1. EXECUTION OF THE CONTRACT: The date the contract is signed by the last party, either the Owner or the Contractor.
   2. WORKING DAYS: Monday through Friday except holidays as directed by the Owner.
   3. PRELIMINARY SCHEDULE: A schedule showing detailed activity for the first 90 days of the Project, and a general work plan for construction activity from the 91st day until the Contractual Completion Date.
   4. BASELINE SCHEDULE: The initial detailed Progress Schedule prepared by the Contractor defining its plan for constructing the Project in accordance with the Contract Documents.
   5. SCHEDULE UPDATE: The initially accepted Baseline Schedule, or subsequently approved Revised Baseline Schedules, updated each month to reflect actual start and finish dates of each schedule activity and the remaining duration of activities that began during the period.
   6. CURRENT SCHEDULE: The current schedule is either the Baseline Schedule or Revised Baseline Schedule including and incorporating Schedule Updates.
   7. REVISED BASELINE SCHEDULE: The initially accepted Baseline Schedule revised to reflect approved contract change orders and modifications.
   8. RECOVERY SCHEDULE:
      a. A schedule indicating the Contractor's plan for recovering lost time.

b. A recovery schedule will be requested when the Contractor is forecasting at least 10 working days or more delays in meeting a contract milestone or the contract completion date.

9. SHORT INTERVAL SCHEDULE:
   a. Schedule prepared by the Contractor reflecting the work planned for the coming weeks.
   b. This is also known as a Look-Ahead Schedule.
10. RESOURCES: Manpower, materials, permanent equipment, and construction equipment needed to construct the work.

1.4 SUBMITTALS

A. Project Schedule Preparation
   1. Within five (5) days from Execution of the Contract, Contractor shall submit the name of the person responsible for the preparation, maintenance, updating and revision of all schedules.
   2. Qualifications necessary:
      a. Produced, updated, and maintained for at least five (5) years complex construction schedules for projects of similar type, size and complexity.
      b. Proficient in the use of the scheduling program selected for this project.
      c. If the Contractor changes the person responsible for developing and maintaining the schedule, the Contractor will provide documentation verifying the new person meets the minimum qualifications.

B. Preliminary Schedule:
   1. Submittal and review:
      a. Submit within 10 days after Execution of the Contract or the effective date of the contract, whichever is earlier.
      b. The CM will review and provide comments to the Contractor within ten (10) working days after receipt of the schedule.
      c. The Contractor will review and modify the preliminary schedule and return the schedule within five (5) working days. If there are concerns about the comments provided, the CM and Contractor will meet to review and resolve those concerns.
   2. Submittal package:
      a. Provide a detailed plan for the first ninety (90) days of the project and summary activities of the work to achieve the project milestones.
      b. CPM time-scaled network diagram:
         1) A printed logic diagram and PDF that include the following information:
            a) Unique activity number/identifier; numeric, alpha or combination of numeric/alpha.
            b) Activity description.
            c) Activity duration.
            d) Early start and early finish for each activity.
            e) Late start and late finish for each activity.
            f) Total float (TF) for each activity.
            g) Predecessor activities.
            h) Successor activities.
            i) Bar showing the early start and completion dates of each activity.
         2) The activities will be sorted by area, trades, and subcontractors as agreed on with the CM.
         3) Print the CPM time-scaled network diagram on minimum sheet size of 11 IN x 17 IN.

C. Baseline Schedule and Narrative Report:
   1. Submittal and review:
      a. Submit within 30 days after Execution of the Contract or the effective date of the contract, whichever is earlier.

b. The CM shall review the baseline schedule and provide comments to the Contractor within twenty (20) working days after receipt of the schedule.
c. After receiving comments, the Contractor and CM shall meet to review the comments within five (5) working days.
d. After the meeting, the Contractor will modify the schedule as agreed and resubmit the baseline schedule within 5 working days.
e. After the CM confirms that the Contractor has made the changes as agreed, the schedule will become the baseline schedule.

2. Submittal package:
   a. CPM time-scaled network diagram:
      1) A printed logic diagram and PDF that include the following information:
         a) Unique activity number/identifier; numeric, alpha or combination of numeric/alpha.
         b) Activity description.
         c) Activity duration.
         d) Early start and early finish for each activity.
         e) Late start and late finish for each activity.
         f) Total float (TF) for each activity.
         g) Predecessor activities.
         h) Successor activities.
         i) Cost/budget to complete the work in the activity.
         j) Resources needed to complete the activity.
         k) Bar showing the early start and completion dates of each activity.
      2) The activities will be sorted by area, trades, and subcontractors as agreed on with the CM.
      3) Print the CPM time-scaled network diagram on minimum sheet size of 11 IN x 17 IN.
      4) Provide electronic data in accordance with the Early Completion paragraph in the GENERAL REQUIREMENTS Article.
   b. Narrative report:
      1) The Contractor shall provide a Narrative Report along with the CPM time-scaled network diagram that will include the following information:
         a) Executive Summary explaining how the Contractor plans to execute its plan to construct the project.
         b) Assumptions used to develop the schedule.
         c) Constraints included in the schedule as defined by the Contract Documents.
         d) The critical path and near critical path activities with an explanation of why those activities are included on those paths.
         e) Number of planned working days per week including shifts per day.
         f) Manpower plan including craft on site per day.
         g) Production rates assumptions.
         h) Major equipment planned for the project and durations for their use.
         i) Resource constraints.
         j) Identification of unusual conditions or restrictions regarding labor, equipment or material.
         k) Calendar(s) used in the contract and how the multiple calendars are used.
         l) Holidays observed during construction.

D. Schedule Updates including:
   1. Submittal and Review:
      a. The Contractor shall provide a Schedule Update on the 4th of each month after the Baseline Schedule is completed.
      b. The CM shall provide comments to the Contractor on the Schedule Update.
      c. The Contractor shall incorporate the all comments into the next Schedule Update.
   2. CPM time-scaled network diagram as described for the Baseline Schedule:
      a. Do not change the description of an activity number.

1) Any activity added to the schedule shall have a new unique activity number and description.
2) If activities are deleted, the deleted activity number(s) will not be used again.

3. Narrative Schedule Report identifying the following:
   a. Provide a narrative report with each Schedule Update detailing the work completed during the month, any changes to the schedule logic, any changes to activity durations, any changes to the critical path, and any changes to it's assumptions for constructing the Work, including assumed constraints included in the schedule as defined by the Contract Documents, permits, or the Contractor.
   b. Indicate the reasons the Contractor made the changes to logic, durations, and the critical path.

E. Revised Baseline Schedule:
1. Submittal and Review:
   a. Provide a Revised Baseline Schedule to reflect approved Change Orders as requested by the CM.
      1) Submit with ten (10) working days
   b. Activities will be added or the durations modified to reflect the work approved in change orders.
   c. The CM will review and provide comments to the Contractor on the Revised Baseline Schedule within five (5) working days.
   d. Incorporate the CM comments into the Revised Baseline Schedule.
   e. After acceptance by the CM}, the Revised Baseline Schedule, use for future Schedule Updates.
2. CPM time-scaled network diagram as described for the Baseline Schedule:
   a. Do not change the description of an activity number.
      1) Any activity added to the schedule shall have a new activity number and description.
      2) If activities are deleted, the deleted activity number(s) will not be used again.
3. Provide a narrative with an explanation of the changes in logic, duration of activities.

F. Recovery Schedule:
1. When the activities on the critical path or the completion milestones appear to be fifteen (15) working days beyond the contract time, the CM may request and the Contractor shall provide a Recovery Schedule demonstrating how the Contractor will recover the lost time so that the Work will be completed within the Contract Time.
2. Provide the Recovery schedule within ten (10) working days after requested by the CM.
3. Activities will be added or the durations modified to reflect the changes to the work.
4. The CM will review and provide comments to the Contractor on the Recovery Schedule within five (5) working days.
5. Incorporate the CM comments into the Recovery Schedule.
6. After acceptance by the CM, the Recovery Schedule use for future Schedule Updates.
7. CPM time-scaled network diagram as described for the Baseline Schedule:
   a. Do not change the description of an activity number.
      1) Any activity added to the schedule shall have a new activity number and description.
      2) If activities are deleted, the deleted activity number(s) will not be used again.
8. Provide a narrative with an explanation of the changes in logic and/or activity durations.

G. Short Interval Schedule:
1. Provide a four-week schedule each week during the Contract Time. This schedule can be reviewed at each progress meeting.
   a. Provide an accurate representation of the work performed the previous week and work planned for the current week and subsequent three (3) weeks.
2. Provide in a tabular format with bars or other graphic representing work duration.
   a. Reference activity ID numbers on the Baseline, Revised Baseline, or Updated Schedule, which ever is being currently used.

b. Note by color, highlight or underscore all activities on the critical path.

3. Identify inspection hold points including special inspections needed before the Contractor can move forward with the work.
4. Identify the day materials provided by the Owner or others needed on site.
5. Identify utility tie-ins and traffic changes including road and/or lane closures.

1.5 GENERAL REQUIREMENTS

A. Prepare and submit construction progress schedules as specified herein.

1. Develop and maintain Baseline, Updates and Recovery schedules using Primavera P3, P6, SureTrack, or Constructor by Primavera Systems, unless approved by the CM.
   a. Scheduling Software Features:
      1) The following specific features are not allowed to be applied in the Baseline and Record Schedules:
         a) Resource leveling.
         b) Activity or event constraints, other than those specified by the Contract Documents.
      2) Durations shall have positive values.
   b. Default progress data:
      1) Start and finish dates shall not be automatically updated.
      2) Update with actual start and finish dates documented from field reports.
      3) Update work activities by actual Work progression, not cash flow driven.
      4) Updating of activity percent complete and remaining duration shall be independent functions, not one parameter calculated from the other.
      5) Out-of-sequence progress shall be accounted for through retained logic, not a default option of progress override.
2. Include the following information:
   a. Construction start dates (Award date, Notice(s) to Proceed date).
   b. Procurement activities.
   c. Preparation of key submittals for materials and equipment.
   d. Engineers review and approval of key submittals.
   e. Material and equipment fabrication lead times.
   f. Material and equipment deliveries for Contractor, Owner and third parties.
   g. Shutdowns.
   h. Utility tie-ins.
   i. Plant tie-ins.
   j. Traffic changes and closers.
   k. Inspections and hold points.
   l. Start up of equipment.
   m. Testing of equipment and systems.
   n. Commissioning.
   o. Contract milestones:
      1) Intermediate milestones.
      2) Substantial Completion Date.
      3) Physical Completion Date.
   p. Costs for each activity.
   q. Resources: Number of craft per day (not crews per day) for each activity and construction equipment planned for each activity.
3. Do not utilize any float suppression techniques or other software features that effect the pure mathematical model calculating the critical path.
4. The following CPM schedule outputs will be rejected without further review:
   a. Schedules indicating the start of the critical path at a date point or activity beyond the date of Notice to Proceed, or schedules indicating a discontinuous critical path from Notice to Proceed to Contract completion.
   b. Schedules defining critical activities as those on a path or paths having some minimum value of float.

c. Schedules with multiple critical paths.
d. Schedules indicating a completion date beyond the contractual completion date.

B. The number of activities shall be sufficient to assure adequate planning of the project, to permit monitoring and evaluation of progress, and to do an analysis of time impacts.
1. Work activities shall not exceed durations of 10 days or 2 weeks.
a. Procurement and fabrication activity durations may exceed 10 days or 2 weeks.
2. Schedule activities shall include the following:
a. A clear and legible description.
b. At least one (1) predecessor and one (1) successor activity, except for project start and finish milestones.

C. Early Completion Schedule:
1. Contractor may show early completion time on any schedule provided that the requirements of the contract are met.
2. Contractor may increase early completion time by improving production, reallocating resources to be more efficient, performing sequential activities concurrently or by completing activities earlier than planned.
3. Any time between the Contractor's early completion and the Contract Time will be considered float.

D. Plan working durations to incorporate the effects of normal weather impacts.

E. Float:
1. The project owns the float, therefore neither the Owner nor the Contractor has exclusive use of the float; the float can used by either party.
2. Once float is used, liability for delay of the project completion date rests with the party actually causing delay to the project completion date.

1.6 START-UP, DEMONSTRATION, TRAINING, AND FINAL COMPLETION

A. The Baseline Schedule must include broad-based activities for start-up, operator training, and final completion.
1. The Baseline Schedule may not necessarily contain sufficient detail on all activities listed in Specification Section 01650 for start-up and demonstration.
2. At least 90 days prior to any activities, submit a detailed schedule in conformance with the requirements of Specification Section 01650:
a. Identify task for the substantial completion notification.
b. Pre-demonstration period:
1) Identify equipment start-up for all major equipment.
2) Identify all operator trainings required by individual Specification Sections.
3) Complete submission of all required submittals.
c. Demonstration period: Identify for each project classified system.

1.7 CONSTRUCTION SCHEDULING MEETINGS

A. The Contractor and CM will participate in a pre-construction scheduling meeting.
1. The meeting shall occur within ten (10) working days after Execution of the Contract.
2. The Contractor's Project Manager, Superintendent(s), Scheduler and other key personnel shall attend the pre-construction scheduling meeting.
3. The pre-construction scheduling meeting will review the requirements of this Specification Section and other specified scheduling and sequencing requirements defined in the Contract Documents.

B. The Contractor shall meet with the CM monthly to review the CPM schedule.
1. The meeting agenda will include review of changes made since the previous schedule submittal and CM comments.

1.8 TIME IMPACT ANALYSIS (TIA)

A. The Contractor shall provide a TIA to support all requests for increases to the Contract Time.

B. The Contractor shall use the Current Schedule to develop the TIA.
   1. The TIA must be attached to any change order proposal prior to approval of any change to time or cost when requesting additional time.
   2. Contractor shall submit a written narrative report to the CM with each request for adjustment to the Contract Time, or when Contractor or CM consider that an approved or anticipated change may impact the critical path or progress of the work.
      a. Include a description of delaying factors and their impact with an explanation of corrective actions taken or proposed.
      b. The TIA shall illustrate the impacts of each change or delay on the current scheduled completion date or internal milestone, as appropriate.
      c. The analysis shall use the schedule that has a data date closest to and prior to the event or change.
      d. The analysis shall identify the activities on the critical path prior to the event or change, the activities added or extended as a result of the event or change, and the impact of those changes on the critical path activities.
      e. The analysis shall identify the impacts that the Contractor attributed to the change or Owner, those impacts that are the result of the Contractor's actions and those impacts that are considered concurrent.
      f. If the impact schedule shows that incorporating the event modifies the critical path and scheduled completion date of the accepted CPM Schedule, the difference between scheduled completion dates of the two (2) schedules shall be equal to the adjustment of Contract Time.

C. Contractor shall submit a TIA within fifteen (15) working days of receiving a written request for a TIA from the CM or after the event.
   1. Contractor shall allow the CM thirty (30) days after receipt to approve or reject the submitted TIA.
   2. All approved TIA schedule changes shall be shown on the next Schedule Update.

D. Rejections of a TIA:
   1. If a TIA submitted by the Contractor is rejected by the CM, the Contractor shall meet with the CM to discuss and resolve issues related to the TIA.
   2. If agreement is not reached, the Contractor will be allowed ten (10) working days from the meeting with the CM to give notice.
   3. The CM will withhold a portion of the progress payment if a TIA is requested by CM and not submitted by Contractor within fifteen (15) working days.
   4. The payment will resume on the next estimate after the requested TIA is submitted and accepted by the CM.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

SECTION 01340
SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mechanics and administration of the submittal process for:
      a. Shop Drawings.
      b. Samples.
      c. Informational submittals.
   2. General content requirements for Shop Drawings.

1.2 DEFINITIONS

A. Shop Drawings:
   1. See General Conditions.
   2. Product data and samples are Shop Drawing information.

B. Informational Submittals:
   1. Submittals other than Shop Drawings and samples required by the Contract Documents that do not require review and/or approval by the Engineer.
   2. Representative types of informational submittal items include but are not limited to:
      a. HVAC test and balance reports.
      b. Installed equipment and systems performance test reports.
      c. Manufacturer's installation certification letters.
      d. Instrumentation and control commissioning reports.
      e. Warranties.
      f. Service agreements.
      g. Construction photographs.
      h. Survey data.
      i. Health and safety plans.
      j. Work plans.
      k. Delegated designs per performance specification requirements
   3. For-Information-Only submittals upon which the Engineer is not expected to conduct review or take responsive action may be so identified in the Contract Documents.

1.3 SUBMITTAL SCHEDULE

A. Schedule of Shop Drawings:
   1. Submitted and approved within 10 days of receipt of Notice to Proceed.
   2. Account for multiple transmittals under any Specification Section where partial submittals will be transmitted, e.g. rebar shop drawings.
   3. Submittal and approval prior to 50 percent completion.

B. Informational Submittals:
   1. Reports and installation certifications submitted within five (5) working days of conducting testing or examination.

C. The submittal schedule shall include the following columns as a minimum:

Submittal Section	Submittal Description	Planned Submittal Date	Submittal Need Date	Actual Submittal Date	Actual Return Date	Disposition

1.4 PREPARATION OF SUBMITTALS

A. Legibility:
   1. All submittals and all pages of all copies of a submittal shall be completely legible.
   2. Submittals which, in the Engineer’s sole opinion, are illegible will be returned without review.

B. Shop Drawings, Product Data, and Samples:
   1. Scope of any submittal and letter of transmittal:
      a. Limited to one (1) Specification Section.
      b. Do not submit under any Specification Section entitled (in part) "Basic Requirements" unless the product or material submitted is specified, in total, in a "Basic Requirements" Specification Section.
   2. Numbering letter of transmittal:
      a. Use the Specification Section number followed by a series number ("-xx" and beginning with "01"); increase the series number sequentially with each additional transmittal for that Specification Section.
   3. Describing transmittal contents:
      a. Provide listing of each component or item in submittal capable of receiving an independent review action.
      b. Identify for each item:
         1) Manufacturer and Manufacturer's Drawing or data number.
         2) Contract Document tag number(s).
         3) Unique page numbers for each page of each separate item.
      c. When submitting "or-equal" items that are not the products of named manufacturers, include the words "or-equal" in the item description.
   4. Contractor certification of review and approval:
      a. Contractor's review and approval certification stamp shall be applied either to the letter of transmittal or a separate sheet preceding each independent item in the submittal.
         1) Stamp may be either a wet ink stamp or electronically embedded.
         2) Clearly identify the person who reviewed the submittal and the date it was reviewed.
         3) Shop Drawing submittal stamp shall read "(Contractor's Name) has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval as stipulated in the General Conditions."

{or}

      b. Contractor shall execute Exhibit AA, Contractor's Submittal Certification form, to indicate Contractor has reviewed and approved the submittal contents.
         1) Clearly identify the person who reviewed the submittal and the date it was reviewed."
      c. Submittals containing multiple independent items shall be prepared with each item listed on the letter of transmittal or on an index sheet for all items listing the discrete page numbers for each page of each item, which shall be stamped with the Contractor's review and approval stamp.
         1) Each independent item shall have a cover sheet with the transmittal number and item number recorded.
            a) Provide clear space of 3 IN SQ for Engineer stamping.
         2) Individual pages or sheets of independent items shall be numbered in a manner that permits the entire contents of a particular item to be readily recognized and associated with Contractor's certification.
   5. Resubmittals:
      a. Number with original Specification Section and series number with a suffix letter starting with "A" on a (new) duplicate transmittal form.
      b. Do not increase the scope of any prior transmittal.

c. Provide cover letter indicating how each "B", "C", or "D" Action from previous submittal was addressed and where the correction is found in the resubmittal.
d. Account for all components of prior transmittal.
    1) If items in prior transmittal received "A" or "B" Action code, list them and indicate "A" or "B" as appropriate.
        a) Do not include submittal information for items listed with prior "A" or "B" Action in resubmittal.
    2) Indicate "Outstanding-To Be Resubmitted At a Later Date" for any prior "C" or "D" Action item not included in resubmittal.
        a) Obtain Engineer's approval to exclude items.

6. For 8-1/2 x 11 IN, 8-1/2 x 14 IN, and 11 x 17 IN size sheets, provide five (5) copies of each submittal for Engineer plus the number required by the Contractor.
    a. The number of copies required by the Contractor will be defined at the Preconstruction Conference, but shall not exceed three (3).
    b. All other size sheets:
        1) Submit one (1) reproducible transparency or high resolution print and one (1) additional print of each Drawing until approval is obtained.
        2) Utilize mailing tube; do not fold.
        3) The Engineer will mark and return the reproducible to the Contractor for reproduction and distribution.
7. Contractor shall not use red color for marks on transmittals.
    a. Duplicate all marks on all copies transmitted, and ensure marks are photocopy reproducible.
    b. Engineer will use red marks or enclose marks in a cloud.
8. Transmittal contents:
    a. Coordinate and identify Shop Drawing contents so that all items can be easily verified by the Engineer.
    b. Provide submittal information or marks defining specific equipment or materials utilized on the Project.
        1) Generalized product information, not clearly defining specific equipment or materials to be provided, will be rejected.
    c. Identify equipment or material project application, tag number, Drawing detail reference, weight, and other Project specific information.
    d. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.
    e. Do not modify the manufacturer's documentation or data except as specified herein.
    f. Submit items such as equipment brochures, cuts of fixtures, product data sheets or catalog sheets on 8-1/2 x 11 IN pages.
        1) Indicate exact item or model and all options proposed.
    g. When a Shop Drawing submittal is called for in any Specification Section, include as appropriate, scaled details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout Drawings, rough-in diagrams, wiring diagrams, controls, weights and other pertinent data in addition to information specifically stipulated in the Specification Section.
        1) Arrange data and performance information in format similar to that provided in Contract Documents.
        2) Provide, at minimum, the detail specified in the Contract Documents.
    h. If proposed equipment or materials deviate from the Contract Drawings or Specifications in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.

9. Samples:
    a. Identification:
        1) Identify sample as to transmittal number, manufacturer, item, use, type, project designation, tag number, Specification Section or Drawing detail reference, color, range, texture, finish and other pertinent data.
        2) If identifying information cannot be marked directly on sample without defacing or adversely altering samples, provide a durable tag with identifying information securely attached to the sample.
    b. Include application specific brochures, and installation instructions.
    c. Provide Contractor's review and approval certification stamp or Contractor's Submittal Certification form as indication of Contractor's checking and verification of dimensions and coordination with interrelated work.
    d. Resubmit revised samples of rejected items.

C. Informational Submittals:
    1. Prepare in the format and detail specified in Specification requiring the informational submittal.

1.5 TRANSMITTAL OF SUBMITTALS

A. Shop Drawings and Samples:
    1. Transmit all submittals to:

        Carollo Engineers
        Attn: Michael Warriner

    2. Utilize two (2) copies of attached Exhibit A to transmit all Shop Drawings and samples.
    3. All submittals must be from Contractor.
        a. Submittals will not be received from or returned to subcontractors.

B. Informational Submittals:
    1. Transmit under Contractor's standard letter of transmittal or letterhead.
    2. Submit in triplicate or as specified in individual Specification Section.
    3. Transmit to:

        Carollo Engineers
        Attn: Michael Warriner

    4. Provide copy of letter of transmittal without attachments to Engineer.
        a. Exception for concrete, soils compaction and pressure test reports.
            1) Transmit one (1) copy of test reports to Resident Project Representative.
            2) Transmit one (1) copy of test reports to location and individual indicated above for other informational submittals.

C. Electronic Transmission of Submittals:
    1. Transmittals shall be made electronically.
        a. Use email.
        b. Protocols and processes will be determined at the Pre-Construction Conference.
    2. Scan all transmittals into Adobe Acrobat Portable Document Format (PDF), latest version, with printing enabled.
        a. Do not password protect or lock the PDF document.
        b. Rotate sheets that are normally viewed in landscape mode so that when the PDF file is opened the sheet is in the appropriate position for viewing.
    3. Required signatures may be applied prior to scanning for transmittal.

1.6 ENGINEER'S REVIEW ACTION

A. Shop Drawings and Samples:

1. Items within transmittals will be reviewed for overall design intent and will receive one (1) of the following actions:
    a. A - FURNISH AS SUBMITTED.
    b. B - FURNISH AS NOTED (BY ENGINEER).
    c. C - REVISE AND RESUBMIT.
    d. D - REJECTED.
    e. E - ENGINEER'S REVIEW NOT REQUIRED.
2. Submittals received will be initially reviewed to ascertain inclusion of Contractor's approval stamp.
    a. Submittals not stamped by the Contractor or stamped with a stamp containing language other than that specified herein will not be reviewed for technical content and will be returned rejected.
3. In relying on the representation on the Contractor’s review and approval stamp, Owner and Engineer reserve the right to review and process poorly organized and poorly described submittals as follows:
    a. Submittals transmitted with a description identifying a single item and found to contain multiple independent items:
        1) Review and approval will be limited to the single item described on the transmittal letter.
        2) Other items identified in the submittal will:
            a) Not be logged as received by the Engineer.
            b) Be removed from the submittal package and returned without review and comment to the Contractor for coordination, description and stamping.
            c) Be submitted by the Contractor as a new series number, not as a re-submittal number.
    b. Engineer, at Engineer’s discretion, may revise the transmittal letter item list and descriptions, and conduct review.
        1) Unless Contractor notifies Engineer in writing that the Engineer’s revision of the transmittal letter item list and descriptions was in error, Contractor’s review and approval stamp will be deemed to have applied to the entire contents of the submittal package.
4. Submittals returned with Action "A" or "B" are considered ready for fabrication and installation.
    a. If for any reason a submittal that has an "A" or "B" Action is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal.
    b. Destroy or conspicuously mark "SUPERSEDED" all documents having previously received "A" or "B" Action that are superseded by a resubmittal.
5. Submittals with Action "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected) will be individually analyzed giving consideration as follows:
    a. The portion of the submittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference).
        1) One (1) copy or the one (1) transparency of the "C" or "D" Drawings will be marked up and returned to the Contractor.
            a) Correct and resubmit items so marked.
    b. Items marked "A" or "B" will be fully distributed.
    c. If a portion of the items or system proposed are acceptable, however, the major part of the individual Drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" Action.
        1) This is at the sole discretion of the Engineer.
        2) In this case, some Drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package."
        3) Distribution to the Owner and field will not be made (unless previously agreed to otherwise).

6. Failure to include any specific information specified under the submittal paragraphs of the Specifications will result in the submittal being returned to the Contractor with "C" or "D" Action.
7. Calculations required in individual Specification Sections will be received for information purposes only, as evidence calculations have been stamped by the professional as defined in the specifications and for limited purpose of checking conformance with given performance and design criteria. The Engineer is not responsible for checking the accuracy of the calculations and the calculations will be returned stamped "E. Engineer's Review Not Required" to acknowledge receipt.
8. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.
9. Transmittals of submittals which the Engineer considers as "Not Required" submittal information, which is supplemental to but not essential to prior submitted information, or items of information in a transmittal which have been reviewed and received "A" or "B" action in a prior submittal, will be returned with action "E. Engineer's Review Not Required."
10. Samples may be retained for comparison purposes.
    a. Remove samples when directed.
    b. Include in bid all costs of furnishing and removing samples.
11. Approved samples submitted or constructed, constitute criteria for judging completed work.
    a. Finished work or items not equal to samples will be rejected.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

EXHIBIT A

Shop Drawing Transmittal No.

_____-_____

(Spec Section) (Series)

Project Name:		Date Received:	
Project Owner:		Checked By:	
Contractor:	HDR Engineering, Inc.	Log Page:	
Address:	Address:	HDR No.:	
		Spec Section:	
		Drawing/Detail No.:	
Attn:	Attn:	1st. Sub	ReSub.
Date Transmitted:	Previous Transmittal Date:		

Item No.	No. Copies	Description	Manufacturer	Mfr/Vendor Dwg or Data No.	Action Taken*

Remarks:

* The Action designated above is in accordance with the following legend:

A - Furnish as Submitted

B - Furnish as Noted

C - Revise and Submit
1. Not enough information for review.
2. No reproducibles submitted.
3. Copies illegible.
4. Not enough copies submitted.
5. Wrong sequence number.
6. Wrong resubmittal number.
7. Wrong spec. section.
8. Wrong form used.
9. See comments.

D - Rejected

E - Engineer's review not required
1. Submittal not required.
2. Supplemental Information. Submittal retained for informational purposes only.
3. Information reviewed and approved on prior submittal.
4. See comments.
5. Delegated Design - Submittal received as requested by the Contract Documents. The Engineer did not review the engineering or technical content of the submittal.

Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.

Comments:

By Date

Distribution: Contractor File Field Owner Other

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EXHIBIT AA

Contractor's Submittal Certification

Shop Drawing Transmittal No.: _____

Contract/Project Name: _____

_____

Company Name: _____

has

1. reviewed and coordinated this Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

2. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

3. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

4. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

☐ This Submittal **does not** contain any variations from the requirements of the Contract Documents.

☐ This Submittal **does** contain variations from the requirements of the Contract Documents. A separate description of said variations and a justification for them is provided in an attachment hereto identified as:

"Shop Drawing Transmittal No. _____Variation and Justification Documentation"

Insert picture file or electronic signature of Authorized Representative

_____ _____

Authorized Representative Date

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Revision Log

SECTION 01342
OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administration of the submittal process for Operation and Maintenance Manuals.
   2. Content requirements for Operation and Maintenance Manuals.

1.2 DEFINITIONS

A. Equipment Operation and Maintenance Manuals:
   1. Contain the technical information required for proper installation, operation and maintenance of process, electrical and mechanical equipment and systems.

B. Building Materials and Finishes Operation and Maintenance Manuals:
   1. Contain the information required for proper installation and maintenance of building materials and finishes.

1.3 SUBMITTALS

A. List of all the Operation and Maintenance Manuals required by the Contract as identified in the Technical Specification Sections.

B. Operation and Maintenance Manuals:
   1. Draft and final electronic copies.
   2. Final paper copies: One (1).

1.4 SUBMITTAL SCHEDULE

A. List of Required Operation and Maintenance Manuals:
   1. Submit list with Specification Section number and title within 90 days after Notice to Proceed.

B. Draft Operation and Maintenance Manuals:
   1. Submit approvable draft manuals in electronic format (PDF) within 30 days following approval of the respective Shop Drawing.
      a. Include placeholders or fly sheet pages where information is not final or is missing from the draft manual.
   2. All Draft Operation and Maintenance Manuals shall be received by no later than 50 percent project completion.

C. Final Operation and Maintenance Manuals:
   1. Final approval of Operation and Maintenance Manuals in electronic format (PDF) must be obtained 45 days prior to equipment start-up.
   2. Provide paper copies and CD-ROMs of approved final Operation and Maintenance Manuals in electronic format (PDF), a minimum of 30 days prior to equipment start-up.
   3. Issue addenda to Final Approved Operation and Maintenance Manual to include:
      a. Equipment data that requires collection after start-up, for example but not limited to HVAC balancing reports, electrical switchgear, automatic transfer switch and circuit breaker settings.
      b. Equipment field testing data.
      c. Equipment start-up reports.

1.5 PREPARATION OF SUBMITTALS

A. General:
   1. All pages of the Operation and Maintenance Manual submittal shall be legible.

a. Submittals which, in the Engineer's sole opinion, are illegible will be rejected without review.

2. Identify each equipment item in a manner consistent with names and identification numbers used in the Contract Documents, not the manufacturer's catalog numbers.
3. Neatly type any data not furnished in printed form.
4. Operation and Maintenance Manuals are provided for Owner's use, to be reproduced and distributed as training and reference materials within Owner's organization.
   a. This requirement is:
      1) Applicable to both paper copy and electronic files.
      2) Applicable to materials containing copyright notice as well as those with no copyright notice.
5. Notify supplier and/or manufacturer of the intended use of Operations and Maintenance Manuals provided under the Contract.

B. Operation and Maintenance Manual Format and Delivery:
1. Draft electronic submittals:
   a. Provide manual in Adobe Acrobat Portable Document Format (PDF), latest version.
   b. Create one (1) PDF file for each equipment Operation and Maintenance Manual.
   c. Do not password protect or lock the PDF document.
   d. Drawings or other graphics must be converted to PDF file format from the original drawing file format and made part of the PDF document.
   e. Scanning of drawings is to be used only where actual file conversion is not possible and drawings must be scanned at a resolution of 300 dpi or greater.
   f. Rotate sheets that are normally viewed in landscape mode so that when the PDF file is opened the sheet is in the appropriate position for viewing.
   g. Create bookmarks in the bookmarks panel for the Operation and Maintenance Manual cover, the Table of Contents and each major section of the Table of Contents.
   h. Using Adobe Acrobat Standard or Adobe Acrobat Professional, set the PDF document properties, initial view as follows:
      1) Select File →Properties→Initial View.
      2) Select the Navigation tab: Bookmarks Panel and Page.
      3) Select the Page layout: Single Page.
      4) Select the Magnification: Fit Page.
      5) Select Open to page: 1.
      6) Set the file to open to the cover page of the manual with bookmarks to the left, and the first bookmark linked to the cover page.
   i. Set the PDF file "Fast Web View" option to open the first several pages of the document while the rest of the document continues to load.
      1) To do this:
         a) Select Edit→Preferences→ Documents→Save Settings.
         b) Check the Save As optimizes for Fast Web View box.
   j. PDF file naming convention:
      1) Use the Specification Section number, the manufacturer's name and the equipment description, separated by underscores.
      2) Example: 46 51 21_Sanitaire_Coarse_Bubble_Diffusers.pdf.
      3) Do not put spaces in the file name.
2. Final electronic submittals:
   a. Submit two (2) copies in PDF file format on two (2) CD-ROM discs (one (1) copy per CD-ROM), each secured in a jewel case.
   b. CD-ROM Labeling:
      1) Provide the following printed labeling on all CD-ROM discs:
         a) Project name.
         b) Specification Section.
         c) Equipment names and summary of tag(s) covered.
         d) Manufacturer name.
         e) Date (month, year).

c. CD-ROM Jewel Case Holder:
   1) Insert jewel cases containing labeled CD-ROM discs in three-ring binder holder (C-Line Products, www.c-lineproducts.com stock number CLI-61968 or equivalent) at the front of each final paper copy.

3. Final paper copy submittals:
   a. Quantity: Provide two (2) copies.
   b. Paper: 8.5 x 11 IN or 11 x 17 IN bright white, 20 pound paper with standard three-hole punching.
   c. 3-Ring Binder:
      1) Provide D-ring binder with clear vinyl sleeves (i.e. view binder) on front and spine.
      2) Insert binder title sheet with the following information under the front and spine sleeves:
         a) Project name.
         b) Specification Section.
         c) Equipment names and summary of tag(s) covered.
         d) Manufacturer name.
         e) Date (month, year).
      3) Provide plastic sheet lifters prior to first page and following last page.
   d. Drawings:
      1) Provide all drawings at 11 x 17 IN size, triple folded and three-hole punched for insertion into manual.
      2) Where reduction is not practical to ensure readability, fold larger drawings separately and place in three-hole punched vinyl envelopes inserted into the binder.
      3) Identify vinyl envelopes with drawing numbers.
   e. Use plastic coated dividers to tab each section of each manual in accordance with the Table of Contents.

C. Equipment Operation and Maintenance Manual Content:
   1. Provide a cover page as the first page of each manual with the following information:
      a. Manufacturer(s) Name and Contact Information.
      b. Vendor's Name and Contact Information.
      c. Date (month, year).
      d. Project Owner and Project Name.
      e. Specification Section.
      f. Project Equipment Tag Numbers.
      g. Model Numbers.
      h. Engineer's Name.
      i. Contractor's Name.
   2. Provide a Table of Contents for each manual.
   3. Provide Equipment Record sheets as follows:
      a. Printed copies of the Equipment Record (Exhibits B1, B2 and B3), as the first tab following the Table of Contents.
      b. Exhibits B1-B3 are available as Fillable PDF Form documents from the Engineer.
      c. Each section of the Equipment Record must be completed in detail; simply referencing the related equipment Operation and Maintenance Manual sections for nameplate, maintenance, spare parts or lubricant information is not acceptable.
      d. For equipment involving separate components (for example, a motor and gearbox), a fully completed Equipment Record is required for each component.
      e. Submittals that do not include the Equipment Record(s) will be rejected without further content review.
   4. Provide a printed copy of the Manufacturer's Field Services report as required by Specification Section 01650 following the Equipment Record sheets.
   5. Provide the following detailed information, as applicable:
      a. Use equipment tag numbers from the Contract Documents to identify equipment and system components.
      b. Equipment function, normal and limiting operating characteristics.

c. Instructions for assembly, disassembly, installation, alignment, adjustment, and inspection.
d. Operating instructions for start-up, normal operation, control, shutdown, and emergency conditions.
e. Lubrication and maintenance instructions.
f. Troubleshooting guide.
g. Mark each sheet to clearly identify specific products and component parts and data applicable to the installation for the Project; delete or cross out information that does not specifically apply to the Project.
h. Parts lists:
   1) A parts list and identification number of each component part of the equipment.
   2) Exploded view or plan and section views of the equipment with a detailed parts callout matching the parts list.
   3) A list of recommended spare parts.
   4) List of spare parts provided as specified in the associated Specification Section.
   5) A list of any special storage precautions which may be required for all spare parts.
i. General arrangement, cross-section, and assembly drawings.
j. Electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, and interconnection diagrams.
k. Test data and performance curves.
l. As-constructed fabrication or layout drawings and wiring diagrams.
m. Copy of the equipment manufacturer’s warranty meeting the requirements of the Contract.
n. Copy of any service contracts provided for the specific piece of equipment as part of the Contract.

6. Additional information as required in the associated equipment or system Specification Section.

D. Building Materials and Finishes Operation and Maintenance Manual Content:
1. Building products, applied materials and finishes:
   a. Include product data, with catalog number, size, composition and color and texture designations.
   b. Provide information for ordering custom manufactured products.
2. Necessary precautions:
   a. Include product MSDS for each approved product.
   b. Include any precautionary application and storage guidelines.
3. Instructions for care and maintenance:
   a. Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
4. Moisture protection and weather exposed products:
   a. Include product data listing, applicable reference standards, chemical composition, and details of installation.
   b. Provide recommendations for inspections, maintenance and repair.
5. Additional requirements as specified in individual product specifications.

1.6 TRANSMITTAL OF SUBMITTALS

A. Operation and Maintenance Manuals.
1. Transmit all submittals to:
   a. {he address specified in Specification Section 01340 - SUBMITTALS.

2. Transmittal form: Use Operation and Maintenance Manual Transmittal, Exhibit A.
3. Transmittal numbering:
   a. Number each submittal with the Specification Section number followed by a series number beginning with "-01" and increasing sequentially with each additional transmittal, followed by "-OM" (for example: 43 23 14-01-OM).

4. Submit draft and final Operation and Maintenance Manual in electronic format (PDF) to Engineer, until manual is approved.

B. Expedited Return Delivery:
   1. Include prepaid express envelope or air bill in submittal transmittal package for any submittals Contractor expects or requires express return mail.
   2. Inclusion of prepaid express envelope or air bill does not obligate Engineer to conduct expedited review of submittal.

1.7 ENGINEER'S REVIEW ACTION

A. Draft Electronic (PDF) Submittals:
   1. Engineer will review and indicate one of the following review actions:
      a. A - ACCEPTABLE
      b. B - FURNISH AS NOTED
      c. C - REVISE AND RESUBMIT
      d. D - REJECTED
   2. Submittals marked as Acceptable or Furnish As Noted will be retained; however, the transmittal form will be returned with a request for the final paper and electronic documents to be submitted.
   3. Copies of submittals marked as Revise and Resubmit or Rejected will be returned with the transmittal form marked to indicate deficient areas.
   4. Resubmit until approved.

B. Final Paper Copy Submittals:
   1. Engineer will review and indicate one (1) of the following review actions:
      a. A - ACCEPTABLE
      b. D - REJECTED
   2. Submittals marked as Acceptable will be retained with the transmittal form returned as noted.
   3. Submittals marked as Rejected will be returned with the transmittal form marked to indicate deficient areas.
   4. Resubmit until approved.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

EXHIBIT A **Operation and Maintenance Manual Transmittal _____-_____ - OM**

(Spec Section) (Series)

Project Name: Date Received:

Project Owner: Checked By:

Contractor: Owner: Log Page:

Address: Address: HDR No.:

Attn: Attn:

1st. Sub. ReSub.

Date Transmitted: Previous Transmittal Date:

No. Copies	Description of Item	Manufacturer	Dwg. or Data No.	Action Taken*

Remarks:

To: From:

HDR Engineering, Inc.

Date:

* The Action designated above is in accordance with the following legend:
A - Acceptable
B - Furnish as Noted
C - Revise and Resubmit
D - Rejected

Comments:

By Date

Distribution: Contractor File Field Owner Other

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EXHIBIT B1

Equipment Record

Equipment Data and Spare Parts Summary

Project Name	Specification Section:
Equipment Name	Year Installed:
Project Equipment Tag No(s).	

Equipment Manufacturer		Project/ Order No.
Address		Phone
Fax	Web Site	E-mail
Local Vendor/Service Center		
Address		Phone
Fax	Web Site	E-mail

MECHANICAL NAMEPLATE DATA

Equip.		Serial No.		
Make		Model No.		
ID No.	Frame No.	HP	RPM	Cap.
Size	TDH	Imp. Sz.	CFM	PSI
Other:				

ELECTRICAL NAMEPLATE DATA

Equip.				Serial No.				
Make				Model No.				
ID No.	Frame No.	HP	V.	Amp.	HZ	PH	RPM	SF
Duty	Code	Ins. Cl.	Type	NEMA	C Amb.	Temp. Rise	Rating	
Other:								

SPARE PARTS PROVIDED PER CONTRACT

Part No.	Part Name	Quantity

RECOMMENDED SPARE PARTS

Part No.	Part Name	Quantity

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EXHIBIT B2

Equipment Record

Recommended Maintenance Summary

Equipment Description	Project Equip. Tag No(s).	

RECOMMENDED BREAK-IN MAINTENANCE (FIRST OIL CHANGES, ETC.)	INITIAL COMPLETION * FOLLOWING START-UP							
	D	W	M	Q	S	A	RT	Hours

RECOMMENDED PREVENTIVE MAINTENANCE	PM TASK INTERVAL *							
	D	W	M	Q	S	A	RT	Hours

* D = Daily W = Weekly M = Monthly Q = Quarterly S = Semiannual A = Annual Hours = Run Time I

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EXHIBIT B3

Equipment Record

Lubrication Summary

Equipment Description	Project Equip. Tag No(s).

Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					

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SECTION 01560
ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Minimizing the pollution of air, water, or land; control of noise, the disposal of solid waste materials, and protection of deposits of historical or archaeological interest.

1.2 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Prior to the start of any construction activities submit:
      a. A detailed proposal of all methods of control and preventive measures to be utilized for environmental protection.
      b. A drawing of the work area, haul routes, storage areas, access routes and current land conditions including trees and vegetation.
      c. A copy of the NPDES permit for storm water discharges from construction activities.
      d. A copy of the approved pollution prevention plan.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Employ and utilize environmental protection methods, obtain all necessary permits, and fully observe all local, state, and federal regulations.

B. Land Protection:
   1. Except for any work or storage area and access routes specifically assigned for the use of the Contractor, the land areas outside the limits of construction shall be preserved in their present condition.
      a. Contractor shall confine his construction activities to areas defined for work within the Contract Documents.
   2. Manage and control all borrow areas, work or storage areas, access routes and embankments to prevent sediment from entering nearby water or land adjacent to the work site.
   3. Restore all disturbed areas including borrow and haul areas and establish permanent type of locally adaptable vegetative cover.
   4. Unless earthwork is immediately paved or surfaced, protect all side slopes and backslopes immediately upon completion of final grading.
   5. Plan and execute earthwork in a manner to minimize duration of exposure of unprotected soils.
   6. Except for areas designated by the Contract Documents to be cleared and grubbed, the Contractor shall not deface, injure or destroy trees and vegetation, nor remove, cut, or disturb them without approval of the Engineer.
      a. Any damage caused by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense.

C. Surface Water Protection:
   1. Utilize, as necessary, erosion control methods to protect side and backslopes, minimize and the discharge of sediment to the surface water leaving the construction site as soon as rough grading is complete.
      a. These controls shall be maintained until the site is ready for final grading and landscaping or until they are no longer warranted and concurrence is received from the Engineer.
      b. Physically retard the rate and volume of run-on and runoff by:
         1) Implementing structural practices such as diversion swales, terraces, straw bales, silt fences, berms, storm drain inlet protection, rocked outlet protection, sediment traps and temporary basins.
         2) Implementing vegetative practices such as temporary seeding, permanent seeding, mulching, sod stabilization, vegetative buffers, hydroseeding, anchored erosion control blankets, sodding, vegetated swales or a combination of these methods.
         3) Providing Construction sites with graveled or rocked access entrance and exit drives and parking areas to reduce the tracking of sediment onto public or private roads.
   2. Discharges from the construction site shall not contain pollutants at concentrations that produce objectionable films, colors, turbidity, deposits or noxious odors in the receiving stream or waterway.

D. Solid Waste Disposal:
   1. Collect solid waste on a daily basis.
   2. Provide disposal of degradable solid waste to an approved solid waste disposal site.
   3. Provide disposal of nondegradable solid waste to an approved solid waste disposal site or in an alternate manner approved by Engineer and regulatory agencies.
   4. No building materials wastes or unused building materials shall be buried, dumped, or disposed of on the site.

E. Fuel and Chemical Handling:
   1. Store and dispose of chemical wastes in a manner approved by regulatory agencies.
   2. Take special measures to prevent chemicals, fuels, oils, greases, herbicides, and insecticides from entering drainage ways.
   3. Do not allow water used in onsite material processing, concrete curing, cleanup, and other waste waters to enter a drainage way(s) or stream.
   4. The Contractor shall provide containment around fueling and chemical storage areas to ensure that spills in these areas do not reach waters of the state.

F. Control of Dust:
   1. The control of dust shall mean that no construction activity shall take place without applying all such reasonable measures as may be required to prevent particulate matter from becoming airborne so that it remains visible beyond the limits of construction.
      a. Reasonable measures may include paving, frequent road cleaning, planting vegetative groundcover, application of water or application of chemical dust suppressants.
      b. The use of chemical agents such as calcium chloride must be approved by the State of California DOT.
   2. Utilize methods and practices of construction to eliminate dust in full observance of agency regulations.
   3. The Engineer will determine the effectiveness of the dust control program and may request the Contractor to provide additional measures, at no additional cost to Owner.

G. Burning:
   1. Do not burn material on the site.
   2. If the Contractor elects to dispose of waste materials by burning, make arrangements for an off-site burning area and conform to all agency regulations.

H. Control of Noise:
   1. Control noise by fitting equipment with appropriate mufflers.

I. Completion of Work:
   1. Upon completion of work, leave area in a clean, natural looking condition.
   2. Ensure all signs of temporary construction and activities incidental to construction of required permanent work are removed.

J. Historical Protection:
   1. If during the course of construction, evidence of deposits of historical or archaeological interests is found, cease work affecting find and notify Engineer.
      a. Do not disturb deposits until written notice from Engineer is given to proceed.
   2. The Contractor will be compensated for lost time or changes in construction to avoid the find based upon normal change order procedures.

3.2 MITIGATION MEASURES

A. The requirements of the MMRP are set forth between the regulating Authority and the Owner. However, the Contractor in its operations and execution of the Work, shall be responsible to comply with the requirements of the MMRP, and shall assume the responsibility for any non-compliance violations.

B. The MMRP measures are summarized in the following table:

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
3.1 Air Quality and Odors		
3.1-1	**Implement BAAQMD Dust Control Measures** **Applies to: Options 1 and 2** The City shall require its contractors to implement all applicable control measures for minimizing fugitive PM dust emissions that are recommended by BAAQMD at the time construction is performed. Requirements to implement these measures shall be included in the contracts the City establishes with the contractor(s) it selects to work on the project. These measures may include but are not limited to the following: ► Water all active construction areas at least twice daily. ► Cover all trucks hauling soil, sand, and other loose materials or require all trucks to maintain at least 2 feet of freeboard. ► Pave, apply water three times daily, or apply (nontoxic) soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites. ► Sweep daily (with water sweepers) all paved access roads, parking areas, and staging areas at construction sites. ► Sweep streets daily (with water sweepers) if visible soil material is carried into adjacent public streets. ► Hydroseed or apply (nontoxic) soil stabilizers to inactive construction areas (previously graded areas inactive for 10 days or more). ► Enclose, cover, water twice daily or apply (nontoxic) soil binders to exposed stockpiles (e.g., dirt, sand). ► Limit traffic speeds on unpaved roads to 15 mph.	The Contractor shall be responsible to comply with Mitigation Measure Number 3.1-1.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	► Install sandbags or other erosion control measures to prevent silt runoff to public roadways. ► Replant vegetation in disturbed areas as quickly as possible. ► Install wheel washers for all exiting trucks, or wash off the tires or tracks of all trucks and equipment leaving unpaved areas of the WPCP site and unpaved areas of new corporation yard. ► Install wind breaks (if they do not already exist), or plant trees/vegetative wind breaks at windward sides of construction areas at the WPCP site and the site of the new corporation yard. ► Suspend all excavation and grading activity when wind speeds (as instantaneous gusts measured by an on-site anemometer) exceed 25 mph and dust has the potential to adversely affect adjacent residential properties. Wind speeds shall be measured with an anemometer on site a minimum of one time per day. Additional hourly anemometer measurements shall be conducted if wind conditions noticeably increase or are forecast to be greater than 15 mph. ► Limit the area subject to excavation, grading, and other construction activity at any one time. Implementation of Mitigation Measure 3.1-1 would reduce fugitive PM dust emissions levels by approximately 75% through implementation of BAAQMD-recommended fugitive PM dust control measures. BAAQMD considers implementation of all feasible dust control measures, such as those listed above, to reduce construction-related emissions of fugitive PM10 dust (including fugitive PM2.5 dust) to a less-than-significant level (BAAQMD 1999).	
3.2 Cultural Resources		
3.2-1	**Provide Construction Personnel Training in the Recognition of Cultural Materials, Stop Work If Materials are Encountered, and Implement Procedures Necessary for Resource Protection and Treatment.** **Applies to: Option 1 (Pipeline Alignment and Corporation Yard Only)** Before the start of project-related ground-disturbing activities at the corporation yard or within 500 feet of site P-07-459 near the pipeline alignment, a qualified professional archaeologist shall provide a brief training session to all construction personnel. This training will provide basic information on recognizing the kinds of cultural resources that could be encountered as a result of project ground-disturbing activities; briefly review applicable cultural resources regulations; and outline procedures that must be followed upon the discovery of cultural materials or possible human remains. If traces of prehistoric occupation (e.g., midden soils, unusual amounts of shell, artifacts, bone) or historic-era remains (e.g., building or structure traces, concentrations of early historic- era refuse) are encountered, ground-disturbing activities in the vicinity of the find shall cease until the archaeologist can determine the nature and potential significance of the find and recommend a treatment	Mitigation Measure Number 3.2-1 does not apply to this project, which does not include the pipeline alignment or the new corporation yard.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	plan. The treatment plan could include but is not necessarily limited to avoidance through construction rerouting or revisions, additional archival research, and subsurface excavations for archaeological testing and/or data recovery. Implementation of Mitigation Measure 3.2-1 would reduce potentially significant impacts on documented cultural resources to a less-than-significant level because construction worker personnel training would be provided, work would be halted should a cultural resources be discovered, and a qualified archaeologist would prepare a treatment plan.	
3.2-2	**Monitor Ground-Disturbing Activities in Areas Determined to Be Highly Sensitive for Containing Prehistoric and/or Historic-Era Cultural Materials and Human Remains.** **Applies to: Options 1 and 2** A qualified professional archaeologist shall monitor all ground disturbing activities at the Pinole-Hercules WPCP, effluent pipeline trenching on the south bank of present-day Pinole Creek and along San Pablo Avenue as noted above, and initial grading and utility trenching at the site of the proposed corporation yard. If traces of prehistoric occupation (e.g., midden soils, unusual amounts of shell, artifacts, bone) or historic-era remains (e.g., building or structure traces, concentrations of early-historic-era refuse) are encountered, ground-disturbing activities in the vicinity of the find shall cease until the archaeologist can determine the nature and potential significance of the find and recommend a treatment plan. The treatment plan could include but is not necessarily limited to avoidance through construction rerouting or revisions, additional archival research, and subsurface excavations for archaeological testing and/or data recovery. Implementation of Mitigation Measure 3.2-2 would reduce potentially significant impacts resulting from inadvertent damage or destruction of unknown cultural resources during construction to a less-than-significant level through the recovery of potentially important scientific data and/or the preservation in place of CRHR/NRHP–eligible cultural resources.	The Contractor shall be responsible to comply with Mitigation Measure Number 3.2-2. The City shall retain a qualified professional archaeologist to provide the monitoring. If any Cultural Materials or Human Remains are found, the Contractor shall immediately inform the City of their findings.
	Implement Mitigation Measure 3.2-1. **Applies to: Options 1 and 2** Implementation of Mitigation Measures 3.2-1 and 3.2-2 would reduce potentially significant impacts resulting from inadvertent damage or destruction of unknown cultural resources during construction to a less-than-significant level because a professional archaeological monitor would be present during ground-disturbing activities in sensitive areas, and if any resources were discovered, potentially important scientific data would be recovered and/or CRHR/NRHP–eligible cultural resources would be preserved in place.	See Mitigation Measure 3.2-1 and 3.2-2, above.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
3.2-3	**If Human Remains are Uncovered During Ground-Disturbing Activities, Halt Potentially Damaging Excavation in the Area of the Burial and Contact the Contra Costa County Coroner and a Professional Archaeologist to Determine the Nature and Extent of the Remains.** **Applies to: Options 1 and 2** The coroner is required to examine all discoveries of human remains within 48 hours of receiving notice of a discovery on private or state lands (California Health and Safety Code, Section 7050.5[b]). If the coroner determines that the remains are those of a Native American, he or she must contact the Native American Heritage Commission by phone within 24 hours of making that determination (Health and Safety Code, Section 7050[c]). Following the coroner's findings, the property owner, the City of Pinole or its construction contractor, an archaeologist, and the NAHC-designated most likely descendant (MLD) shall determine the ultimate treatment and disposition of the remains and take appropriate steps to ensure that additional human interments are not disturbed. The responsibilities for acting upon notification of a discovery of Native American human remains are identified in Section 5097.9 of the California Public Resources Code. The landowner shall ensure that the immediate vicinity (according to generally accepted cultural or archaeological standards and practices) is not damaged or disturbed by further development activity until consultation with the MLD has taken place. The MLD shall have 48 hours to complete a site inspection and make recommendations after being granted access to the site. A range of possible treatments for the remains, including nondestructive removal and analysis, preservation in place, relinquishment of the remains and associated items to the descendants, or other culturally appropriate treatment may be discussed. Assembly Bill (AB) 2641 (Chapter 863, Statutes of 2006), which amended Section 5097.98 of the California Public Resources Code, suggests that the concerned parties may extend discussions beyond the initial 48 hours to allow for the discovery of additional remains. AB 2641(e) (i.e., Public Resources Code, Section 5097.98[e]) includes a list of site protection measures and states that the landowner shall do one or more of the following: ► Record the site with the NAHC or the appropriate Information Center. ► Utilize an open-space or conservation zoning designation or easement. ► Record a document with the county in which the property is located. The landowner or an authorized representative must rebury the Native American human remains and associated grave goods with appropriate dignity on the property in a location not subject to further subsurface disturbance if the NAHC is unable to identify a MLD or if the MLD fails to make a recommendation within 48 hours after being granted access to the site. The landowner or authorized representative may also	The City and its Contractors shall be responsible to comply with Mitigation Measure Number 3.2-3.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	reinter the remains in a location not subject to further disturbance if they reject the recommendation of the MLD, and mediation by the NAHC fails to provide measures acceptable to the landowner. Implementation of Mitigation Measure 3.2-4 would reduce potential impacts on human remains to a less-than-significant level by immediately suspending work in the vicinity of the discovery and complying with state laws requiring contact with the applicable county coroner and a professional archaeologist to determine the nature of the find, and subsequent contact with the NAHC and appropriate treatment if the remains are determined to be those of a Native American.	
3.4 Fisheries and Aquatic Resources		
3.4-1a	**Prepare and Implement a Spill Prevention Plan** **Applies to: Option 1** A spill prevention plan shall be prepared outlining measures to be taken to immediately clean up and properly dispose of any fluid spills. Staging and storage areas shall be established away from the in-water construction areas to store, service, and maintain construction equipment and supplies and thereby minimize the potential for leaks or spills of oil, diesel fuel, gasoline, or related chemicals to enter the water, further contributing to degradation of water quality in the creeks.	The Contractor shall be responsible to comply with Mitigation Measure Number 3.4-1a.
3.4-1b	**Develop and Implement a Frac-Out Plan for Jack and Bore Drilling.** **Applies to: Option 1** A qualified engineer shall develop a frac-out plan for jack and bore drilling at any of the creek crossings. The frac-out plan shall include, at a minimum, frac-out prevention, monitoring, and response measures and all provisions of this plan shall be implemented during construction operations. The plan shall be submitted to the City of Pinole for review and approval prior to the start of any jack and bore operations.	Mitigation Measure Number 3.4-1a does not apply to this project. There are no creek crossings in the design.
	Implement Mitigation Measure 3.4-1b. **Applies to: Option 1** Implementation of Mitigation Measures 3.9-1 and 3.4-1b would reduce potentially significant impacts on coastal salt marsh, riparian, and freshwater wetland habitats along the proposed pipeline alignment under Option 1 to a less-than-significant level by requiring that trained biological monitors clearly identify and flag sensitive habitats; by limiting all construction activity to areas set back from sensitive habitats; by employing BMPs, including fencing, so that sensitive habitats are avoided during construction activities; and by preparing a frac-out plan with slurry containment measures.	See Mitigation Measure 3.4-1b, above.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
3.5 Geology and Soils		
3.5-1a	**Prepare Site-Specific Geotechnical Report per CBC Requirements and Implement Appropriate Recommendations.** **Applies to: Options 1 and 2** Before building permits are issued and construction activities begin any project development phase, the City of Pinole shall hire a licensed geotechnical engineer to prepare a final geotechnical subsurface investigation report for the proposed facilities, which shall be submitted for review and approval to the City of Pinole Planning Department. The final geotechnical engineering report shall address and make recommendations on the following: ► site preparation; ► soil bearing capacity; ► appropriate sources and types of fill; ► potential need for soil amendments; ► structural foundations, including retaining-wall design; ► grading practices; ► soil corrosion of concrete and steel; ► erosion/winterization; ► seismic ground shaking; ► liquefaction; ► subsidence; and ► expansive/unstable soils. In addition to the recommendations for the conditions listed above, the geotechnical investigation shall include subsurface testing of soil and groundwater conditions, and shall determine appropriate foundation designs that are consistent with the version of the CBC that is applicable at the time building and grading permits are applied for. All recommendations contained in the final geotechnical engineering report shall be implemented by the City of Pinole. Special recommendations contained in the geotechnical engineering report shall be noted on the grading plans and implemented as appropriate before construction begins. Design and construction of all new project development shall be in accordance with the CBC.	Mitigation Measure Number 3.5-1a has been addressed in the design and geotechnical engineering report.
3.5-1b	**Monitor Earthwork during Ground-Disturbing Activities.** **Applies to: Options 1 and 2** All earthwork shall be monitored by a qualified geotechnical or soils engineer retained by the City of Pinole. The geotechnical or soils engineer shall provide oversight during all excavation, placement of fill, and disposal of materials removed from and deposited on both on- and off-site construction areas.	The Contractor shall be responsible to comply with Mitigation Measure Number 3.2-1. The City shall retain a qualified engineer to provide the training.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	Implementation of Mitigation Measures 3.5-1a and 3.5-1b would reduce the potentially significant impact of possible damage to people and structures from strong seismic ground shaking under both Options 1 and 2 to a less-than-significant level by requiring that the design recommendations of a geotechnical engineer to reduce damage from seismic events be incorporated into buildings, structures, and infrastructure as required by the CBC, and that a geotechnical or soils engineer provide on-site monitoring to make sure that earthwork is being performed as specified in the plans.	
3.5-3	**Prepare and Implement a Grading and Erosion Control Plan.** **Applies to: Option 1** Before grading permits are issued, the City of Pinole shall retain a California Registered Civil Engineer to prepare a grading and erosion control plan. The plan shall be consistent with the City's Grading Ordinance and the state's NPDES permit, and shall include the site-specific grading associated with development for all project components. The plan referenced above shall include the location, implementation schedule, and maintenance schedule of all erosion and sediment control measures, and a description of the location and methods of storage and disposal of construction materials. Erosion and sediment control measures could include the use of detention basins, berms, swales, wattles, and silt fencing, and covering or watering of stockpiled soils to reduce wind erosion. Stabilization on slopes could include construction of retaining walls and reseeding with vegetation after construction. Stabilization of construction entrances to minimize trackout (control dust) is commonly achieved by installing filter fabric and crushed rock to a depth of approximately 1 foot. The City of Pinole shall ensure that the construction contractor is responsible for securing a source of transportation and deposition of excavated materials. Implementation of Mitigation Measure 3.6-3a (discussed in Section 3.6, "Hydrology and Water Quality") would also help reduce erosion-related impacts. Implementation of Mitigation Measure 3.5-4 along with Mitigation Measure 3.6-3a (discussed in Section 3.6, "Hydrology and Water Quality"), would reduce potentially significant construction-related erosion impacts under Option 1 to a less-than-significant level because a grading and erosion control plan with specific erosion and sediment control measures such as those suggested above or listed in Mitigation Measure 3.6-3a would be prepared, approved by the City of Pinole Planning Department, and implemented.	
	Implement Mitigation Measure 3.5-1a and 3.5-1b. **Applies to: Options 1 and 2** Implementation of Mitigation Measures 3.5-1a and 3.5-1b would reduce potential geologic hazards from construction related to liquefaction and subsidence to a less-than-significant level because a licensed geotechnical engineer would performed a site-specific geotechnical	See Mitigation Measures 3.5-1a and 3.5-1b, above.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	investigation that would include a determination of liquefaction potential as required by the California Building Standards Code, as well as evaluation of subsidence potential and soil bearing strength, and all recommendations made by the engineer regarding building and foundation design would be implemented. Furthermore, all earthwork would be monitored by a soils or geotechnical engineer to make sure that project plans and specifications are complied with.	
	Implement Mitigation Measures 3.5-1a and 3.5-1b. **Applies to: Options 1 and 2** Implementation of Mitigation Measures 3.5-1a and 3.5-1b would reduce the potentially significant impact of damage to people and structures from construction in expansive soils under both Options 1 and 2 to a less-than-significant level by requiring that the design recommendations of a geotechnical engineer to reduce damage from expansive soils be incorporated into buildings, structures, and infrastructure as required by the CBC, and that a geotechnical or soils engineer provide on-site monitoring to make sure that earthwork is being performed as specified in the plans.	See Mitigation Measures 3.5-1a and 3.5-1b, above.
	Implement Mitigation Measure 3.5-1a. **Applies to: Options 1 and 2** Implementation of Mitigation Measure 3.5-1a would reduce the potentially significant impact of damage to structures from construction in corrosive soils under both Options 1 and 2 to a less-than-significant level by requiring that a licensed geotechnical engineer perform a site-specific corrosivity evaluation, and requiring that the design recommendations of a geotechnical engineer to reduce damage from corrosive soils be incorporated into project-related buildings, structures, and infrastructure.	See Mitigation Measures 3.5-1a above.
3.5-8	**Conduct Construction Personnel Education, Monitor Earthwork, Stop Work if Paleontological Resources are Discovered, Assess the Significance of the Find, and Prepare and Implement a Recovery Plan as Required.** **Applies to: Option 1 (Pipeline Alignment Only)** To minimize potential adverse impacts on previously unknown potentially unique, scientifically important paleontological resources during earthmoving activities along the proposed pipeline alignment, the City of Pinole shall do the following: ► Before the start of any earthmoving activities along the proposed pipeline alignment, the City of Pinole shall retain a qualified paleontologist or archaeologist to train all construction personnel involved with earthmoving activities, including the project superintendent, regarding the possibility of encountering fossils, the appearance and types of fossils likely to be seen during construction, and proper notification procedures should fossils be encountered.	Mitigation Measure Number 3.5-8 does not apply to this project. The Pipeline Alignment will not be constructed.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	► The City of Pinole shall hire a qualified paleontologist to provide monitoring during all earthmoving activities along the proposed pipeline alignment, except in those areas underlain by Holocene alluvial fan deposits and artificial fill as shown in Exhibit 3.5-1. ► If paleontological resources are discovered during earthmoving activities, the construction crew shall immediately cease work in the vicinity of the find and notify the on-site paleontologist and the City of Pinole. The paleontologist shall evaluate the resource and prepare a recovery plan in accordance with Society of Vertebrate Paleontology guidelines (1996). The recovery plan may include, but is not limited to, an intensive field survey in the vicinity of the find, sampling and data recovery, museum storage coordination for any specimen recovered, and a report of findings. All feasible recommendations contained in the recovery plan shall be implemented before construction activities can resume at the site where the paleontological resources were discovered. Implementation of Mitigation Measure 3.5-8 would reduce potentially significant impacts related to damage or destruction of unique paleontological resources to a less-than-significant level under Option 1 because construction workers would be alerted to the possibility of encountering paleontological resources, and in the event that resources were encountered, fossil specimens would be recovered and recorded and would undergo appropriate curation.	
3.6 Hydrology and Water Quality		
3.6-1a	**Prepare Site Drainage Plans** **Applies to: Option 1 (Corporation Yard Only)** The City shall develop plans for stormwater drainage at the site of the new corporation yard that are consistent with site design and drainage system guidelines provided by CCCWP and associated implementation of the San Francisco Bay RWQCB new MRP adopted in October 2009. The plans shall establish drainage performance criteria for off-site drainage, in consultation with City engineering staff, such that project-related drainage is consistent with City-determined facility designs, discharge rates, erosion protection, and routing to drainage channels, which could be accomplished by, but is not limited to, the following techniques: ► minimizing directly connected impervious areas; ► maximizing permeability of the site; ► stormwater quality controls such as infiltration, detention/retention, and/or biofilters; and ► basins, swales, and pipes in the system design. The storm drain system at the corporation yard shall be designed to manage both quality and volume of runoff. The plans shall be developed in accordance with the “Standard Plans for Drainage” provided by the County (Contra Costa County 2008).	Mitigation Measure Number 3.6-1a does not apply to this project, which does not include the new corporation yard design.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
3.6-1b	**Prepare and Implement a Stormwater Control Plan** A stormwater control plan shall be prepared, in accordance with RWQCB requirements, (don't need if less than 1 acre) to comply with CCCWP's Stormwater Management Plan and C.3 Stormwater Guidebook. The stormwater control plan shall detail permanent stormwater management facilities. Storm drain facilities shall be designed in accordance with the site design and drainage system guidelines provided by CCCWP, which include, but are not limited to, the following: ► minimizing directly connected impervious areas; ► maximizing permeability of the site; ► stormwater quality controls such as infiltration, detention/retention, and/or biofilters; and ► basins, swales, and pipes in the system design. The storm drain system shall be designed to manage both quality and volume of runoff. The stormwater control plan shall be submitted to CCCWP for review and approval consistent with the requirements of the NPDES permit. Implementation of Mitigation Measures 3.6-1a and 3.6-1b would reduce potentially significant drainage and water quality impacts from relocation of the corporation yard under Option 1 to a less-than-significant level, because it would require that stormwater runoff from the construction activities and impervious surfaces be appropriately controlled, treated, and any offsite drainage would be appropriately routed to existing or created drainage [GJN1]features such that off-site properties would not be adversely affected.. Furthermore, a stormwater control plan would be prepared such that facilities would be designed in compliance with CCCWP guidelines, which would minimize the project-related volume and quality of runoff.	The Contractor shall be responsible to comply with Mitigation Measure Number 3.6-1b.
	Implement Mitigation Measure 3.6-1. **Avoid Encroachment of Pipelines onto Peak Channel Flows and Minimize Exposure of Facilities to Flooding** **Applies to: Option 1** Further, the City shall design and construct new treatment facilities at the Pinole-Hercules WPCP to provide appropriate flood protection such that plant operations are not adversely affected by inland flooding and inundation. The City shall consult with CCCFCWCD on the design of stream crossings for the new pipeline such that the minimum elevation of the pipeline would be above the predicted surface-water elevation of the 100-year peak flow. **Applies to: Option 2** The City shall require construction contractors to design and construct new treatment facilities at the Pinole-Hercules WPCP to provide appropriate flood protection measures to ensure that plant operations are not adversely affected by inland flooding and inundation. The plans	Mitigation Measure Number 3.6-1 has been addressed in the design for Option 1. The pipeline alignment will not be constructed and therefore no stream crossings are planned. Option 2 will not be constructed.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	shall be developed in accordance with the "Standard Plans for Drainage" provided by the County (Contra Costa County 2008). Implementation of Mitigation Measures 3.6-1 and 3.6-2 would reduce potentially significant drainage and flooding impacts from construction of project facilities under Option 1 and Option 2 to a less-than-significant level, because it would require that facilities would be designed to minimize exposure of property to flooding and flood hazards or creation of such hazards and would reduce and control off-site runoff from impervious areas.	
3.6-3a	**Obtain an NPDES Permit and Develop and Implement a SWPPP with BMPs** **Applies to: Options 1 and 2** The project's construction area is expected to be larger than 1 acre and therefore would require appropriate stormwater construction permits. To avoid or minimize the potential for adverse construction-related effects on water quality, the City shall develop a SWPPP and obtain authorization under the City's municipal stormwater authority or the statewide NPDES stormwater permit for general construction activity before beginning work. To comply with the NPDES regulations, the City shall identify and implement construction-related BMPs to avoid and minimize erosion and contaminant runoff. Such BMPs may include, but are not limited to, the following: ► keeping construction grade below lot curb at 2 inches to prevent runoff, ► covering small areas with rolled material during rain, ► covering large areas with erosion control blankets and/or mulch, ► distributing rock bags in the gutter before an inlet to slow flow and filter sediment, ► protecting inlets with straw wattles and rock bags, ► putting stucco and concrete supplies and materials in one place with pH sampling equipment and covering with plastic, ► using large river rock to stabilize entrance and exit areas and prevent tracking to streets, ► minimizing construction work near or in drainage channels, and ► locating staging areas as far as practicable from surface waters. **Other preventive good housekeeping practices could include, but are not limited to, road sweeping, sediment tracking and hauling, and dust control; and diversion measures such as berms to prevent clear runoff from contacting disturbed areas, and contaminated runoff from entering surface waters. Erosion and sedimentation control measures can also include soil stabilization, mulching, silt fencing, or temporary desilting basins.**	The Contractor shall be responsible to comply with Mitigation Measure Number 3.6-3a.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	The NPDES permit and SWPPP shall also be applied to construction activities involving pipe crossings at Pinole, Ohlone, Refugio, and Rodeo Creeks. Streamflow shall be maintained downstream of the stream crossing sites at all times during construction, and not otherwise restrict flow in any manner that would restrict passage of fish around the sites.	
3.6-3b	**Divert Discharge from Construction Dewatering to Pinole-Hercules WPCP Headworks** **Applies to: Options 1 and 2** To avoid the potential for adverse effects on water quality of adjacent surface water bodies, any groundwater that is dewatered as a result of construction activities at the Pinole-Hercules WPCP shall be sent to the Pinole-Hercules WPCP headworks for treatment with the wastewater stream. (This mitigation measure does not require a separate NPDES permit.) Implementation of Mitigation Measures 3.6-3a and 3.6-3b would reduce potentially significant impacts on stormwater quality from construction activities under Options 1 and 2 to a less-than significant level because it would require the implementation of a SWPPP and BMPs, which would minimize the effect of runoff on stormwater quality and volume. Furthermore, groundwater encountered during construction dewatering would be diverted to the headworks of the Pinole-Hercules WPCP and therefore adverse water quality impacts from dewatering would be avoided.	The Contractor shall be responsible to comply with Mitigation Measure Number 3.6-3b.
	Implement Mitigation Measures 3.6-3a and 3.6-3b. **Applies to: Option 1**	See Mitigation Measure 3.6-3a and 3.6-3b, above.
3.8-1	**Reduce Short-Term Increases in Noise Levels from Construction Sources.** **Applies to: Option 1 (WPCP and Pipeline Alignment Only) and Option 2** To reduce impacts associated with noise generated during project related construction activities at the WPCP and along the proposed pipeline route, the City of Pinole and its primary construction contractors shall ensure that the following requirements are implemented at each work site in any year of project construction to avoid and minimize construction noise effects on sensitive receptors. Measures that shall be used to limit noise shall include the items listed below: 1. To the maximum extent feasible, construction activities (except for the use of the drilling machine required for horizontal directional drilling HDD associated with jack-and-bore operations and the pipeline connections to existing equipment at the WPCP) shall be limited to the hours of 7 a.m. to 5 p.m. Monday through Friday, and from 9 a.m. to 6 p.m. on Saturday in commercial zones only. 2. Construction equipment shall be properly maintained and equipped with noise control, such as mufflers, in accordance with manufacturers'	The Contractor shall be responsible to comply with Mitigation Measure Number 3.8-1. The pipeline alignment portion of Option 1 will not be constructed.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	specifications. Impact tools shall be shielded per manufacturer's specifications. 3. Temporary barriers shall be erected for the stationary construction noise sources at the sites of HDD activity and along the eastern side of the Pinole-Hercules WPCP, in accordance with all of the following specifications: ► The barrier shall be placed as close to stationary noise sources as possible and shall break the line of sight between the source and receptor. ► The barrier shall be constructed of ¾-inch Medium Density Overlay plywood sheeting, or other acceptable material having a surface weight of 2 lb/sq. ft. or greater, and a demonstrated Sound Transmission Class (STC) rating of 25 or greater as defined by the American Society for Testing and Materials (ASTM) Test Method E90. ► For a temporary acoustical curtain, the material shall be weather and abuse resistant, and exhibit superior hanging and tear strength during construction and with a surface weight of at least 1 lb/sq. ft. The material shall have a minimum breaking strength of 120 pounds per inch (lb/in) per Federal Test Method Standard 191 A-M5102 and minimum tear strength of 30 lb/in per ASTM D117. Based on the same test procedures, the absorptive material facing shall have a minimum breaking strength of 100 lb/in and minimum tear strength of 7 lb/in. The material shall have a STC rating of 25 or greater, based on certified sound transmission loss data taken according to ASTM Test Method E90. It shall also have a Noise Reduction Coefficient rating of 0.70 or greater, based on certified sound absorption coefficient data according to ASTM Test Method C423. ► When barrier units are joined together, the mating surfaces ofthe barrier sides shall be flush with each other. Gaps between barrier units, and between the bottom edge of the barrier panels and the ground, shall be closed with material that will completely close the gaps, and be dense enough to attenuate noise. 4. The City of Pinole shall provide notice to all property owners and tenants within 500 feet of the edge of the construction right-of-way at the WPCP and along the pipeline route at least 2 weeks in advance of construction. 5. The City of Pinole shall designate a disturbance coordinator to whom concerned residents may address their construction related noise complaints. The name and phone number of the coordinator shall be conspicuously posted at construction areas and on all advanced notifications required in (4) above. The coordinator shall respond to all complaints. With implementation of Mitigation Measure 3.8-1, construction activities would generally be limited, except for the drilling machine required for HDD and pipeline connections to existing WPCP equipment, to the less-sensitive daytime hours. In addition, temporary noise barriers would be erected to provide noise reduction, construction	

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	equipment would be provided with appropriate shielding, advance notice to nearby residents would be provided, and a disturbance coordinator would be designated to respond to complaints. However, construction-generated noise levels would still exceed the applicable standards at nearby sensitive receptors for all project components (with the exception of the corporation yard). Thus, this impact would remain significant and unavoidable.	
3.9 Terrestrial Biology		
3.9-1	**Implement Measures to Minimize Potential Impacts on Sensitive Habitats Along the Proposed Pipeline Alignment** **Applies to: Option 1** The following measures to avoid potential loss or degradation of coastal salt marsh, riparian, and freshwater marsh habitat resulting from construction activities within the 100-foot potential disturbance area shall be implemented along the proposed pipeline alignment: 1. Whenever ground-disturbing activity is expected to occur within 100 feet of any sensitive habitat, including wetlands or potentially jurisdictional waters as shown on Exhibits 3.9-1 through 3.9-4, a qualified biologist shall be present to monitor these activities to make sure that no loss or degradation of habitat occurs and to provide guidance on establishing and maintaining adequate setbacks from sensitive habitats. 2. Ground-disturbing activities shall not occur within 25 feet of the sensitive habitats shown on Exhibits 3.9-1 through 3.9-4 unless those activities are entirely limited to roadways and other unvegetated surfaces. 3. No vehicles shall be used outside of the defined disturbance area. 4. Temporary soil and debris stockpiles shall be carefully located away from sensitive habitats, so the material will not enter or run off into waterways. 5. Temporary soil and debris stockpiles shall be covered to prevent erosion and runoff into creeks. 6. All staging areas, parking areas, equipment, and storage areas for fuel, lubricants, and solvents shall be located in areas away from sensitive habitats and adjacent creeks, drainages, and waterways. 7. Construction best management practices (BMPs) shall be implemented. Specifically, silt fencing shall be installed between the construction area and sensitive habitats that could support special-status species and nesting migratory birds; fueling and vehicle/equipment maintenance areas shall be demarcated with construction fencing or lathes and colored flagging; and staging areas adjacent to sensitive habitats or water bodies shall be demarcated with construction fencing or lathes and colored flagging. Silt fencing shall be installed in all areas where construction occurs within 25 feet of sensitive habitat or actively flowing water.	Mitigation Measure Number 3.5-8 does not apply to this project. The pipeline alignment will not be constructed.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	Implement Mitigation Measure 3.9-1. **Applies to: Option 1**	See Mitigation Measure 3.9-1, above.
	Implement Mitigation Measure 3.9-1. **Applies to: Option 1** Implementation of Mitigation Measures 3.4-1a, 3.4-1b, 3.6-3a, 3.6-3b, and 3.9-1 would reduce the potentially significant impacts related to construction-related water quality effects on salmonids to a less-than-significant level because the potential for pollutants and/or sediments associated with construction-related activities to enter the creeks would be minimized through preparation and implementation of a spill prevention plan, SWPPP, and BMPs; a biological monitor would be onsite during construction activities adjacent to the creeks; and a frac-out plan would be prepared to address sediment generated by jack and bore drilling.	See Mitigation Measure 3.9-1, above.
3.9-2	**Conduct Surveys for Nesting Raptors and, If Nesting Raptors are Discovered, Cease Construction and Consult with DFG to Prevent Nest Failure** **Applies to: Option 1** To reduce impacts on raptors, the City of Pinole shall retain a qualified biologist to conduct preconstruction surveys and to identify active nests within 500 feet of the proposed pipeline alignment. Preconstruction surveys for raptor species shall be conducted during the nesting season (March 15 to August 15) no more than 14 days and no fewer than 7 days before any construction activity begins. Any construction activity that occurs between August 16 and March 14 shall not require preconstruction surveys for raptors. Should nesting raptors be discovered within the survey area, a qualified biologist shall notify DFG. No new disturbance shall occur within one-half mile of the nest until the nest is no longer active or appropriate avoidance measures are developed in consultation with DFG to ensure that the nest is adequately protected. Potential avoidance measures can include visual screening, timing restrictions for construction activity, and monitoring of active nests. Should an active raptor nest be found, monitoring (funded by the City of Pinole) of active nests by a qualified biologist shall be performed to make sure that project construction does not disturb raptors at the nest site. Implementation of Mitigation Measure 3.9-1 would reduce potentially significant impacts on special-status wildlife species along the proposed pipeline alignment under Option 1 to a less-than-significant level by using trained biological monitors to clearly identify and flag habitat that could support special-status wildlife; by limiting all construction activity to areas outside of habitats that could support special-status wildlife; and by employing BMPs to avoid habitats that could support special status wildlife.	Mitigation Measure Number 3.9-2 does not apply to this project. The pipeline alignment will not be constructed.

MITIGATION MEASURE NUMBER	SYNOPSIS OF MITIGATION MEASURE	COMMENT
	Implementation of Mitigation Measure 3.9-2 would reduce the project's impact on nesting raptor species to a less-than-significant level by requiring that project activities do not impede the use of raptor nesting sites.	
	Implement Mitigation Measures 3.9-1, 3.4-1b, 3.6-3a, and 3.6-3b. **Applies to: Option 1** Implementation of Mitigation Measures 3.9-1, 3.4-1b, 3.6-3a, and 3.6-3b would reduce potentially significant impacts on wetlands and potentially jurisdictional waters along the proposed pipeline alignment under Option 1 to a **less-than-significant** level by requiring that trained biological monitors clearly identify and flag waters; by limiting all construction activity to areas setback from waters; by employing BMPs including fencing so that waters are physically avoided and sediment and contaminant discharge during construction activities is avoided; and by preparing a frac-out plan that would contain any slurry spills.	See Mitigation Measures 3.9-1, 3.4-1b, 3.6-3a, and 3.6-3b.

C. The MMRP measures table references Options 1 and 2. These options were being considered during regulatory reviews. Option 1, without the Effluent Pipeline and new corporation yard, was selected for design. The comment column of the MMRP measures table in Article 3.2 B. of this specification section states which MMRP measures the Contractor is responsible for and which MMRP measures are applicable to the project.

END OF SECTION

SECTION 01600
PRODUCT DELIVERY, STORAGE, AND HANDLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Scheduling of product delivery.
   2. Packaging of products for delivery.
   3. Protection of products against damage from:
      a. Handling.
      b. Exposure to elements or harsh environments.

B. Payment:
   1. No payment will be made to Contractor for equipment or materials not properly stored and insured or without approved Shop Drawings.
      a. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

1.2 DELIVERY

A. Scheduling: Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.

B. Packaging: Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.

C. Identification: Clearly and fully mark and identify as to manufacturer, item, and installation location.

D. Protection and Handling: Provide manufacturer's instructions for storage and handling.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 PROTECTION, STORAGE AND HANDLING

A. Manufacturer's Instruction:
   1. Protect all products or equipment in accordance with manufacturer's written directions.
      a. Store products or equipment in location to avoid physical damage to items while in storage.
      b. Handle products or equipment in accordance with manufacturer's recommendations and instructions.
   2. Protect equipment from exposure to elements and keep thoroughly dry.
   3. When space heaters are provided in equipment, connect and operate heaters during storage until equipment is placed in service.

3.2 STORAGE FACILITIES

A. Temporary Storage Building:
   1. Provide a weatherproof temporary storage building specifically for the purpose of providing for protection of products and equipment.

a. Size building to accommodate anticipated storage items; however, not less than 10 FT x 20 FT.

2. Equip building with lockable doors and lighting, and provide electrical service for equipment space heaters and heating or ventilation as necessary to provide storage environments acceptable to specified manufacturers.
3. Provide methods of storage of products and equipment off the ground.
4. Provide this structure within 60 days after Notice to Proceed.
   a. Locate building on-site where shown on the Drawings or in location approved by Engineer.
   b. Remove building from site prior to startup and demonstration period.

3.3 FIELD QUALITY CONTROL

A. Inspect Deliveries:
   1. Inspect all products or equipment delivered to the site prior to unloading.
      a. Reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.

B. Monitor Storage Area: Monitor storage area to ensure suitable temperature and moisture conditions are maintained as required by manufacturer or as appropriate for particular items.

END OF SECTION

SECTION 01601
JOB CONDITIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Job conditions.

1.2 PROJECT CONDITIONS

A. Prior to installation of material, equipment and other work, verify with subcontractors, material or equipment manufacturers, and installers that the substrate or surface to which those materials attach is acceptable for installation of those materials or equipment. (Substrate is defined as building surfaces to which materials or equipment is attached to i.e., floors, walls, ceilings, etc.).

B. Correct unacceptable substrate until acceptable for installation of equipment or materials.

C. Maintaining Facility Operations:

PART 2 - PRODUCTS – (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION – (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

SECTION 01640
PRODUCT SUBSTITUTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. The procedure for requesting the approval of substitution of a product that is not equivalent to a product which is specified by descriptive or performance criteria or defined by reference to one or more of the following:
      a. Name of manufacturer.
      b. Name of vendor.
      c. Trade name.
      d. Catalog number.
   2. Substitutions are not "or-equals."
   3. This Specification Section does not address substitutions for major equipment.

B. Request for Substitution - General:
   1. Base all bids on materials, equipment, and procedures specified.
   2. Certain types of equipment and kinds of material are described in specifications by means of references to names of manufacturers and vendors, trade names, or catalog numbers.
      a. When this method of specifying is used, it is not intended to exclude from consideration other products bearing other manufacturer's or vendor's names, trade names, or catalog numbers, provided said products are "or-equals," as determined by Engineer.
   3. Other types of equipment and kinds of material may be acceptable substitutions under the following conditions:
      a. Or-equals are unavailable due to strike, discontinued production of products meeting specified requirements, or other factors beyond control of Contractor; or,
      b. Contractor proposes a cost and/or time reduction incentive to the Owner.

1.2 QUALITY ASSURANCE

A. In making request for substitution or in using an approved product, Contractor represents Contractor:
   1. Has investigated proposed product, and has determined that it is adequate or superior in all respects to that specified, and that it will perform function for which it is intended.
   2. Will provide same guarantee for substitute item as for product specified.
   3. Will coordinate installation of accepted substitution into Work, to include building modifications if necessary, making such changes as may be required for Work to be complete in all respects.
   4. Waives all claims for additional costs related to substitution which subsequently arise.

1.3 DEFINITIONS

A. Product: Manufactured material or equipment.

1.4 PROCEDURE FOR REQUESTING SUBSTITUTION

A. Substitution shall be considered only:
   1. After Award of Contract.
   2. Under the conditions stated herein.

B. Written request through Contractor only.

C. Transmittal Mechanics:
   1. Follow the transmittal mechanics prescribed for Shop Drawings in Specification Section 01340.

a. Product substitution will be treated in a manner similar to "deviations," as described in Specification Section 01340.
b. List the letter describing the deviation and justifications on the transmittal form in the space provided under the column with the heading DESCRIPTION.
1) Include in the transmittal letter, either directly or as a clearly marked attachment, the items listed in Paragraph D below.

D. Transmittal Contents:
1. Product identification:
a. Manufacturer's name.
b. Telephone number and representative contact name.
c. Specification Section or Drawing reference of originally specified product, including discrete name or tag number assigned to original product in the Contract Documents.
2. Manufacturer's literature clearly marked to show compliance of proposed product with Contract Documents.
3. Itemized comparison of original and proposed product addressing product characteristics including but not necessarily limited to:
a. Size.
b. Composition or materials of construction.
c. Weight.
d. Electrical or mechanical requirements.
4. Product experience:
a. Location of past projects utilizing product.
b. Name and telephone number of persons associated with referenced projects knowledgeable concerning proposed product.
c. Available field data and reports associated with proposed product.
5. Data relating to changes in construction schedule.
6. Data relating to changes in cost.
7. Samples:
a. At request of Engineer.
b. Full size if requested by Engineer.
c. Held until substantial completion.
d. Engineer not responsible for loss or damage to samples.

1.5 APPROVAL OR REJECTION

A. Written approval or rejection of substitution given by the Engineer.

B. Engineer reserves the right to require proposed product to comply with color and pattern of specified product if necessary to secure design intent.

C. In the event the substitution is approved, the resulting cost and/or time reduction will be documented by Change Order in accordance with the General Conditions.

D. Substitution will be rejected if:
1. Submittal is not through the Contractor with his stamp of approval.
2. Request is not made in accordance with this Specification Section.
3. In the Engineer's opinion, acceptance will require substantial revision of the original design.
4. In the Engineer's opinion, substitution will not perform adequately the function consistent with the design intent.

E. Contractor shall reimburse Owner for the cost of Engineer's evaluation whether or not substitution is approved.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

EXHIBIT A

Substitution Request Form
(One Item per each Form)

Project:		Date:
Substitution Requestor:		
Contractor:		
Specification Section No:	Paragraph No. (i.e. 2.1.A.1.c):	Specified Item:
Proposed Substitution:		

Provide Product Data Sheets, Manufacturer's written installation instructions, drawings, diagrams, or any other information as an attached to this Form that will demonstrate the proposed substitution is an Approved Equal.

In the lines provided state differences between proposed substitutions and specified item. Differences include but are not limited to interrelationship with other items; materials, equipment, function, utility, life cycle costs, applied finished, appearances, and quality.

In the lines provided demonstrate how the proposed substitution is compatible with or modifies other systems, parts, equipment or components of the Project and Work under the Contract
:

In the lines provided, describe what effect the proposed substitution has on dimensions indicated on the Drawings and previously reviewed Shop Drawings?

In the lines provided, describe what effect the proposed substitution has on the Construction Schedule and Contract Time.

In the lines provided, describe what effect the proposed substitution has on the Contract Price. This includes all direct, indirect, impact and delay costs.

Manufacturer's guarantees of the proposed and specified items are:

☐ Same ☐ Different (explain on attachment)

The undersigned state that the function, utility, life cycle costs, applied finishes, appearance and quality of the proposed substitution are equal or superior to those of the specified item.

For use by Project Representative:

☐ Accepted ☐ Accepted as Noted

☐ Not Accepted ☐ Received Too Late

(Contractor's Signature)

(Contractor's Firm)

(Date)

(Firms Address)

(Telephone)

Comments:

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SECTION 01650
FACILITY START-UP, SEQUENCING AND CONSTRAINTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Procedures and actions, required of the Contractor, which are necessary to achieve and demonstrate Substantial Completion.
   2. Requirements for Substantial Completion Submittals.

1.2 DEFINITIONS

A. Project Classified System (PCS): A defined part of the Project, consisting of an arrangement of items, such as equipment, structures, components, piping, wiring, materials, or incidentals, so related or connected to form an identifiable, unified, functional, operational, safe, and independent system.

B. Pre-Demonstration Period: The period of time, of unspecified duration after initial construction and installation activities during which Contractor, with assistance from manufacturer's representatives, performs in the following sequence:
   1. Finishing type construction work to ensure the Project or each PCS has reached a state of Substantial Completion.
   2. Equipment start-up.
   3. Personnel training.

C. Demonstration Period: A period of time, of specified duration, following the Pre-Demonstration Period, during which the Contractor initiates process flow through the Project Classified System and starts up and operates the Project Classified System, without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components and the control interfaces of the respective equipment and components comprising the Project Classified System as evidence of Substantial Completion.

D. Substantial Completion: See the General Conditions.

1.3 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. Submit in the chronological order listed below prior to the completion of the Pre-Demonstration Period.
   1. Master operation and maintenance training schedule:
      a. Submit 30 days (minimum) prior to first training session for Owner's personnel.
      b. Schedule to include:
         1) Target date and time for Owner witnessing of each system initial start-up.
         2) Target date and time for Operation and Maintenance training for each system, both field and classroom.
         3) Target date for initiation of Demonstration Period.
      c. Submit for review and approval by Owner.
      d. Include holidays observed by Owner.
      e. Attend a schedule planning and coordination meeting 90 calendar days prior to first anticipated training session.
         1) Provide a status report and schedule-to-complete for requirements prerequisite to manufacturer's training.
         2) Identify initial target dates for individual manufacturer's training sessions.

f. Owner reserves the right to insist on a minimum seven (7) days' notice of rescheduled training session not conducted on master schedule target date for any reason.
g. Schedule to be resubmitted until approved.

2. Substantial Completion Submittal:
   a. File Contractor's Notice of Substantial Completion and Request for Inspection.
   b. Approved Operation and Maintenance manuals received by Engineer minimum 30 days prior to scheduled training.
   c. Written request for Owner to witness each system pre-demonstration start-up.
      1) Request to be received by Owner minimum one (1) week before scheduled training of Owner's personnel on that system.
   d. Equipment installation and pre-demonstration start-up certifications.
   e. Letter verifying completion of all pre-demonstration start-up activities including receipt of all specified items from manufacturers or suppliers as final item prior to initiation of Demonstration Period.

1.4 SEQUENCING AND SCHEDULING

A. Phased Construction: See Specification Section 01010.

1.5 COST OF START-UP

A. Contractor to pay all costs associated with Facility start-up.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 GENERAL

A. Facility Start-up Divided into Two Periods:
   1. Pre-Demonstration Period including:
      a. Completion of construction work to bring Project to a state of Substantial Completion.
      b. Start-up of Equipment.
      c. Training of Personnel.
      d. Completion of the filing of all required submittals.
      e. Filing of Contractor's Notice of Substantial Completion and Request for Inspection.
   2. Demonstration Period including:
      a. Demonstration of functional integrity of facility or PCS.

3.2 PRE-DEMONSTRATION PERIOD

A. Completion of Construction Work:
   1. Complete the work to bring the PCS to a state of substantial completion.

B. Equipment Start-up:
   1. Requirements for individual items of equipment are included in the Technical Specification Sections.
   2. Prepare the equipment so it will operate properly and safely and be ready to demonstrate functional integrity during the Demonstration Period.
   3. Perform Equipment Start-up to extent possible without introducing product flow.
   4. Procedures include but are not necessarily limited to the following:
      a. Test or check and correct deficiencies of:
         1) Power, control, and monitoring circuits for continuity prior to connection to power source.
         2) Voltage of all circuits.
         3) Phase sequence.

4) Cleanliness of connecting piping systems.
5) Alignment of connected machinery.
6) Vacuum and pressure of all closed systems.
7) Lubrication.
8) Valve orientation and position status for manual operating mode.
9) Tankage for integrity using clean water.
10) Pumping equipment using clean water.
11) Instrumentation and control signal generation, transmission, reception, and response.
12) Tagging and identification systems.
13) All equipment: Proper connections, alignment, calibration and adjustment.

b. Calibrate all safety equipment.
c. Manually rotate or move moving parts to assure freedom of movement.
d. "Bump" start electric motors to verify proper rotation.
e. Perform other tests, checks, and activities required to make the equipment ready for Demonstration Period.
f. Documentation:
1) Prepare a log showing each equipment item subject to this paragraph and listing what is to be accomplished during Equipment Start-up.
2) Provide a place for the Contractor to record date and person accomplishing required work.
3) Submit completed document before requesting inspection for Substantial Completion certification.

5. Obtain certifications, without restrictions or qualifications, and deliver to Engineer:
a. Manufacturer's equipment installation check letters (sometimes referred to as Manufacturer’s Field Services report).
b. Instrumentation Supplier's Instrumentation Installation Certificate.

C. Personnel Training:
1. See individual equipment specification sections.
2. Conduct all personnel training after completion of Equipment Start-up for the equipment for which training is being conducted.
a. Personnel training on individual equipment or systems will not be considered completed unless:
1) All pretraining deliverables are received and approved before commencement of training on the individual equipment or system.
2) No system malfunctions occur during training.
3) All provisions of field and classroom training specifications are met.
b. Training not in compliance with the above will be performed again in its entirety by the manufacturer at no additional cost to Owner.
3. Field and classroom training requirements:
a. Hold classroom training on-site.
b. Notify each manufacturer specified for on-site training that the Owner reserves the right to video record any or all training sessions.
1) Organize each training session in a format compatible with video recording.
c. Training instructor qualification: Factory trained and familiar with giving both classroom and "hands-on" instructions.
d. Training instructors:
1) Be at classes on time.
2) Session beginning and ending times to be coordinated with the Owner and indicated on the master schedule.
3) Normal time lengths for class periods can vary, but brief rest breaks should be scheduled and taken.
e. Organize training sessions into maintenance verses operation topics and identify on schedule.

f. Plan for minimum class attendance of five people at each session and provide sufficient classroom materials, samples, and handouts for those in attendance.
g. Instructors to have a typed agenda and well prepared instructional material.
    1) The use of visual aids, e.g., films, pictures, and slides is recommended for use during the classroom training programs.
    2) Deliver agendas to the Engineer a minimum of seven (7) days prior to the classroom training.
    3) Provide equipment required for presentation of films, slides, and other visual aids.
h. In the on-site training sessions, cover the information required in the Operation and Maintenance Manuals submitted according to Specification Section 01342 and the following areas as applicable to PCS's.
    1) Operation of equipment.
    2) Lubrication of equipment.
    3) Maintenance and repair of equipment.
    4) Troubleshooting of equipment.
    5) Preventive maintenance procedures.
    6) Adjustments to equipment.
    7) Inventory of spare parts.
    8) Optimizing equipment performance.
    9) Capabilities.
    10) Operational safety.
    11) Emergency situation response.
    12) Takedown procedures (disassembly and assembly).
i. Address above Paragraphs 1), 2), 8), 9), 10), and 11) in the operation sessions. Address above Paragraphs 3), 4), 5), 6), 7), and 12) in the maintenance sessions.
j. Maintain a log of classroom training provided including: Instructors, topics, dates, time, and attendance.

D. Complete the filing of all required submittals:
    1. Shop Drawings.
    2. Operation and Maintenance Manuals.
    3. Training material.

E. Filing of Contractor's Notice of Substantial Completion and Request for Inspection of Project or PCS:
    1. File the notice when the following have been completed:
        a. Construction work (brought to state of Substantial Completion).
        b. Equipment Start-up.
        c. Personnel Training.
        d. Submittal of required documents.
    2. Engineer will review required submittals for completeness within 5 calendar days of Contractor's notice. If complete, Engineer will complete inspection of the Work, within 10 calendar days of Contractor's notice.
    3. Engineer will inform Contractor in writing of the status of the Work reviewed, within 14 calendar days of Contractor's notice.
        a. Work determined not meeting state of Substantial Completion:
            1) Contractor: Correct deficiencies noted or submit plan of action for correction within 5 days of Engineer's determination.
            2) Engineer: Reinspect work within 5 days of Contractor's notice of correction of deficiencies.
            3) Reinspection costs incurred by Engineer will be billed to Owner who will deduct them from final payment due Contractor.
        b. Work determined to be in state of tentative Substantial Completion: Engineer to prepare tentative "Engineer's Certificate of Substantial Completion."
        c. Engineer's Certificate of Substantial Completion:
            1) Certificate tentatively issued subject to successful Demonstration of functional integrity.

2) Issued for Project as a whole or for one or more PCS.
3) Issued subject to completion or correction of items cited in the certificate (punch list).
4) Issued with responsibilities of Owner and Contractor cited.
5) Executed by Engineer.
6) Accepted by Owner.
7) Accepted by Contractor.

d. Upon successful completion of Demonstration Period, Engineer will endorse certificate attesting to the successful demonstration, and citing the hour and date of ending the successful Demonstration Period of functional integrity as the effective date of Substantial Completion.

3.3 DEMONSTRATION PERIOD

A. General:
1. Demonstrate the functional integrity of the mechanical, electrical, and control interfaces of the respective equipment and components comprising the PCS as evidence of Substantial Completion.
2. Duration of Demonstration Period: 120 consecutive hours.
3. If, during the Demonstration Period, the aggregate amount of time used for repair, alteration, or unscheduled adjustments to any equipment or systems that renders the affected equipment or system inoperative exceed 10 percent of the Demonstration Period, the demonstration of functional integrity will be deemed to have failed.
   a. In the event of failure, a new Demonstration Period will recommence after correction of the cause of failure.
   b. The new Demonstration Period shall have the same requirements and duration as the Demonstration Period previously conducted.
4. Conduct the demonstration of functional integrity under full operational conditions.
5. Owner will provide operational personnel to provide process decisions affecting plant performance.
   a. Owner's assistance will be available only for process decisions.
   b. Contractor will perform all other functions including but not limited to equipment operation and maintenance until successful completion of the Demonstration Period.
6. Owner reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, etc., to verify the functional integrity of automatic and manual backup systems and alternate operating modes.
7. Time of beginning and ending any Demonstration Period shall be agreed upon by Contractor, Owner, and Engineer in advance of initiating Demonstration Period.
8. Throughout the Demonstration Period, provide knowledgeable personnel to answer Owner's questions, provide final field instruction on select systems and to respond to any system problems or failures which may occur.
9. Provide all labor, supervision, utilities, chemicals, maintenance, equipment, vehicles or any other item necessary to operate and demonstrate all systems being demonstrated.

END OF SECTION

SECTION 01710
CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Intermediate and final cleaning of Work not including special cleaning of closed systems specified elsewhere.

1.2 STORAGE AND HANDLING

A. Store cleaning products and cleaning wastes in containers specifically designed for those materials.

1.3 SCHEDULING

A. Schedule cleaning operations so that dust and other contaminants disturbed by cleaning process will not fall on newly painted surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents:
   1. Compatible with surface being cleaned.
   2. New and uncontaminated.
   3. For Manufactured Surfaces: Material recommended by manufacturer.

PART 3 - EXECUTION

3.1 CLEANING - GENERAL

A. Prevent accumulation of wastes that create hazardous conditions.

B. Conduct cleaning and disposal operations to comply with laws and safety orders of governing authorities.

C. Do not dispose of volatile wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains or sewers.

D. Dispose of degradable debris at an approved solid waste disposal site.

E. Dispose of nondegradable debris at an approved solid waste disposal site or in an alternate manner approved by Engineer and regulatory agencies.

F. Handle materials in a controlled manner with as few handlings as possible.

G. Do not drop or throw materials from heights greater than 4 FT or less than 4 FT if conditions warrant greater care.

H. On completion of work, leave area in a clean, natural looking condition.
   1. Remove all signs of temporary construction and activities incidental to construction of required permanent Work.

I. Do not burn on-site.

3.2 INTERIOR CLEANING

A. Cleaning During Construction:
   1. Keep work areas clean so as not to hinder health, safety or convenience of personnel in existing facility operations.
   2. At maximum weekly intervals, dispose of waste materials, debris, and rubbish.
   3. Vacuum clean interior areas when ready to receive finish painting.
      a. Continue vacuum cleaning on an as-needed basis, until substantial completion.

B. Final Cleaning:
   1. Complete immediately prior to Demonstration Period.
   2. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed surfaces.
   3. Wipe all lighting fixture reflectors, lenses, lamps and trims clean.
   4. Wash and shine glazing and mirrors.
   5. Polish glossy surfaces to a clear shine.
   6. Ventilating systems:
      a. Clean permanent filters and replace disposable filters if units were operated during construction.
      b. Clean ducts, blowers and coils if units were operated without filters during construction.
   7. Replace all burned out lamps.
   8. Broom clean process area floors.
   9. Mop office and control room floors.

3.3 EXTERIOR (SITE) CLEANING

A. Cleaning During Construction:
   1. Construction debris:
      a. Confine in strategically located container(s):
         1) Cover to prevent blowing by wind.
         2) Haul from site minimum once a week.
      b. Remove from work area to container daily.
   2. Vegetation: Keep weeds and other vegetation trimmed to 3 IN maximum height.
   3. Soils, sand, and gravel deposited on paved areas and walks:
      a. Remove as required to prevent muddy or dusty conditions.
      b. Do not flush into storm sewer system.

B. Final Cleaning:
   1. Remove trash and debris containers from site.
      a. Re-seed areas disturbed by location of trash and debris containers.
   2. Clean paved roadways.

3.4 FIELD QUALITY CONTROL

A. Immediately prior to Demonstration Period, conduct an inspection with Engineer to verify condition of all work areas.

END OF SECTION

SECTION 01800
OPENINGS AND PENETRATIONS IN CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Methods of installing and sealing openings and penetrations in construction.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 501, Class 1 Locations.
      b. 90A, Standard for Installation of Air Conditioning and Ventilating Systems.
   4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

B. Obtain prior approval from Engineer when any opening larger than 100 SQ IN must be made in existing or newly completed construction.

1.3 DEFINITIONS

A. Hazardous Areas: Areas shown in the Contract Documents as having Class I or Class II area classifications.

B. Washdown Areas: Areas having floor drains or hose bibs.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. For each structure provide dimensioned or scaled (minimum 1/8 IN = 1 FT) plan view drawings containing the following information:
      a. Vertical and horizontal location of all required openings and penetrations.
      b. Size of all openings and penetrations.
      c. Opening type.
      d. Seal type.
   3. Manufacturer's installation instructions for standard manufactured products.

1.5 PROJECT CONDITIONS

A. For purposes of this Project, water table level is elevation 102.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe Sleeves: Steel, ASTM A53, Schedule 40, black.

B. Pipe Sleeves Penetrating into Corrosive Areas: Stainless steel, 1/4 IN minimum thickness.

C. Backing Rod and Sealant: See Specification Section 07900.

D. Modular Mechanical Seals:
   1. Acceptable manufacturers:
      a. Link-Seal.
   2. 316 stainless steel bolts, nuts and washers.

E. Firestopping Material: Per Building Code.

F. Sheet Metal Sleeves: Steel, ASTM A36, 12 GA.

G. Commercial Wall Castings:
   1. For unclassified areas both sides of penetration:
      a. Ductile iron, class equal to connecting piping system.
   2. For wet/corrosive areas either side of penetration:
      a. Stainless steel, 304L.

H. Grating:
   1. Aluminum
   2. Steel
   3. FRP

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Perform HVAC penetrations in accordance with NFPA 90A.

B. Perform electrical penetrations in accordance with NFPA 70, Article 501.

C. Install sleeves and castings in accordance with ACI 318, Chapter #6.

D. Hot-dip galvanize in accordance with Specification Section 05505 (or paint in accordance with Specification Section 09905) all steel sleeves installed.

E. When mechanical or electrical work cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, insets, fixtures or devices necessary to permit installation later.
   1. Lay out chases, holes or other openings which must be provided in masonry, concrete or other work.

F. Where pipes, conduits or ducts pass through floors in washdown areas, install sleeves with top 3 IN above finish floors.
   1. In non-washdown areas, install sleeves with ends flush with finished surfaces.

G. Size sleeves, blockouts and cutouts which will receive sealant seal such that free area to receive sealant is minimized and seal integrity may be obtained.

H. For insulated piping and ducts, size sleeves, blockouts and cutouts large enough to accommodate full thickness of insulation.

I. Where pipes, conduits or ducts pass through grating or are removed where passing through grating provide banding at the entire perimeter of the opening.
   1. Where opening is vacated, provide banding at perimeter and cover opening with 1/4 IN plate of the same material of the grating (aluminum or steel).
   2. For FRP, provide full depth cover meeting same loading requirement as existing material or replace grating section.

J. Do not cut into or core drill any beams, joists, or columns.

K. Do not install sleeves in beams, joists, or columns.

L. Do not install recesses in beams, joists, columns, or slabs.

M. Field Cutting and Coring:
   1. Saw or core drill with non-impact type equipment.
   2. Mark opening and drill small 3/4 IN or less holes through structure following opening outline.
   3. Sawcut opening outline on both surfaces.
      a. Knock out within sawcuts using impact type equipment.
      b. Do not chip or spall face of surface to remain intact.
      c. Do not allow any overcut with saw kerf.

N. Precast-Prestressed Concrete Construction:
   1. Do not cut openings nor core drill vertically or horizontally through stems of members.
   2. Do not locate or install sleeves or recess sleeves vertically or horizontally through or in stems of members.
   3. Cast openings and sleeves into flanges of units.
   4. Cast openings larger than 6 IN in diameter or 6 IN maximum dimension in units at time of manufacture.
   5. Cast openings smaller than 6 IN in diameter or 6 IN maximum dimensions in flanges of units at time of manufacture or field cut.

O. Where alterations are necessary or where new and old work join, restore adjacent surfaces to their condition existing prior to start of work.

P. Provide waterstop plate/anchor flange for piping, ducts, castings and sleeves cast-in-place in concrete.
   1. For fabricated units, weld plate to sleeve, pipe, or ductwork.
   2. For commercial castings, cast water stop/anchor with wall pipe.
   3. Plate is to be same thickness as sleeve, pipe, casting or ductwork.
   4. For fabricated units, diameter of plate or flange to be 4 IN larger than outside diameter of sleeve, pipe or ductwork.
   5. For commercial castings, waterstop/anchor size to be manufacturer standard.
   6. Provide continuous around entire circumference of sleeve, pipe, or ductwork.

Q. Where area is blocked out to receive sheet metal sleeve at later date:
   1. If blockout size is sufficient to allow placement, utilize dowels for interface of initially placed concrete and sleeve encasement concrete which is placed later.
      a. Size blockout based on sleeve size required plus 4 to 6 IN each side of sleeve for concrete encasement.
      b. Provide #4 dowels at 12 IN spacing along each side of blockout with minimum of two (2) dowels required per side.
   2. If blockout size is not sufficient to allow placement of dowels, provide keyway along all sides of blockout.
      a. Size blockout based on sleeve size required plus 2 to 4 IN each side of sleeve for concrete encasement.

R. For interior wall applications where backer rod and sealant are specified, provide backer rod and sealant at each side of wall.

S. Refer to Drawings for location of fire-rated walls, floors, and ceilings.
   1. Utilize firestopping materials and procedures in conjunction with scheduled opening type to produce the required fire rating.

T. Use full depth expanding foam sealant for seal applications where single or multiple pipes, conduits, etc., pass through a single sleeve.

U. Do not make duct or conduit penetrations below high water levels when entering or leaving tankage, wet wells, or other water holding structures.

V. Modular Mechanical Seals:
   1. Utilize one (1) seal for concrete thickness less than 8 IN and two (2) seals for concrete, 8 IN thick or greater.

2. Utilize two (2) seals for piping 16 IN diameter and larger if concrete thickness permits.
3. Install seals such that bolt heads are located on the most accessible side of the penetration.

W. Backer Rod and Sealant:
1. Install in accordance with Specification Section 07900.
2. Provide backer rod and sealant for modular mechanical seal applications.
   a. Apply on top side of slab penetrations and on interior, dry side wall penetrations.

3.2 SCHEDULES

A. General Schedule of Penetrations through Floors, Grating, Roofs, Foundation Base Slabs, Foundation Walls, Foundation Footings, Partitions and Walls for Ductwork, Piping, and Conduit:
1. Provide the following opening and penetration types:
   a. Type A - Block out 2 IN larger than outside dimensions of duct, pipe, or conduits.
   b. Type B - Saw cut or line-drill opening. Place new concrete with integrally cast sheet metal or pipe sleeve.
   c. Type C - Fabricated sheet metal sleeve or pipe sleeve cast-in-place. Provide pipe sleeve with water ring for wet and/or washdown areas.
   d. Type D - Commercial type casting or fabrication.
   e. Type E - Saw cut or line-drill opening. Place new concrete with integrally cast pipe, duct or conduit spools.
   f. Type F - Integrally cast pipe, duct or conduit.
   g. Type G - Saw cut or line-drill and remove area 1 IN larger than outside dimensions of duct, pipe or conduit.
   h. Type H - Core drill.
   i. Type I - Block out area. At later date, place new concrete with integrally cast sheet metal or pipe sleeve.
   j. Type J- Grating Banding for any field cut openings
2. Provide seals of material and method described as follows.
   a. Category 1 - Modular Mechanical Seal.
   b. Category 2 - Roof curb and flashing according to SMACNA specifications unless otherwise noted on Drawings.
   c. Category 3 - 12 GA sheet metal drip sleeve set in bed of silicon sealant with backing rod and sealant used in sleeve annulus.
   d. Category 4 - Backer rod and sealant.
   e. Category 5 - Full depth compressible sealant with escutcheons on both sides of opening.
   f. Category 6 - Full depth compressible sealant and flanges on both sides of opening. Flanges constructed of same material as duct, fastened to duct and minimum 1/2 IN larger than opening.
   g. Category 7 - Full depth compressible sealant and finish sealant or full depth expanding foam sealant depending on application.
   h. Category 8- Banding for all grating openings and banding and cover plate of similar materials for abandoned openings
3. Furnish openings and sealing materials through new floors, roofs, grating, partitions and walls in accordance with Schedule A, Openings and Penetrations for New Construction.
4. Furnish openings and sealing materials through existing floors, grating, roofs, partitions and walls in accordance with Schedule B, Openings and Penetrations for Existing Construction.

SCHEDULE A. OPENINGS AND PENETRATIONS SCHEDULE
FOR NEW CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors with bottom side a hazardous location	C F I	7 Not Req 7	D F I (1)	Not Req Not Req 7	C F	7 Not Req
Through floors on grade above water table	C F I	4 Not Req 4	C F I (1)	7 Not Req 7	C F I (1)	4 Not Req 7
Through slab on grade below water table	F	Not Req	F	Not Req	F	Not Req
Through floors in washdown areas	C I	4 4	C H (2) I (1)	4 3 4	F H (2) I (1)	Not Req 3 7
Through walls where one side is a hazardous area	C F I	7 Not Req 7	D F I (1)	Not Req Not Req 7	C F	7 Not Req
Through exterior wall below grade above water table	C F I	7 Not Req 7	C D F I (1)	1 Not Req Not Req 1	F I (1)	Not Req 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	C F I	7 Not Req 7	C D F H (2)	1 Not Req Not Req 1	C F H (2) I (1)	7 Not Req 7 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	F	Not Req	F	Not Req	F	Not Req
Through exterior wall above grade	A B C	6 6 6	A B D H (2)	5 5 Not Req 5	C H (2)	5 4
Roof penetrations	A	2	A	2	A	2
Through interior walls and slabs not covered by the above applications	A C	4 4	A C	4 4	A C F	4 4 Not Req
Grating openings and penetrations	J	8	J	8	J	8

SCHEDULE B. OPENINGS AND PENETRATIONS SCHEDULE FOR EXISTING CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors with bottom side a hazardous location	B E	7 Not Req	B (1) E (3) H (2)	7 Not Req 7	B (1) E (3) H (2)	7 Not Req 7
Through floors on grade above water table	B	7	B	7	B	7
Through slab on grade below water table	E	Not Req	E	Not Req	E	Not Req
Through floors in washdown areas	G	3	G H (2)	3 3	G H (2)	3 3
Through walls where one side is a hazardous area	B E	7 Not Req	B (1) B (3) E H (2)	7 1 Not Req 7	B (1) (3) E H (2)	7 Not Req 7
Through exterior wall below grade above water table	B	7	B (1) B (3) H (2)	7 1 7	B (1) (3) H (2)	7 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	B E	7 Not Req	B E H (2)	1 Not Req 1	B (1) (3) E H (2)	7 Not Req 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	E	Not Req	E	Not Req	E	Not Req
Through exterior wall above grade	G	6	G (1) (3) H (2)	5 5	G (1) (3) H (2)	5 7
Roof penetrations	G	2	G (1) (3) H (2)	2	G	2
Through interior walls and slabs not covered by the above applications	G	4	G (1) (3) H (2)	4 4	G (1) (3) H (2)	4 4
Grating openings and penetrations	J	8	J	8	J	8

(1) Multiple piping 3 IN and smaller or multiple conduits.
(2) Single pipe 3 IN and smaller or single conduit.
(3) Single pipe or conduit larger than 3 IN.

END OF SECTION

SECTION 01900
SOIL INVESTIGATION DATA

PART 1 - GENERAL

1.1 INVESTIGATION

A. Soil and subsurface investigations were conducted at the plant site. A Geotechnical Investigation report was prepared for this project:
   1. Title: Pinole/Hercules Water Pollution Control Plant Upgrades.
   2. Date: April 6, 2015

B. A copy of the soils boring logs is included at the end of this section.

C. Reproductions of information will NOT be available or made at the office of the Engineer.

D. This report of explorations and tests of subsurface conditions at the site has been utilized by the Engineer in preparation of the Contract Documents. Bidder may rely upon the accuracy of the "technical" data contained in such reports but not upon nontechnical data, interpretations or opinions contained therein or for the completeness thereof for the purposes of bidding or construction.

E. This report is **not** part of the Contract Documents but the technical data contained therein upon which Bidder is entitled to rely are incorporated therein by reference. Such technical data is boring method, location and logs; and laboratory test methods and results.

F. Before submitting a Bid, each Bidder will, at Bidder's own expense, make or obtain any additional examinations, investigations, explorations, tests and studies and obtain any additional information and data, which pertain to the physical conditions, surface or subsurface, at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work and which Bidder deems necessary to determine its Bid for performing and furnishing the Work in accordance with the time, price and other terms and conditions of the Contract Documents.

END OF SECTION

SECTION 02072
DEMOLITION, CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition, cutting and patching of existing construction where shown on Drawings, or as required to accommodate new work shown or specified.

1.2 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Indicating manufacturer and type of:
      a. Proposed nonshrink grout.
      b. Epoxy bonding adhesive.
      c. Proposed materials and methods to be used for matching and repairing existing construction.

1.3 DELIVERY, STORAGE, AND HANDLING

A. General:
   1. Salvage items, designated for Owner's salvage, as a functional unit.
   2. Clean, list and tag for storage.
   3. Protect from damage and deliver to location designated.
   4. Salvage each item with auxiliary or associated equipment required for operation.

1.4 PROJECT CONDITIONS

A. Perform preliminary investigations as required to ascertain extent of work.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate and reschedule work as required to preclude interference with other operations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   1. Nonshrink grout:
      a. Supreme Grout by Gifford Hill.
      b. Masterflow 713 Plus by BASF Building Systems.
      c. Sika Grout 212 by Sika.
      d. Five Star Grout by Five Star Products, Inc.
   2. Epoxy bonding adhesive:
      a. Euco No.452 MV by Euclid Chemical Co.
      b. Sikadur 32, Hi-Mod by Sika Corporation.
   3. Epoxy patch:
      a. Depth of patch:
         1) Greater than 3/4 IN: Five Star MP Epoxy Patch.
         2) Between 1/8 IN and 3/4 IN: Five Star Fluid Epoxy.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Temporary Partitions:
   1. Plywood: 1/2 IN minimum for interior or exterior use.
   2. Paneling: 1/4 IN minimum for interior use.

B. Nonshrink Grout:
   1. Nonmetallic, noncorrosive and nonstaining.
   2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
   3. Grout to produce a positive but controlled expansion.
      a. Mass expansion not to be created by gas liberation or by other means.
   4. Minimum compressive strength at 28 days to be 6500 psi.
   5. Coat exposed edges of grout with a cure/seal compound recommended by grout manufacturer.

C. Epoxy Bonding Adhesive:
   1. Two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide temporary partitions as required in public areas.
   1. Construct partitions of braced plywood in exterior areas.
   2. Adequately braced paneling may be used in interior areas.

B. Provide covered passageways where necessary to ensure safe passage of persons in or near areas of work.

C. Provide substantial barricades and safety lights as required.

D. Provide temporary dustproof partitions where indicated or necessary.
   1. Prevent infiltration of dust into occupied areas.

E. Provide temporary weather protection as necessary.

3.2 INSTALLATION

A. Cutting and Removal:
   1. Remove existing work indicated to be removed, or as necessary for installation of new work.
   2. Neatly cut and remove materials, and prepare all openings to receive new work.
   3. Remove masonry or concrete in small sections.

B. Modification of Existing Concrete:
   1. Where indicated, remove existing concrete and finish remaining surfaces as specified in Specification Section 03348.
      a. Protect remaining concrete from damage.
      b. Make openings by sawing through the existing concrete.
      c. Break out concrete after initial saw cuts in the event concrete thickness prevents cutting through.
      d. Make openings by drilling holes around perimeter of opening and then chipping out the concrete where sawing is not possible.
         1) Holes shall be sufficient in number to prevent damage to remaining concrete.
   2. Oversize required openings in existing concrete 1 IN on all sides and build back to required opening size by means of nonshrink grout epoxy bonded to the existing concrete.

3. Where oversized openings cannot be made, remove the concrete to the required opening size and cut back exposed reinforcing 1 IN from face of concrete and fill resulting holes with nonshrink grout.

C. Removal of Existing Anchor Bolts or Other Protruding Elements:
1. Remove all protruding elements.
2. Remove to a depth of 1/4 IN from finished surface.
3. Fill void with epoxy patch.

D. Matching and Patching:
1. Walls, ceilings, floors or partitions:
   a. Repair abutting walls, ceilings, floors or partitions disturbed by removal.
   b. Match and patch existing construction disturbed during installation of new work.
2. Methods and materials:
   a. Similar in appearance, and equal in quality to adjacent areas for areas or surfaces being repaired.
   b. Subject to review of Owner.
3. Reinforcing steel that is cut and exposed:
   a. Remove to a depth of 1/4 IN.
   b. Fill void with epoxy patch.

E. Salvaged Items:
1. Thoroughly dry and clean all metal surfaces.
2. Prime all bare metal in accordance with Specification Section 09905.
3. Clean and lubricate motors and other moving parts.
4. Brace motors attached to flexible mountings until reinstallation.
5. Dispose of items or materials not designated for Owner's salvage or reuse.
   a. Promptly remove from site.
6. Do not store or sell Contractor salvaged items or materials on-site.
7. Carefully remove items to be salvaged and reused or to be delivered to Owner's storage.
   a. Store and protect items indicated on Drawings or those which have been marked by Owner to be salvaged or to be reused in Work.
   b. Replace any item damaged through carelessness in removal, storage, or handling with new items of same type.
   c. Do not reuse materials or equipment not specifically indicated or specified to be reused.
8. Preparation of equipment for storage:
   a. Identify each component with markings or tags to show its position in the assembly and the assembly of which it belongs.
   b. Place small parts of wooden boxes and clearly mark contents on the outside.
   c. Remove oil from oil-lubricated bearings and gear boxes and replace with storage oil.
   d. Grease grease-lubricated bearings.
   e. Replace any breather plug with solid plug.
   f. Megger test motor windings: Attach report of the test results to the unit and furnish one (1) copy to the Engineer.
   g. Attach unit to suitable crate bottom.
   h. Enclose unit in polyethylene film and seal all seams and the film to the base of the unit with tape.
   i. Construct crate of wooden slats around top and sides of unit.
   j. Attach permanent instruction tag to outside of crate stating "This unit has been prepared for storage--replace oil, vent plugs, and lubricant in accordance with manufacturer's instructions before start-up."

F. Clean Up: Transport debris and legally dispose of off-site.

3.3 SCHEDULE

A. Items to be Salvaged to Owner:
1. All Watson Marlow dosing pumps for Hypo and Bisulfite

2. Thickener moyno Muncher
3. Thickener Scum pump (Seepex)
4. Water filter for #4 water to poly dosers
5. Back flow preventer in DAF
6. Air compressors in influent room (2) and DAF (1)
7. All PVC Y strainers
8. PLC cabinets and inside components
9. All level transmitters
10. Polymer feed pumps
11. Water filter at Effluent Station for filling trucks
12. All Pressure regulators
13. 20 x 20 shed
14. Three (3) hoists and railings from Influent and shop
15. Effluent pump and motor
16. Corp. Yard storage building roof and support beams
17. 4” check valves at #1 and #2 primary clarifier sludge pumps
18. 4” check valve at #3 primary - #4 sludge pump
19. 4” check valve at RST hopper pump
20. 4” Dezurik valve at RST hopper pump
21. 3 way actuator valves in Effluent Building and PLC 9

END OF SECTION

SECTION 02110
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Site clearing, tree protection, stripping topsoil and demolition.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing trees and other vegetation to remain against damage.
   1. Do not smother trees by stockpiling construction materials or excavated materials within drip line.
   2. Avoid foot or vehicular traffic or parking of vehicles within drip line.
   3. Provide temporary protection as required.

B. Repair or replace trees and vegetation damaged by construction operations.
   1. Repair to be performed by a qualified tree surgeon.
   2. Remove trees which cannot be repaired and restored to full-growth status.
   3. Replace with new trees of minimum 4 IN caliper.

C. Owner will obtain authority for removal and alteration work on adjoining property.

3.2 SITE CLEARING

A. Topsoil Removal:
   1. Strip topsoil to depths encountered.
      a. Remove heavy growths of grass before stripping.
      b. Stop topsoil stripping sufficient distance from such trees to prevent damage to main root system.
      c. Separate from underlying subsoil or objectionable material.
   2. Stockpile topsoil where directed by Engineer.
      a. Construct storage piles to freely drain surface water.
      b. Seed or cover storage piles to prevent erosion.
   3. Do not strip topsoil in wooded areas where no change in grade occurs.
   4. Borrow topsoil: Reasonably free of subsoil, objects over 2 IN DIA, weeds and roots.

B. Clearing and Grubbing:
   1. Clear from within limits of construction all trees not marked to remain.
      a. Include shrubs, brush, downed timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, structures and debris.
   2. Grub (remove) from within limits of construction all stumps, roots, root mats, logs and debris encountered.
      a. Totally grub under areas to be paved.
      b. Grubbing in lawn areas:
         1) In cut areas, totally grub.
         2) In fill areas, where fill is less than 3 FT totally grub ground.

3) Where fill is 3 FT or more in depth, stumps may be left no higher than 6 IN above existing ground surface.

C. Disposal of Waste Materials:
   1. Do not burn combustible materials on site.
   2. Remove all waste materials from site.
   3. Do not bury organic matter on site.

3.3 ACCEPTANCE

A. Upon completion of the site clearing, obtain Engineer's acceptance of the extent of clearing, depth of stripping and rough grade.

END OF SECTION

SECTION 02155
TEMPORARY BYPASS PUMPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Scope
   1. The Contractor shall furnish all labor, materials, equipment, utilities, and incidentals to design, install and maintain operation of temporary bypass pumping systems for the purpose of diverting the existing plant flow around work areas as defined in this specification.
   2. The Contractor shall comply with all federal, state and local laws and regulations concerning pollution arising from construction activities.

1.2 CONTRACTOR QUALIFICATIONS

A. The Contractor assigned to fulfill the duties outlined by this Specification shall possess the following minimum qualifications:
   1. Specialize in the design and operation of temporary bypass pumping systems.
   2. Contractor shall be regularly engaged in projects of similar size and scope.
   3. Contractor shall provide relatively new and reliable equipment for sewer bypass service.

1.3 SUBMITTALS

A. Submit a temporary pumping plan for approval by the Owner and Construction Manager. The temporary pumping plan shall include, at a minimum, the following:
   1. Demonstrate compliance with sequencing constraints identified in Section 01010.
   2. Drawings and details showing
      a. Proposed intake/suction locations,
      b. Pump staging areas,
      c. Pipeline routes, sizes, and discharge locations.
      d. Number, material, and size of all suction and discharge pipes.
      e. Pipeline information, including information on:
         1) Thrust restraint provisions.
         2) Temporary pipe supports, and anchorage.
         3) Protection from damage during use
      f. Elevation schematic showing elevation, on/off levels for each temporary pump, and static head.
   3. A site plan of each bypass pump system, including:
      a. Standby generators.
      b. Protection provisions for both existing operations and temporary systems.
      c. Pump containment systems to ensure that sewage and fuel, where applicable, do not exit the pump staging areas.
   4. Unless otherwise coordinated with Owner, provide information on generator backup power and automatic transfer switch.
   5. System analysis information, including:
      a. Required static lift, frictional and minor headlosses, pipe velocities, and a system curve based on the actual suction and discharge pipeline configuration.
      b. Pipe sizing, material, and quantity information for the temporary piping.
      c. Pump cut sheets and pump curves showing pump capacity and TDH of the proposed system.
      d. Detail the number of pumps used for regular operation and the pumps provided for redundancy.
   6. Electrical plans (or equivalent for engine driven unit), including:
      a. Panel location.
      b. Temporary conduit runs.

c. Connection to back-up power, etc.
d. Manufacturer's information for all electrical equipment.

7. Submit manufacturer's information on the pump Variable Frequency Drive (VFD). Include a letter from the pump manufacturer stating that the VFD is compatible with the submitted pump.
8. Temporary alarm systems for bypass pumping systems.
9. List of names and telephone numbers of the Contractor's personnel that will be notified by the alarm.
10. Provide a plan detailing out the provisions to maintain operation of the temporary pumping systems in the event of mechanical or electrical failure.
11. Information on the instrumentation systems that will control the water surface elevation in the pump sumps.
12. Provide manufacturer's information for all bypass pumping system appurtenances necessary to properly operate and maintain the temporary system.
13. Product information for sound attenuating materials required to meet the requirements of Section 01560.
14. Qualification verification information, including:
    a. Five recent projects of similar size and scope that were completed within the last three years.
    b. Reference names and current phone numbers of the Owner, Contractor, Engineer, or Construction Manager.

B. Submit a System Outage Request (SOR) Form for each bypass/outage plan.

PART 2 - PRODUCTS

2.1 FLOW REQUIREMENTS

A. It is essential to the operation of the treatment plant that no interruptions in the flow occur throughout the duration of the project.

B. Plant flows vary depending on the time of year and the time of day. The bypass system must be able to accommodate all flow conditions including and between the minimum and peak flows as summarized in Section 01010.

C. The bypass system will be operating 24 hours per day.

D. At no time shall sewage be allowed to back-up in the influent pipelines to an elevation higher than the Owner-determined high water alarm level in the bypass pump sumps.

2.2 BYPASS PUMPS

A. Each temporary pumping system shall include at least two pumps.

B. The system shall be capable of providing the maximum specified flow with the largest pump out of service.

C. Pumps shall be installed in parallel and shall run on a variable frequency drive in order to match pump system output flows to flows in the plant.

D. Level controls in the sump shall interface to VFD controls.

E. Pump operation shall be fully automatic.

F. Either submersible or self-priming pumps are acceptable. Pump priming systems that require foot valves or vacuum pumps will not be allowed.

G. Pumps may be electric or diesel powered.

H. Pumps shall come with all necessary start/stop controls and electrical panel.

I. Pumping systems shall meet local noise ordinances.

J. Relatively new and reliable pumps shall be furnished.

K. Pumps shall be non-clog and sewage rated.

L. Pumps shall shutdown when the water surface elevation falls below the control range.

2.3 STAND-BY POWER

A. A back-up power supply shall be provided to ensure that the pumping system is continually operational.

B. Generator shall be supplied with an automatic transfer switch.

C. Generator shall be equipped with exhaust silencers as needed to comply with Section 01560.

D. The emergency power system must be sized to operate all required pumps to meet the peak pumping rates.

E. The emergency power system controls must allow the operation of the lead and the lag pumps, but not allow the operation of multiple pumps beyond the emergency power generator's output rating.

2.4 TEMPORARY PIPING

A. Piping shall be sized for a maximum velocity of 10 feet per second.

B. Acceptable pipe materials are steel, ductile iron, PVC, and polyethylene.

C. All joints shall be positive, restrained joints meeting the requirements of Division 15 of these specifications.

D. Piping and joints shall not leak or show signs of deterioration or rust.

E. Provide check and isolation valves on the discharge side of each bypass pump.

2.5 SYSTEM APPURTENANCES

A. A containment area shall be provided around all equipment that utilizes and/or stores fuel to protect the surrounding area from fuel leakage.

B. Provide all equipment and appurtenances required to operate the bypass pumping system. Appurtenances include but are not limited to electrical control, wiring and panels, instrumentation equipment, controls & wiring, an alarm system notification system, etc.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage and Handling
   1. Comply with Section 01600.

3.2 INSTALLATION

A. All equipment associated with the temporary bypass pumping shall be installed in accordance with manufacturer's instructions.

3.3 TESTING

A. Perform leakage and pressure testing of the bypass pump discharge piping. The tests shall be conducted using clean water prior to introducing sewage flows.

B. Notify Construction Manager 24 hours prior to testing.

3.4 INSPECTION AND MAINTENANCE

A. The Contractor shall continually inspect the bypass pumping system to ensure the system is operating properly.

B. The pumps shall be continuously monitored by a qualified mechanic while in operation.

C. If fuel is required, the contractor shall provide the Construction Manager with a fueling schedule.

D. It is the Contractor's responsibility to provide fuel necessary to maintain continuous operation of the temporary bypass pumping system.

3.5 BYPASS MONITORING

A. Contractor shall have qualified staff on-site at all times during the operation of bypass pumping systems, including nights, weekends, and holidays. The Contractor's staff shall attend to any problems that should occur with pumps or bypass piping.

END OF SECTION

SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Earthwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. C136, Standard Test Method for Sieve Analysis of Fine and Course Aggregates.
      c. D422, Method for Particle Size Analysis of Soils.
      d. D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m)).
      e. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
      f. D2487, Classification of Soils for Engineering Purposes.
      g. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
      h. D3786, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm.
      i. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      j. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
      k. D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
      l. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
      m. D4767. Standard Test Method for Consolidation Undrained Triaxial Compression Test for Cohesive Soils.
      n. D5084, Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
      o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear methods (Shallow Depth).
   2. CALTRANS Test Method:
      a. 202, Sieve Analysis of Fine and Course Aggregates.
      b. 204, Plasticity Index.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Source of fill, backfill and import material.
   3. Certifications.

4. Test reports:
   a. Soils inspection and testing results.

B. Samples:
   1. Submit samples and source of fill and backfill materials proposed for use.
   2. Submit certifications and lab test demonstrating compliance of fill and backfill with specified requirements and material source.
   3. Submit samples and source of borrow materials proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fill and Backfill: On-site or imported material approved by Engineer meeting the following requirements:

PROPERTY		TEST METHOD ASTM	TEST METHOD CALTRANS
Sieve Size	Percent Passing		
4 IN	100	ASTM D422	202
2-1/2 IN	≥85	ASTM D422	202
Liquid Limit	<40%	ASTM D4318	204
Plasticity Index	<12	ASTM D4318	204
Organic Content	<3%	ASTM D2974	-
Expansion Potential	20 or less	ASTM D4829	-

   1. Contractor to make own determination of quantities and suitability of on-site material available for fill and backfill meeting the above requirements.

B. Sand: Clean, with 100 percent passing a 3/8 IN sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.

C. Granular Fill Under Building Floor Slabs-On-Grade: Clean, crushed, nonporous rock, crushed or uncrushed gravel complying with ASTM C33 gradation size No. 67, 3/4 IN to No. 4.

D. Granular Fill Under Base Slabs with Pressure Relief Valves (including under equalization basins, biosolids storage lagoon, and aeration basin bottom slab) and 3/4 IN Drain Rock:
   1. Conform to ASTM C33, gradation Size No. 6.

E. Geotextile Filter Fabric:
   1. Nonwoven type.
   2. Equivalent opening size: 50-100 (U.S. Standard Sieve).
   3. Permeability coefficient (cm/second): 0.07 minimum, 0.30 maximum.
   4. Grab strength: 90 LBS minimum in either direction in accordance with ASTM D4632 requirements.
   5. Mullen burst strength: 125 psi minimum in accordance with ASTM D3786 requirements.

F. Aggregate Base: meeting requirements of Class 2 Aggregate Base ¾ IN maximum as defined by Section 26-1.02A of the CalTrans Specifications.

G. 3/4 - IN Drain Rock: Clean, crushed, nonporous rock, crushed or uncrushed gravel complying with ASTM C33 gradation size No. 67, ¾ IN to No. 4.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect existing surface and subsurface features on-site and adjacent to site as follows:
   1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items not to be removed.
   2. Protect and maintain bench marks, monuments or other established reference points and property corners.
      a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
   3. Verify location of utilities.
      a. Omission or inclusion of utility items does not constitute non-existence or definite location.
      b. Secure and examine local utility records for location data.
      c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
      d. Repair damages to utility items at own expense.
      e. In case of damage, notify Engineer at once so required protective measures may be taken.
   4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
      a. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
      b. All repairs to be made and paid for by Contractor.
   5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
   6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
   7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.
   8. Repair damage to existing facilities at own expense.

B. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.

C. Dispose of waste materials, legally, off site.
   1. Burning, as a means of waste disposal, is not permitted.

3.2 SITE EXCAVATION AND GRADING

A. The work includes all operations in connection with excavation, borrow, construction of fills and embankments, rough grading, and disposal of excess materials in connection with the preparation of the site for construction of the proposed facilities.

B. Excavation and Grading: Perform as required by the Contract Drawings.
   1. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
      a. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
      b. Perform other layout work required.
      c. Replace property corner markers to original location if disturbed or destroyed.
   2. Preparation of ground surface for embankments or fills:
      a. Surface soils shall be over-excavated to 12 IN minimum depth.
      b. Scarify to a minimum depth of 8 IN.
      c. Compact per Section 3.6.
      d. Where ground surface is steeper than one vertical to four horizontal excavate horizontal benches a minimum of 5 FT wide and located at vertical intervals of not more than 5 FT to provide for placement and compaction of the new fill on horizontal surfaces.

3. Protection of finish grade:
    a. During construction, shape and drain embankment and excavations.
    b. Maintain ditches and drains to provide drainage at all times.
    c. Protect graded areas against action of elements prior to acceptance of work.
    d. Reestablish grade where settlement or erosion occurs.

C. Borrow:
1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
2. Include cost of all borrow material in original proposal.
3. Fill material to be approved by Engineer prior to placement.

D. Construct embankments and fills as required by the Contract Drawings:
1. Construct embankments and fills at locations and to lines of grade indicated.
    a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
2. Provide approved fill material which is free from roots, organic matter, trash, frozen material, and stones having maximum dimension greater than 6 IN.
    a. Ensure that stones larger than 4 IN are not placed in upper 6 IN of fill or embankment.
    b. Do not place material in layers greater than 8 IN loose thickness.
    c. Place layers horizontally and compact each layer prior to placing additional fill.
    d. Onsite clay soils may only be used in fill areas beyond structures.
3. Compact by sheepsfoot, pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
    a. Control moisture for each layer necessary to meet requirements of compaction.

3.3 ROCK EXCAVATION

A. All rock excavation is unclassified. No additional payment will be due to the Contractor.

3.4 USE OF EXPLOSIVES

A. Blasting with any type of explosive is prohibited.

3.5 FIELD QUALITY CONTROL

A. Moisture density relations, to be established by the Engineer required for all materials to be compacted.

B. Extent of compaction testing will be as necessary to assure compliance with Specifications.

C. Give minimum of 24 HR advance notice to Engineer when ready for compaction or subgrade testing and inspection.

D. Should any compaction density test or subgrade inspection fail to meet Specification requirements, perform corrective work as necessary.

E. Contractor shall pay for all costs associated with corrective work and retesting resulting from failing compaction density tests.

3.6 COMPACTION DENSITY REQUIREMENTS

A. Obtain approval from Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.

B. Provide dewatering system necessary to successfully complete compaction and construction requirements.

C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Engineer.

D. Stabilize subgrade with well graded granular materials as directed by Engineer.

E. Assure by results of testing that compaction densities comply with the following requirements:
   1. Sitework:

LOCATION	COMPACTION DENSITY
Upper 12 IN of pavement subgrade:	
Aggregate Base	95 percent relative compaction per ASTM D1557
Embankment fill subgrades:	95 percent relative compaction per ASTM D1557 at moisture condition between 3 and 5 percent above optimum

   2. Structures:

LOCATION	COMPACTION DENSITY
Structure subgrades	95 percent relative compaction per ASTM D1557 at moisture condition between 3 and 5 percent above optimum
Structure backfill	95 percent per ASTM D1557
Subsurface Structure subgrades:	
12 IN granular fill	95 percent relative compaction per ASTM D1557

3.7 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:
   1. In general, work includes, but is not necessarily limited to, excavation for structures and retaining walls, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
   2. Obtain fill and backfill material necessary to produce grades required.
      a. Materials and source to be approved by Engineer.
      b. Excavated material approved by Engineer may also be used for fill and backfill.
   3. In this Section of the Specifications, the word "foundations" includes footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil.
   4. In the paragraphs of this Section of the Specifications, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:
   1. General:
      a. Do not commence excavation for foundations for structures until Engineer approves:
         1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
         2) Density and moisture content of site area compacted fill material meets requirements of specifications.
      b. Engineer grants approval to begin excavations.
   2. Dimensions:
      a. Excavate to elevations and dimensions indicated or specified.
      b. Allow additional space as required for construction operations and inspection of foundations.

3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Drawings.
    a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Engineer.
4. Level off bottoms of excavations to receive foundations, floor slabs, equipment support pads, or compacted fill.
    a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.
    b. Where compacted fill material must be placed to bring subgrade elevation up to underside of construction, scarify existing subgrade upon which fill material is to be placed to a depth of 8 IN and then compact to density stated in this Specification Section before fill material can be placed thereon.
    c. Do not carry excavations lower than shown for foundations except as directed by Engineer.
    d. If any part of excavations is carried below required depth without authorization, maintain excavation and start foundation from excavated level with concrete of same strength as required for superimposed foundation, and no extra compensation will be made to Contractor therefore.
5. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
6. Notify Engineer as soon as excavation is completed in order that subgrades may be inspected.
    a. Do not commence further construction until subgrade under compacted fill material, under foundations, under floor slabs-on-grade, under equipment support pads, and under retaining wall footings has been inspected and approved by the Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and building loads to be placed thereon.
    b. Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
    c. Place fill material, foundations, retaining wall footings, floor slabs-on-grade, and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.
    d. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
7. Dewatering:
    a. Groundwater will be encountered during excavation. Contractor to install a dewatering system to prevent softening and disturbance of subgrade below foundations and fill material, to allow foundations and fill material to be placed in the dry, and to maintain a stable excavation side slope.
    b. Groundwater level shall be maintained at least 3 FT below the bottom of any excavation.
    c. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation. Groundwater elevations fluctuate at the site.
    d. Employ dewatering specialist for selecting and operating dewatering system.
    e. Keep dewatering system in operation until dead load of structure exceeds possible buoyant uplift force on structure.
    f. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
        1) Install groundwater monitoring wells as necessary.
    g. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.

8. Subgrade stabilization:
    a. If subgrade under foundations, fill material, floor slabs-on-grade, or equipment support pads is in a loose, wet, or soft condition before construction is placed thereon, remove loose, wet, or soft material and replace with approved compacted material as directed by Engineer.
    b. Provide compaction density of replacement material as stated in this specification section.
    c. Loose, wet, or soft materials, when approved by Engineer, may be stabilized by a compacted working mat of at least 12 IN of well graded crushed stone surrounded by a woven geotextile.
    d. Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.
    e. Method of stabilization shall be performed as directed by Engineer.
    f. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Engineer.
9. Do not place floor slabs-on-grade including equipment support pads until subgrade below has been approved, piping has been tested and approved, reinforcement placement has been approved, and Contractor receives approval to commence slab construction.
    a. Do not place building floor slabs-on-grade including equipment support pads when temperature of air surrounding the slab and pads is or is expected to be below 40 DegF before structure is completed and heated to a temperature of at least 50 DegF.
10. Protection of structures:
    a. Prevent new and existing structures from becoming damaged due to construction operations or other reasons.
    b. Prevent subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
11. Shoring:
    a. Shore, sheet pile, slope, or brace excavations as required to prevent them from collapsing.
    b. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
12. Drainage:
    a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
    b. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water.
    c. Provide pumping required to keep excavated spaces clear of water during construction.
    d. Should any water be encountered in the excavation, notify Engineer.
    e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations.
13. Frost protection:
    a. Do not place foundations, slabs-on-grade, equipment support pads, or fill material on frozen ground.
    b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, floor slabs, equipment support pads, or fill material can be placed immediately after excavation has been completed and approved.
    c. Protect excavation from frost if placing of concrete or fill is delayed.
    d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project by the Owner.
    e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DegF.

C. Fill and Backfill Inside of Structure and Below Foundations, Base Slabs, against Walls, Floor Slabs, Equipment Support Pads and Piping:
   1. General:
      a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Engineer and scarified to a depth of 6 IN and compacted to density specified herein.
      b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2 percent.
      c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Engineer as being free of undesirable material and compacted to specified density.
   2. Obtain approval of fill and backfill material and source from Engineer prior to placing the material.
   3. Granular fill under slabs-on-grade: Place all slabs-on-grade on a minimum of 12 IN of granular fill unless otherwise indicated.
   4. Fill and backfill placement:
      a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Engineer.
      b. Place fill and backfill material in thin lifts as necessary to obtain required compaction density no deeper than 8 IN.
      c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
      d. Use hand operated equipment for filling and backfilling next to walls.
      e. Do not place fill and backfill when the temperature is less than 40 DegF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
      f. Use vibratory equipment to compact granular material; do not use water.
   5. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content, outside the exterior limits of foundations located around perimeter of structure the following horizontal distance whichever is greater:
      a. As required to provide fill material to indicated finished grade.
      b. 5 FT.
      c. Distance equal to depth of compacted fill below bottom of foundations.
      d. As directed by Engineer.
   6. Backfilling against walls:
      a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved.
      b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
      c. Do not place fills against walls until floor slabs at top, bottom, and at intermediate levels of walls are in place and have reached 28-day required compressive strength to prevent wall movement.
      d. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.

D. Filling and Backfilling Outside of Structures.
   1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.
   2. Provide material as approved by Engineer for filling and backfilling outside of structures.
   3. Fill and backfill placement:
      a. Prior to placing fill and backfill material, moisture condition to between 3 and 5 percent above the optimum moisture content.
      b. Place fill and backfill material in thin lift less than 8 IN in loose thickness.
      c. Compact material with equipment of proper type and size to obtain density specified.
      d. Use only hand operated equipment for filling and backfilling next to walls and retaining walls.

e. Do not place fill or backfill material when temperature is less than 40 DegF and when subgrade to receive material is frozen, wet, loose, or soft.
f. Use vibratory equipment for compacting granular material; do not use water.

E. Backfilling Outside of Structures Under Paving:
1. When backfilling outside of structures requires placing backfill material under paving, the material shall be placed from bottom of excavation to underside of paving at the density required for fill under paving as indicated in this Section.
2. This compacted material shall extend transversely to the centerline of paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.
3. Scarify existing ground under pavement to a depth of 12 IN and compact as required for fill under paving as indicated in this Section.

3.8 SPECIAL REQUIREMENTS

A. Erosion Control:
1. Conduct work to minimize erosion of site.
2. Comply with the requirements of Section 9 of the supplementary Conditions, Water Pollution Control, and the Storm Water Pollution Prevention Plan for the project.
3. Construct stilling areas to settle and detain eroded material.
4. Remove eroded material washed off site.
5. Clean streets daily of any spillage of dirt, rocks or debris from equipment entering or leaving site.

END OF SECTION

SECTION 02220
CONTROLLED LOW STRENGTH MATERIAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Controlled low strength material (CLSM), in accordance with the requirements of the Contract Documents.

1.2 SUBMITTALS

A. See Section 01340 for requirement for the mechanics and administration of the submittal process.

B. Preliminary mix designs which show the proportions and gradations of all materials proposed for CLSM trial batch tested for compressive strength by an independent testing laboratory acceptable to the Engineer.

C. Certified Delivery Tickets:
   1. Where ready-mix CLSM is used, Contractor shall provide certified delivery tickets at the time of delivery of each load. Each certificate shall show the state certified equipment used for measuring the total quantities by weight of cement, fly ash, sand each class of aggregate, admixtures, and the amounts of water in the aggregate and added at the batching plant as well as the amount of water allowed to be added at the site for the specific design mix, the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to when the batch was dispatched, when it left the plant, when it arrived at the job, the time that unloading began, and the time that unloading was finished.

D. Where a portable batch plant is used provide certified batch tickets that show the batch quantities for each mix component as required for the certified delivery tickets above.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   3. ASTM C143, Standard Test Method for Slump of Hydraulic-Cement Concrete .
   4. ASTM C150, Standard Specification for Portland Cement.
   5. ASTM C403, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
   6. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

PART 2 - PRODUCTS

2.1 GENERAL

A. CLSM shall consist of cement, fly ash, fine aggregate, water, and admixtures that is placed, consolidated, and cured to produce a controlled low strength material that fills all spaces between the pipe, the bedding, and the trench walls.

B. The fully cured regular strength CLSM shall meet the strength requirements herein, and be capable of excavation by a small backhoe.

2.2 MATERIALS

A. Cement conforming to ASTM C150, Type II or III with total alkali content not more that 0.8 percent.

B. Mixing water shall be clean and potable water.

C. Admixtures shall meet the requirements of Section 03308.

D. Fly ash shall be Class C or Class F in conformance with ASTM C 618.

E. Aggregate Materials:
   1. Densely graded rock conforming to the following gradation.

Sieve Size	Percentage Passing
1 IN	100
No. 8	50-100
No. 200	0-5

2.3 DESIGN REQUIREMENTS

A. The water-cement ratio shall not exceed 3.5.

B. The minimum cement content shall be 50 pounds per cubic yard.

C. Fly ash may be used to improve flow-ability of the fresh CLSM and regulate the strength. Do not use more than 300 pounds per cubic yard unless for use as a flowable fill for pipelines the fly ash content shall be at least 300 pounds per cubic yard.

D. The compressive strength for regular strength CLSM shall be within the range of 100 to 200 psi when tested at 28 days. High strength CLSM shall have a minimum 7-day compressive strength of 400 psi. Test in accordance with ASTM C39.

2.4 CONSISTENCY AND MIXING

A. The consistency of the fresh CLSM intended as pipe embedment shall be that of a thick liquid so that it flows readily and fills spaces and voids around the pipe and structures.

B. Consistency of the CLSM shall be as measured by a slump of 6 – 8 IN when tested by ASTM C143.

C. The freshly mixed CLSM shall have a uniform consistency and appearance just before placement.

D. The mixing method and time shall be that which is required to produce a uniform mixture of cement, fly ash, aggregate, admixtures, and water.

2.5 MEASUREMENT OF CEMENT, FLY ASH, AGGREGATE, AND WATER

A. The amount of cement, fly ash, and aggregate entering into each batch shall be determined by direct weighing equipment furnished by Contractor and acceptable to Engineer. Where batches are proportioned to contain an integral number of conventional sacks of cement, and the cement is delivered at the mixer in the original unbroken sacks, the weight of the cement contained in each sack may be taken without weighing as 94 lbs.

B. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the Engineer and capable of measuring the water in variable amounts within a tolerance of 1 percent.

PART 3 - EXECUTION

3.1 PLACEMENT

A. As CLSM is placed in excavations it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all spaces and voids and bringing only a slight excess of water to the exposed surface. The CLSM shall be placed and consolidated by means that will not cause segregation of the mix.

B. If vibrators are used they shall be high speed power vibrators (8,000 to 10,000 rpm) of an immersion type in sufficient number and with standby units as required.

C. Contractor shall use placement methods that ensure that the CLSM completely fills the trench around the pipe, including spaces and voids around the pipe, spaces between pipes, keyways in trench plugs, and spaces and voids around adjacent and crossing utilities. The placement method shall achieve complete consolidation and contact between the CLSM, the pipe, and the trench walls.

D. CLSM shall not be placed when the air temperature is below 40 DegF unless the temperature is at least 35 DegF and rising. The temperature of the fresh CLSM shall be 50 DegF or greater at the time of placement. CLSM shall not be placed in pipe trenches during inclement weather, when the trench contains water, or when the bottom or walls are frozen or contain frozen material.

E. To prevent flotation of the pipe, Contractor shall place the fresh CLSM in two or more lifts, with each lift reaching an initial set before the succeeding fresh CLSM is placed. Contractor shall be responsible for prevention and, if necessary, correction of flotation and displacement of the pipeline due to the use of CLSM.

3.2 PROTECTION OF CLSM

A. CLSM that has been placed shall be protected from equipment, traffic, and backfilling operations until the surface has achieved an initial set and has hardened enough to develop a minimum penetration number of 650 when tested in accordance with ASTM C 403.

B. If the trench backfill is not to be placed over the CLSM within eight hours after CLSM placement Contractor shall place a 6 IN cover of moist backfill over the CLSM.

3.3 TESTING

A. The cost of production quality tests on cement, fly ash, aggregates, and CLSM will be borne by Owner. However, Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications.

B. Freshly mixed CLSM and constituent materials for testing shall be supplied by Contractor at no cost to Owner, and Contractor shall provide assistance to the Engineer in obtaining all samples, and disposal and cleanup of excess material.

C. CLSM must meet specified requirements including compressive strength.

D. Field Compression Tests:
   1. Compression test specimens will be taken during construction from the first placement of CLSM and at intervals thereafter as selected by Engineer. Each set of test specimens will be a minimum of 3 cylinders for each 200 cubic yards of CLSM placed, with a minimum of 3 cylinders for each location where CLSM is used.
   2. Compression test specimens will be made in accordance with section 9.02 of ASTM C 31. Specimens shall be 6 IN diameter by 12 IN high cylinders.
   3. Compression tests will be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and one at 28 days. The remaining cylinder will be held to verify test results, if needed.
   4. Furnish slump testing equipment and test slump in accordance with ASTM C143.

E. Test Excavations for Pipeline Embedment:
   1. Contractor shall excavate, shore, and maintain test excavations for use by Engineer at intervals of 1,000 FT along the pipeline. Test pit locations shall be as determined by Engineer. The excavations shall enable visual examination completely around the embedded portion of the pipe.
   2. The excavations will be used by Engineer to verify the consolidation of the CLSM around the pipe. If the visual examination of the in place CLSM reveals voids, spaces, or other indications of a lack of consolidation, Contractor shall replace the defective CLSM and modify its mix design and installation procedure to achieve complete consolidation and contact between the CLSM, the pipe, and the trench walls.
   3. After each excavation has been used by Engineer for verification Contractor shall remove the shoring and backfill the excavation in accordance with Section 02200.

END OF SECTION

SECTION 02221

TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation, trenching, backfilling and compacting for all underground utilities.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
      c. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      d. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

B. Qualifications: Hire an independent soils laboratory to conduct in-place moisture-density tests for backfilling to assure that all work complies with this Specification Section.

1.3 DEFINITIONS

A. Excavation: All excavation will be defined as unclassified.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Submit respective pipe or conduit manufacturer's data regarding bedding methods of installation and general recommendations.
   4. Submit sieve analysis reports on all granular materials.

B. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Trench shield (trench box) certification if employed:
      a. Specific to Project conditions.
      b. Re-certified if members become distressed.
      c. Certification by registered professional structural engineer, registered in the state where the Project is located.
      d. Engineer is not responsible to, and will not, review and approve.
   3. Trench Safety Plan and/or trench shoring drawing:
      a. Trench Safety Plan and/or trench shoring drawings submittal is required only as evidence that plans and drawings have been prepared if required by Authorities Having Jurisdiction.
         1) Engineer is not responsible to, and will not, review and approve.

1.5 SITE CONDITIONS

A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.
   1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.

B. Provide full access to public and private premises and fire hydrants, at street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.

C. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.

D. Verify location of existing underground utilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Material:
   1. As approved by Engineer.
      a. See Section 02200 “Fill and Backfill” Materials.

B. Subgrade Stabilization Materials: Provide subgrade stabilization material consisting of granular fill.

C. Bedding Materials:
   1. As approved by the Engineer.
      a. Required from 4-IN (minimum) below pipe invert and extending 12-IN (minimum above top of pipe.
   2. Granular bedding materials:
      a. Clean sands conforming to State of California Department of Transportation (Caltrans) Standard Specification Section 19 3.025 B.
      b. ASTM C33, gradation 67 (3/4 IN to No. 4 sieve) defined below:

Sieve Size	1 IN	3/4 IN	3/8 IN	No. 4	No. 20
Percent Passing by Weight	100	90-100	20-55	0-10	0

         1) Well-graded crushed stone.
         2) Well graded crushed gravel.
         3) Well graded gravel.
   3. Flowable fill:
      a. Description: Flowable fill shall be a mixture of cement, fly ash, fine sand, water, and air having a consistency which will flow under a very low head.
      b. Material characteristics:
         1) The approximate quantities of each component per cubic yard of mixed material shall be as follows:
            a) Cement (Type I or II): 50 LBS.
            b) Fly ash: 200 LBS.
            c) Fine sand: 2,700 LBS.
            d) Water: 420 LBS.
            e) Air content: 10 percent.
         2) Actual quantities shall be adjusted to provide a yield of 1 cubic yard with the materials used.
         3) Approximate compressive strength should be 85 to 175 psi.
         4) Fine sand shall be an evenly graded material having not less than 95 percent passing the No. 4 sieve and not more than 5 percent passing the No. 200 sieve.

PART 3 - EXECUTION

3.1 GENERAL

A. Remove and dispose of unsuitable materials as directed by Engineer to site provided by Contractor.

3.2 EXCAVATION

A. Unclassified Excavation: Remove rock excavation, clay, silt, gravel, hard pan, loose shale, and loose stone as directed by Engineer.

B. Excavation for Appurtenances:
   1. 12 IN (minimum) clear distance between outer surface and embankment.
   2. See Specification Section 02200 for applicable requirements.
   3. See Specification Section 02515 for applicable requirements.

C. Groundwater Dewatering:
   1. Groundwater will be encountered during excavation. Install a dewatering system to prevent softening and disturbance of subgrade to allow pipe, bedding and backfill material to be placed in the dry, and to maintain a stable trench wall or side slope.
   2. Groundwater shall be drawn down and maintained at least 3 FT below the bottom of any trench or manhole excavation prior to excavation.
   3. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
      a. Employ dewatering specialist for selecting and operating dewatering system.
   4. Keep dewatering system in operation until dead load of pipe, structure and backfill exceeds possible buoyant uplift force on pipe or structure.
   5. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
   6. Install groundwater monitoring wells as necessary.
   7. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.

D. Trench Excavation:
   1. Excavate trenches by open cut method to depth shown on Drawings and necessary to accommodate work.
      a. Support existing utility lines and yard piping where proposed work crosses at a lower elevation.
         1) Stabilize excavation to prevent undermining of existing utility and yard piping.
   2. Open trench outside buildings, units, and structures:
      a. No more than the distance between two manholes, structures, units, or 100 LF, whichever is less.
      b. Field adjust limitations as weather conditions dictate.
   3. Trenching within buildings, units, or structures:
      a. No more than 100 LF at any one time.
   4. Any trench or portion of trench, which is opened and remains idle for three (3) calendar days, or longer, as determined by the Owner, may be directed to be immediately refilled, without completion of work, at no additional cost to Owner.
      a. Said trench may not be reopened until Owner is satisfied that work associated with trench will be prosecuted with dispatch.
   5. Observe following trenching criteria:
      a. Trench size:
         1) Excavate width to accommodate free working space.
         2) Maximum trench width at top of pipe or conduit may not exceed outside diameter of utility service by more than the following dimensions:

OVERALL DIAMETER OF UTILITY SERVICE	EXCESS DIMENSION

33 IN and less	18 IN
more than 33 IN	24 IN

3) Cut trench walls vertically from bottom of trench to 1 FT above top of pipe, conduit, or utility service.
4) Keep trenches free of surface water runoff.
   a) Include cost in Bid.
   b) No separate payment for surface water runoff pumping will be made.

E. Trenching for Electrical Installations:
1. Observe the preceding Trench Excavation paragraph in PART 3 of this Specification Section.
2. Modify for electrical installations as follows:
   a. Open no more than 300 LF of trench in exterior locations for trenches more than 12 IN but not more than 30 IN wide.
   b. Any length of trench may be opened in exterior locations for trenches which are 12 IN wide or less.
   c. Do not over excavate trench.
   d. Cut trenches for electrical runs with minimum 30 IN cover, unless otherwise specified or shown on Drawings.
   e. See Division 16 for additional requirements.

F. Flowable Fill:
1. Flowable fill shall be:
   a. Discharged from a mixer by any means acceptable to the Engineer into the area to be filled.
   b. Placed in 4 FT maximum lifts to the elevations indicated.
      1) Allow 12 HR set-up time before placing next lift or as approved by the Engineer.
      2) Contractor shall place flowable fill lifts in such a manner as to prevent flotation of the pipe.
2. Flowable fill shall not be placed on frozen ground.
3. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.
4. Conform to appropriate requirements of Specification Section 02200.
5. Flowable fill batching, mixing, and placing may be started if weather conditions are favorable, and the air temperature is 34 DegF and rising.
6. At the time of placement, flowable fill must have a temperature of at least 40 DegF.
7. Mixing and placing shall stop when the air temperature is 38 DegF or less and falling.
8. Each filling stage shall be as continuous an operation as is practicable.
9. Contractor shall prevent traffic contact with flowable fill for at least 24 HRS after placement or until flowable fill is hard enough to prevent rutting by construction equipment.
10. Flowable fill shall not be placed until water has been controlled or groundwater level has been lowered in conformance with the requirements of the preceding Groundwater Dewatering paragraph in PART 3 of this Specification Section.

3.3 PREPARATION OF FOUNDATION FOR PIPE LAYING

A. Over-Excavation:
1. Backfill and compact to 95 percent of maximum dry density per ASTM D1557.
2. Backfill with granular bedding material as option.

B. Subgrade Stabilization:
1. Stabilize the subgrade when directed by the Owner.
2. Observe the following requirements when unstable trench bottom materials are encountered.
   a. Notify Owner when unstable materials are encountered.
      1) Define by drawing station locations and limits.
   b. Remove unstable trench bottom caused by Contractor failure to dewater, rainfall, or Contractor operations.

1) Replace with subgrade stabilization with no additional compensation.

3.4 BACKFILLING METHODS

A. Do not backfill until tests to be performed on system show system is in full compliance with specified requirements.

B. Carefully Compacted Backfill:
   1. Furnish where indicated on Drawings, specified for trench embedment conditions and for compacted backfill conditions up to 12 IN above top of pipe or conduit.
   2. Comply with the following:
      a. Place backfill in lifts not exceeding 8 IN (loose thickness).
      b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
      c. Observe specific manufacturer's recommendations regarding backfilling and compaction.
      d. Compact each lift to specified requirements.

C. Common Trench Backfill:
   1. Perform in accordance with the following:
      a. Place backfill in lift thicknesses capable of being compacted to densities specified.
      b. Observe specific manufacturer's recommendations regarding backfilling and compaction.
      c. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.

D. Water flushing for consolidation is not permitted.

E. Backfilling for Electrical Installations:
   1. Observe the preceding Carefully Compacted Backfill paragraph or Common Trench Backfill paragraph in PART 3 of this Specification Section or when approved by the Engineer.
   2. Modify for electrical installation as follows:
      a. Observe notes and details on electrical drawings for fill in immediate vicinity of direct burial cables.

3.5 COMPACTION

A. General:
   1. Place and assure bedding, backfill, and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.
   2. In no case shall degree of compaction below minimum compactions specified be accepted.

B. Compaction Requirements:
   1. Unless noted otherwise on Drawings or more stringently by other Specification Sections, comply with following minimum trench compaction criteria.
      a. Bedding material:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	75 percent relative density by ASTM D4253 and ASTM D4254

      b. Carefully compacted backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All applicable areas	Cohesive soils	95 percent of maximum dry density by ASTM D1557
	Cohesionless soils	75 percent relative density by ASTM D4253 and ASTM D4254

c. Trench backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
Under pavements, roadways, surfaces within highway right-of-ways	Cohesive soils	95 percent of maximum dry density by ASTM D1557
Under turfed, sodded, plant seeded, nontraffic areas	Cohesive soils	90 percent of maximum dry density by ASTM D1557

3.6 FIELD QUALITY CONTROL

A. Testing:
1. Perform in-place moisture-density tests as directed by the Owner.
2. Perform tests through recognized testing laboratory approved by Owner.
3. Costs of "Passing" tests paid by Owner.
4. Perform additional tests as directed until compaction meets or exceeds requirements.
5. Cost associated with "Failing" tests shall be paid by Contractor.
6. Reference to Engineer in this Specification Section will imply Soils Engineer when employed by Owner and directed by Engineer to undertake necessary inspections as approvals as necessary.
7. Assure Owner has immediate access for testing of all soils related work.
8. Ensure excavations are safe for testing personnel.

END OF SECTION

SECTION 02260
TOPSOILING AND FINISHED GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Topsoiling and finished grading.

B. Location of Work: All areas within limits of grading and all areas outside limits of grading which are disturbed in the course of the work.

1.2 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Project Data: Test reports for furnished topsoil.

1.3 PROJECT CONDITIONS

A. Verify amount of topsoil stockpiled and determine amount of additional topsoil, if necessary to complete work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil:
   1. Original surface soil typical of the area.
   2. Existing topsoil stockpiled under Specification Section 02110.
   3. Capable of supporting native plant growth.

2.2 TOLERANCES

A. Finish Grading Tolerance: 0.1 FT plus/minus from required elevations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Correct, adjust and/or repair rough graded areas.
   1. Cut off mounds and ridges.
   2. Fill gullies and depressions.
   3. Perform other necessary repairs.
   4. Bring all sub-grades to specified contours, even and properly compacted.

B. Loosen surface to depth of 2 IN, minimum.

C. Remove all stones and debris over 2 IN in any dimension.

3.2 ROUGH GRADE REVIEW

A. Reviewed by Engineer in Specification Section 02110.

3.3 PLACING TOPSOIL

A. Do not place when subgrade is wet or frozen enough to cause clodding.

B. Spread to compacted depth of 4 IN for all disturbed earth areas.

C. If topsoil stockpiled is less than amount required for work, furnish additional topsoil at no cost to Owner.

D. Provide finished surface free of stones, sticks, or other material 1 IN or more in any dimension.

E. Provide finished surface smooth and true to required grades.

F. Restore stockpile area to condition of rest of finished work.

3.4 ACCEPTANCE

A. Upon completion of topsoiling, obtain Engineer's acceptance of grade and surface.

B. Make test holes where directed to verify proper placement and thickness of topsoil.

END OF SECTION

SECTION 02270
SOIL EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Soil erosion and sediment control.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Erosion control standards: Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas by the United Sates Department of Agriculture (USDA), Soil Conservation Service, College Park, Maryland.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Straw bales, twine tied.

B. Pipe Riser and Barrel: 16 GA corrugated metal pipe (CMP) of size indicated.

C. Stone for Stone Filter: 2 IN graded gravel or crushed stone.

D. Grass Seed: Annual ryegrass.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to General Stripping Topsoil and Excavating:
   1. Install perimeter dikes and swales.
   2. Excavate and shape sediment basins and traps.
   3. Construct pipe spillways and install stone filter where required.
   4. Machine compact all berms, dikes and embankments for basins and traps.
   5. Install straw bales where indicated.
      a. Provide two stakes per bale.
      b. First stake angled toward previously installed bale to keep ends tight against each other.

B. Construct sediment traps where indicated on Drawings during rough grading as grading progresses.

C. Temporarily seed basin slopes and topsoil stockpiles:
   1. Rate: 1/2 LB/1000 SF.
   2. Reseed as required until good stand of grass is achieved.

3.2 DURING CONSTRUCTION PERIOD

A. Maintain Basins, Dikes, Traps, Stone Filters, Straw Bales, etc.:
   1. Inspect regularly especially after rainstorms.
   2. Repair or replace damaged or missing items.

B. After rough grading, sow temporary grass cover over all exposed earth areas not draining into sediment basin or trap.

C. Construct inlets as soon as possible.
   1. Excavate and tightly secure straw bales completely around inlets as detailed on Drawings.

D. Provide necessary swales and dikes to direct all water towards and into sediment basins and traps.

E. Do not disturb existing vegetation (grass and trees).

F. Excavate sediment out of basins and traps when capacity has been reduced by 50 percent.
   1. Remove sediment from behind bales to prevent overtopping.

G. Topsoil and Fine Grade Slopes and Swales, etc.: Seed and mulch as soon as areas become ready.

3.3 NEAR COMPLETION OF CONSTRUCTION

A. Eliminate basins, dikes, traps, etc.

B. Grade to finished or existing grades.

C. Fine grade all remaining earth areas, then seed and mulch.

END OF SECTION

SECTION 02315
TUBEX GROUT-INJECTION PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fundex Tubex Grout Injection Piles (TGI Piles).

1.2 SUBMITTALS

A. Shop Drawings:
   1. Contractor shall submit shop drawings of TGI piles proposed for use on the project showing details of piles, reinforcing, concrete mix design, calculations, and other information required to describe proposed materials and construction methods.
   2. Product technical data including:
      a. Contractor shall submit a description of the equipment proposed for installing Tubex Grout-Injection (TGI) Piles.

B. Pile Installation, Layout and Records:
   1. Contractor shall submit piling layout drawing indicating location and numbering system to correspond to installation record.
   2. At the completion of work, Contractor shall submit installation records, which shall not TGI pile depth, crowd and torque pressures, grout pressures and grout quality and any notable occurrences experienced during installation.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Project pipe from damage during transportation, storage and handling.

B. Protect cement and other material from effects of weather.

1.4 PROJECT CONDITIONS

A. Field Measurements:
   1. Pile installation record to show:
      a. Date installed.
      b. Tip elevation/butt elevation.
      c. Torque and crowd pressures of installation.
      d. Quality and pressure of injected grout.
      e. Locations of splices, if any.
      f. Results of grout tests, if any.
      g. Unusual occurrences encountered in drilling operation.

1.5 SEQUENCING AND SCHEDULING

A. Fabrication and Installation:
   1. Do not fabricate or install piles until shop drawings have been reviewed and approved by Engineer unless design is provided in the Contract Documents.

B. Pile Installation Tolerances:
   1. Do not deviate from design location by more than 3 IN in any direction.
   2. Elevation of pile top shall be not more than 2 IN higher or lower than design elevation.
   3. Deviation from vertical:
      a. Note more than 2 percent.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe:
   1. The pile tube shall be pipe of carbon steel conforming to ASTM A252 grades 2 or 3 or API 5L, grade B, seamless, longitudinal fusion, spiral-welded or electric-resistant welding.
   2. Pipe shall be 12-IN to 30-IN in diameter. Minimum wall thickness shall be 0.312 IN. Used pipe meeting the above requirements, with or without reconditioning, may be used subject to Contractor's/Engineer's prior inspection and approval.

B. Pile Tips:
   1. Tips shall be weldable castings or fabrications with grout outlets at the bottom and in conformance to the dimensions and configuration as shown in the Tubex Tip catalog.
   2. Tips will have teeth as necessary for cutting through the soil, and helical fins for mixing the grout with native soil.
   3. Tips shall be 18 IN, 22 IN, 26 IN in diameter, or 36 IN.

C. Concrete:
   1. Concrete in Tubex piles shall have a minimum compressive strength of 3000 psi at 28 days and shall conform to the requirements of Caltrans standard specifications Section 90.

D. Reinforcing:
   1. Reinforcing steel shall have a minimum yield strength of 60 ksi.

E. Cement Grout:
   1. Grout for soil/cement mixture shall conform to the provisions of Caltrans Specification Section 50-1.09, "Bonding and Grouting", except as follows:
      a. The grout shall contain 11 gallons of water per 94 LBS of cement. (Unit weight = 115-124 pcf).
      b. California Test 541 will not be required.
      c. Grout shall not be required to pass through a screen with a 0.7-IN maximum clear opening prior to being introduced into the grout pump.
   2. Admixtures shall conform to the provisions of Caltrans Specifications Section 90-4, "Admixtures", and must be on Caltrans NMT&R list of approved admixtures.
   3. Field grout-mixing specifications as follows:
      a. SI:
         1) <u>Small Batch:</u> Hany or Chemgrout Grout mixer: 5 sacks*, 213 kg total type II cement, 216 liters water, 2.3 kg Interplast-N, (optional retarder: 295 ml Plastiment).
         2) <u>Large Batch:</u> Hany or Chemgrout Grout mixer: 8 sacks*, 341 kg total type II cement, 322 liters water, 3.17 kg Interplast-N, (optional retarder: 473 ml Plastiment).
      b. English:
         1) <u>Small Batch 9.8 C.F:</u> Hany or Chemgrout Grout mixer: 5 sacks* type II cement, 57 gallons water, 5 pounds Interplast-N, (optional retarder: 10 oz Plastiment).
         2) <u>Large Batch 15.6 CF:</u> Hany or Chemgrout Grout mixer: 8 sacks* type II cement, 85 gallons water, 7 pounds Interplast-N, (optional retarder: 16 oz Plastiment).

*94 lb. Sack cement

      c. Mixes using DCI and fly ash can be used for additional corrosion resistance. Mix design to be provided upon request.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that the completed pile is clear of water and debris. Clean before placing concrete or reinforcing steel.

3.2 INSTALLATION

A. Pile Installation:
   1. Where headroom and/or material availability permits, install piles in one piece. Piles shall be installed using an F 2800, IHC AF 25, Fundex F-12 or Tubex machine using torque and down pressure "crowd" to install pile into ground. Splice piles per AWS D1.1 as required for low-overhead conditions, access, or as dictated by material availability.
   2. Water, bentonite, or 1-sack cement-water solution injected through the tip shall be employed as necessary to facilitate the installation. In difficult driving conditions, employ "post-grouting techniques"; begin grouting nearer specified tip elevation. Where soil profile permits, or ground conditions make it advantageous grout pile during installation over its full length otherwise commence grouting when within 3 FT -5 FT of tip elevation.
   3. After achieving a minimum designed tension tip elevation the pile can be stopped if it experiences refusal above design compression tip elevation. The contractor will have the option of performing additional soil investigations or providing Engineer with the geotechnical engineer's review of pile to verify the minimum tip elevation required. Refusal will be defined as when the pile installation rate becomes less than one foot of penetration in five minutes at maximum crowd pressure, or when the torque required to install the pile exceeds 150,000 foot-pounds.
   4. Noise: The installation machine shall operate at less than 85 dB at full torque, when measured at a distance of 20 FT in unconfined areas.
   5. Vibration: Vibration shall not exceed background vibration levels recorded at a distance of 10 FT from the pile location.

B. Grouting:
   1. Mixing/Mixing Equipment: Water shall be first added to the mixer. The grout shall be mixed with mechanical mixing equipment of a type that will produce uniform and thoroughly mixed grout. Retempering of grout shall not be allowed. Grout shall be continuously agitated until it is pumped. Grouting equipment shall be capable of operating at pressures of 588psi.
   2. Injection of grout: Grout Injection Pressure shall be recorded by reading the pressure gauge on the grout pump. Gauge pressure shall be at least 200 psi when grouting. An average pressure reading shall be taken every 5 to 10 FT of pile penetration. Grout shall be continuously or semi-continuously pumped. Pile shall be examined for grout blockage should gauge pressure above 780 psi be observed. Grout blockages shall be hydraulically cleared. Should it not be possible to clear blockage, the pile shall be extracted and replaced.
      a. Unless retarder is used, grout shall be pumped within 90 minutes of batching. Retarded grout shall be pumped within the time parameters of the type and amount of retarder used.
   3. Sequence of Grout Installation: In generalized soil conditions, grouting shall start at a depth not higher than 8D above specified tip elevation, nor less than 3 FT above tip elevation. Specific variances are as follows:
      a. For spliced pipe installations, grouting shall not start until the last splice has been completed.
      b. Where ground water is to be sealed while driving, pile shall be grouted from the surface elevation
      c. Where rock socketing is required, grouting shall start after rock is penetrated
   4. Grout Volumes: The theoretical volume of grout required shall be initially established as 20 percent of the tip cross sectional area less the pipe cross sectional area, times the required grouted height on the pile.

Note: Injected grout volumes are deducted per empirical results from completed projects, and account for injected grout mixing with in situ soils and soil rebound around pipe above the tip. In clayey soils grout take may be as high as 40 percent theoretical volume; in very soft clays (e.g. bay mud) to 20 percent in stiffer clay. In sandy profiles, grout take may be 15 – 25 percent of theoretical

a. Subsequent pile grout volumes may be reduced if the presence of excess grout is seen on the ground surface, to conform to actual soil mixing proportions and reductions in the annular space volume experienced on site. No further reduction shall be made in the theoretical grout volume if grout is not seen on the surface.
b. Where full pile length grouting is required, sufficient grout shall be pumped to force grout to the surface. If the grout comes in contact with open graded gravel such as pipe bedding, other man made fill, or garbage it may not be possible to get grout to the surface. If grout is required around the top of pile for lateral capacity and grout does not come to the surface, the upper 15 FT of annular space around the pile will be hand grouted from the surface. If piles are to be end bearing only, grout injection volume shall be a minimum of 8 diameters.

C. Welding:
1. All welding, except the connection of the tip to the pipe, shall be in accordance with the Structural Welding Codes AWS D1. 1-94.
2. Tip weld is means and method and not subject to inspection.
3. The abutting ends of pipe to be spliced shall be trimmed true and square to the axis of the pile.
4. Commercial back-up rings shall be used to ensure alignment for welding.
5. Splices shall be single-bevel full penetration welds.

D. Concrete Placement:
1. Water Infiltration: Surface water shall not be permitted to enter the Tubex piling. Water that has infiltrated the Tubex piling shall be removed before placing concrete therein. Residual water in the cone of the tip itself need not be removed.
2. Concrete Placement: The concrete to be placed in Tubex piles shall be permitted to free-fall provided that flow of concrete is directed at the center of the pile using a hopper or pump. Concrete in the top 15 FT of the pile shall be vibrated if reinforcing steel is present. Concrete shall not be tremmied or pumped to the pile bottom.

3.3 PAYMENT

A. A Bid Base lump sum bid price for Tubex pile work based on the number of piles and lengths. Price shall include all costs associated with Tubex pile installation, including pipe material, tips, accessories, concrete, reinforcing steel and labor and equipment necessary for the work.

B. Payment shall be based on the pile footage and number, as established between Contractor and Engineer prior to bid.

C. A unit add and a unit deduct price shall apply for additional or deleted footage.

D. Unit prices for load tests shall apply.

E. Unit prices for mobilization shall apply.

F. Unit prices for splicing shall apply.

END OF SECTION

SECTION 02316
TORQUE-DOWN STEEL PILES

PART 1 - GENERAL

1.1 SUMMARY

A. Work included: Provide labor, material, tools, equipment, appliances, transportation and services required to completely furnish and install structural steel piles, as shown on the Drawings and herein specified, including but not limited to the following:
   1. Installation of concrete filled steel pipe piles.
   2. Pre-Drilling equipment and procedures (if required).
   3. Reinforcing steel or other pile to pile cap connection.
   4. Concrete placement for fill of pile sleeves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM) Specifications.
   2. American Concrete Institute (ACI):
      a. ACI 117: "Standard Tolerance for Concrete Construction and Materials".
      b. ACI 301: "Specification of Structural Concrete for Buildings".
      c. ACI 304: "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".
      d. ACI 305: "Report on Hot Weather Concreting".
      e. ACI 311: "Recommended Practice for Concrete Inspection".
      f. ACI 318: "Building Code Requirements for Reinforced Concrete".
   3. "Specification for the Design, Fabrication, and Erection of Structural Steel Buildings", of American Institute of Steel Construction, Ninth Edition with current supplements.
   4. "Structural Welding Code-Steel", AWS D1.1 of the American Welding Society, with current supplements, revisions and addenda.
   5. San Francisco Building Code (SFBC), 2001 Edition.
   6. International Building Code current edition.

B. Qualifications:
   1. The work of this section shall be performed be a Contractor that has performed work for installation of EDTTEX Piles for a minimum of (5) projects in the last (3) years.
   2. Use adequate number of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.3 SUBMITTALS

A. Provisions Comply with Section 01340.

B. Contractors Qualifications: Provide a minimum of five (5) references for previous installation of EDTTEX Pile projects, include the project name, contact person and contact phone number.

C. Means and Methods: Provide written description of the proposed method for steel pipe pile installation and method for concrete placement within the pile, method(s) for placing, positioning and supporting rebar reinforcement (if necessary) method for pile and pile cap connection.

D. Provide calculations, prepared, stamped and signed by a Civil Engineer experienced in pile design and licensed in the State of California. Calculations shall verify axial, shear, and bending capacity of pile including uplift conditions. Calculations shall also provide details of connections to pile caps and reinforcing bars to transmit all design loads.

1. If the indicator pile program indicates early refusal of installation due to unacceptable axial forces experienced at a height less than engineered and/or indicated. Revised pile length and installation criteria for production piles will be determined by the Geotechnical Engineer of record. The pilecap redesign if the pile quantity changes will be done by the Structural Engineer of Record prior to execution of production piles.
2. The Geotechnical Engineer shall be present for inspection of drilling operation to determine official record of un-drilled/cut off lengths and locations. The Geotechnical Engineer of record shall assign load capacity of the affected piles. The Structural Engineer shall determine whether additional piles will be required and provide the grouping redesign.

E. Provide shop drawings prepared under the supervision of, stamped and signed by a Civil Engineer experienced in pile design and licensed in the State of California, that shows detail of pipe piles. Civil Engineer shall be the same engineer who prepares stamps and signs the calculations.

F. Provide the proposed concrete mix design for Concrete Filled Steel Pipe Piles.

G. Reinforcing steel supplier shall furnish steel producer's certified reports of mill analysis with carbon equivalent and tensile and bend test results.

1.4 FIELD TESTING AND INSPECTIONS

A. Owners testing laboratory will test and inspect all materials specified as required by SDBC Chapter 19, Section 1929 and Section of this specifications.

B. Geotechnical Engineer shall provide continuous inspection during indicator and production pile drilling operations.

C. Test Cylinders: Owner's testing laboratory shall perform sampling test cylinders as the concrete is delivered from the mixer to the piles. Cylinders shall be taken full size batches of concrete from each pour day's operation so as to represent 100 cubic yards of concrete. Each sample for testing consist of four (4) cylinders sampled in conformance with ASTM C172, "Sampling Freshly Mixed Concrete", made and cured in accordance with ASTM C31, "Curing Test Specimens in the Field". Place in protected area moisture curing as required per referenced documents. Provide test cylinders marked by number, indicate project location where batch was placed. Indicate slump test results of sample, temperature at the project site at the time of placement.

D. Cylinders shall be tested for compressive strength in accordance with ASTM C39. One cylinder shall be tested normally at seven (7) days; and two tested at 28 days. One cylinder shall be kept spare to be tested if previous 28-day cylinders fail to meet requirements. Make frequent slump tests in the field to control concrete consistency. Provide a minimum of one slump test at the beginning of placement and again at the same time test cylinders are taken. Conform to ASTM C143 for slump test methods.

PART 2 - PRODUCTS

2.1 EDTTEX PILE

A. Concrete filled steel pipe piles shall consist of steel pipe size, diameter and wall thickness indicated that shall have a tip welded on to the end of the steel pipe pile sleeve and used during installation.

B. Piles shall be accepted based on installation proceeding as expected or tested for engineered compliance of axial downward and/or axial uplift load.

C. The design length of piles is indicated in drawings. The actual pile length may vary with variations in soil conditions, torque and crowd force, installation refusal and recorded variations in the indicator pile program.

2.2 MATERIALS

A. Steel Pipe Piles: Steel pipe piles shall be new pipe or undamaged, non-corroded, coated or non-coated recycled used petroleum piping. Size shall be a minimum 16 IN diameter with a 3/8 IN wall thickness. Pipe shall conform to ASTM 252, Grade 3 with minimum yield strength F_Y = 50 KSI. Used steel shall be stress tested for longitudinal tensile strength per ASTM A370 procedures and meet the criteria. Acceptance of used pipe allowed to be used on the job will be by the Owners agent.

B. Reinforcement Bars: Comply with the ASTM A615 of A706, Grade 60, unless indicated otherwise on the drawings.

C. Portland Cement: Standard domestic brands conforming to requirements of "Standard Specifications of Portland Cement," ASTM C150 Type II, mill tested per SFBC Section 1903.2 Concrete mix design shall provide the minimum concrete strength required by the approved design that has a slump of not more than 5 IN, is pumpable, and complies with the requirements of contract documents.

D. Water for Concrete: Clean, potable and free from deleterious substance.

E. Concrete Aggregate: Conform to ASTM C33. Provide aggregate that is tested to be non reactive, with test data to prove compliance and indicate the physical properties of the aggregate and source of supply expected throughout the project.
   1. Coarse Aggregates: Carbonate classification, non-reactive, natural gravel or crushed rock, uniformly, graded from materials where 100 percent (100%) passes 1 inch screen and 100 percent (100%) is retained on #4 mesh screen. Select size 5.
   2. Fine Aggregate: Conform to ASTM C33, consisting of non- reactive, clean natural sand having hard, strong, durable particles, graded to not more than eight percent (8%) passing a #100 sieve and not more than three percent (3%) passing a #200 sieve.

F. Admixtures: Conform to SFBC Section 1903.6. Use admixtures in the strict compliance with manufacturer's directions. Admixtures used to increase cement dispersion or provide increased workability for low-slump concrete may be used subject to the Engineer's acceptance. Use amounts of each admixture as recommended be each selected manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities of admixtures as requires to maintain quality control and provide revised mix designs for review. Do not use admixtures containing chloride ions.

G. Flt Ash: Proposed use of fly ash to replace cement content is to be approved by the Engineer prior to submittal of concrete mix design. Percentage of fly ash in mix design shall be by weight not volume.
   1. Class F fly may be substituted for up to 20 percent of minimum cement at substitution rate sufficient to provide required strength at all specified ages.

H. Welding Electrodes: Comply with AWS D 1.4. Table 5.1 for low- hydrogen electrodes E80XX Series.

I. Other Materials: Provide other materials, not specifically described but requires for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect and Geotechnical Engineer.

J. Equipment and Tools: Fundex rig or equivalent with appropriate modifications to provide up to 200,000 ft-lbs of torque and a crowd (down pressure) of 30 tons.

PART 3 - EXECUTION

3.1 CONCRETE FILL PLACEMENT AND SETTING OF REINFORCEMENT BARS

A. Concrete shall be pumped or poured directly into installed/placed pipe pile sleeves at a rate that allows free flow of the concrete to bottom of pile and as the pipe fills. Use of tremie is not required since there are no obstructions in the pipe to cause segregation of the concrete during placement.

B. Each pile shall be placed continuously from bottom to top.

C. Concrete in the upper 15 FT of the pile shall be vibrated during the placement operations to provide a dense, monolithic concrete section for insertion of reinforcing dowels. The vibration will be applied at top of the pipe using the appropriate vibratory equipment.

D. Where reinforcing steel is required for engagement to pile cap, reinforcing steel bars of the size, spacing, quantity and configuration, as indicated on the structural drawings shall be placed (wet set) immediately after concrete is placed and vibration complete.

3.2 INDICATOR TEST PILE PROGRAM

A. Owner's Special Inspector shall provide the following:
   1. Collect cylinders for concrete testing.
   2. Observe the placement of concrete in piles.
   3. Observe the placement of reinforcing steel, if required.

B. Owner's Geotechnical Engineer shall continuously monitor the production pile installation to include the following:
   1. Observe pile installation per below.
   2. Determine individual pile acceptance criteria.

3.3 PRODUCTION PILES

A. Owner's Geotechnical Engineer shall continuously monitor the production pile installation to include the following:
   1. Torque and crowd readings at 2 FT intervals during each installation to meet the established production pile criteria.
   2. Visual inspection for plumb and pile integrity after installation
   3. Measure each pipe pile internally prior to concrete placement to confirm pile tip elevations.
   4. Submit a report on each pile to general contractor at the end of each day
   5. Provide pile capacity for any pile that does not meet the installation criteria

B. Owner's Special Inspector shall provide the following:
   1. Collect cylinders for concrete testing.
   2. Observe the placement of concrete in piles.
   3. Observe the placement of reinforcing steel for bend testing, as required.
   4. Collect samples of reinforcing steel for bend testing, as required.
   5. Observe the application of corrosion protection coating.

3.4 PILE LOGS

A. Each EDTTEX Pile shall be observed with pertinent data logged by the Owner's Geotechnical Engineer and/or Special Inspector. The pile log shall contain the following information for each pile installed/observed:
   1. Pile group identification/location and individual pile number
   2. Pile diameter and wall thickness
   3. Pile sleeve material designation
   4. Pile tip description
   5. Ground elevation, pile top elevation, pile tip elevation
      a. Pile design length installed (Indicator Pile)
      b. Pile production length (Adjusted by Indicator Program Results)

6. Record Torque/Crowd (Downward Force) Measurements- The hydraulic pressure readings for the drill motor (converted into drill toque) at 1 FT increments during drilling and at termination of drilling.
7. Confirm the pile meets the installation criteria, including having the minimum penetration into the bearing layer required by design calculations or load testing or refusal with the minimum torque determined by testing.
8. Confirm that the center of the pile head is not more than 3 IN off form the contract document location indicated and the pile is not more that 2 percent of its installed length our of plumb/alignment
    a. Piles that exceed these tolerances shall be referred to the Structural Engineer for determination.
    b. Piles tested and found not to meet the specified criteria shall be reviewed by the Geotechnical and Structural Engineer.
    c. Remedial solution shall include assignment and acceptance of a reduced capacity or required replacement with additional pile.

B. At the end of each day, copies of the Geotechnical Engineer, Owner's Special Inspector, and Structural Engineer completed daily log reports shall be submitted to the Owner or authorized representative

3.5 TESTING

A. If Geotechnical Engineer has reason to suspect that any pile may be defective or may otherwise fail to meet the requirements of the specifications, he may order testing of the pile in question. Examples of defective piles include the following:
1. Twisted pipe and/or broken weld during drilling.
2. Failure to meet specified criteria requirements related to installed pile zone design, length, torque requirements and accuracy or placement location and alignment/plumb of installation. The Contractor shall bear the expense of the investigation and/or testing.
3. Water inside the pile shell after installation.

B. The Owner shall bear the expense of the Initial investigation and/or testing of questionable piles to verify compliance with the required installation criteria.

C. If required, the Contractor shall perform the procedures required to remedy any reported deficiencies. The remedial procedures shall be determined by the project Geotechnical and Structural Engineer.
1. Considerations may include acceptance of the con-conformance pile with a reduced capacity or complete replacement with an additional new pile.

3.6 CLEANUP

A. The Contractor shall at all times keep the immediate work area adjacent to pile installation operations free of accumulated material, spoil from pipe pile cut-offs due to early refusal and/or other accumulated debris.

B. At The completion of work, remove all tools and surplus materials from the site, leaving the site in a clean reasonably graded condition in anticipation of subsequent earthwork operations.

3.7 BASIS OF PAYMENT

A. Provide a lump sum proposal for the execution of all work required by the work of this Section. Contract sum shall be based upon the total number of piles required, diameter, and the total length of pile configurations shown on the structural drawings.

B. The Contract sum shall be subject to adjustment up or down depending upon the actual lineal footage of piles installed. Adjustments shall be computed based on the Geotechnical Engineer's daily data log entries documenting the actual installed placement length of each pile. Adjustments to the contract sum will be made only if the installed length is less than the estimated total length minus 10 percent or more than the estimated length plus 10 percent.

C. Provide a lineal foot until price for concrete filled EDTTEX Pile as called for on the Bid Form. Provide a lineal foot unit for adding to or deducting from the Contracted sum when the actual lineal footage of piles installed and accepted, as defined above, varies from the total bid length plus or minus 10 percent.

D. The unit price per lineal foot of pile, shall include all costs for Contractors general conditions, transportation, steel pile pipe sleeves, pre-drilling operations, batched concrete, placement of concrete, reinforcing steel (plain and fabricated), or other indicated anchors, placement of reinforcement, application of corrosion protection coating and any other material or operations incidental to and necessary for pile installation, at the location, positions and the elevation(s) required. No additional charges will be allowed.

E. The Geotechnical Engineer's daily data log will be sued as the official record to determine unit quantities for the work installed for evaluating the final contract payment.

F. Payment will not be made for damaged piles, pile replacements, correction of defective work, or additional pile length as a result of by Contractor defect or error.

END OF SECTION

SECTION 02317

PRECAST AND PRESTRESSED CONCRETE DRIVEN PILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast and prestressed concrete driven piling.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - General Conditions
   2. Division 01 - General Requirements
   3. Section 03208 - Reinforcement
   4. Section 03308 - Concrete, Materials and Proportioning
   5. Section 03350 - Testing

C. Unit Prices
   1. Measurement: Length of piles for payment to be measured from tip to cut off elevation. Pile lengths extending above cut off elevation will be considered as waste.
   2. Payment: Contract bid price for piling to be based on the total lineal footage of piling indicated on the Foundation Plan(s) along with the minimum number of pile load tests required by this Specification Section.
      a. Bid price to include all costs for material, labor, equipment and accessories required for complete pile installation and pile load testing as shown on the Drawings and indicated in this Specification Section.
      b. Adjustment to bid price for pile length and pile load tests to be made in accordance with unit prices in the Bid Proposal. No price adjustment will be made for individual piles but will be made on the total lineal footage of piling installed.
      c. Payment will be made for piles that are discontinued due to hitting obstructions and for additional piles and foundation construction required at locations of discontinued piles.
      d. No payment will be made for the following:
         1) Damaged or rejected piles or for the installation of piles and additional foundation construction resulting from the damaged or rejected piles.
         2) Pile load test where either the testing system, test pile or anchor pile fails before test is completed.
         3) Additional pile(s) and concrete foundation construction required when a test pile fails at a location where the test pile is required for support of the structure.
         4) Piles installed beyond specified tolerance limits and piles and concrete foundation construction required due to piles installed beyond tolerance limits.

1.2 QUALITY ASSURANCE

A. Referenced Standards
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
      b. 5543, Design, Manufacture and installation of concrete piles.
      c. ACI 517.2R - Accelerated Curing of Concrete at Atmospheric Pressure-State of the Art.
   2. ASTM International (ASTM)
      a. A82, Standard Specification Steel Wire, Plain, for Concrete Reinforcement.
      b. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      c. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (Including Supplementary Requirements S1).
      d. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      e. C33, Standard Specification for Concrete Aggregates.

f. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
g. C143, Standard Test Method for Slump of Hydraulic Cement Concrete.
h. C150, Standard Specification for Portland Cement.
i. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
j. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
k. C260, Standard Specification for Air Entraining Admixtures for Concrete.
l. C494, Standard Specification for Chemical Admixtures for Concrete.
m. D1143, Testing Piles Under Axial Compressive Load.
n. D3689, Testing Individual Piles Under Static Axial Tensile Load.
o. E329, Standard Specifications for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
p. Clatrans - Standard Specifications, State of California, Business and Transportation Agency, Department of transportation

3. Prestressed Concrete Institute (PCI):
   a. PCI Design Handbook Precast and Prestressed Concrete.
   b. MNL-116, Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products.

B. Qualifications:
   1. Provide precast prestressed concrete piles produced by an active member of the Prestressed Concrete Institute.
   2. Provide piles manufactured by a plant which has regularly and continuously engaged in the manufacture of piles of same type as those required for a minimum of 3 years.
   3. Pile manufacturer's testing facilities to meet requirements of ASTM E329.

1.3 SUBMITTALS

A. Details of overall construction operation sequence and pile driving sequence.

B. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate request deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

C. Shop Drawings:
   1. See Division 01, General Requirements
   2. Product technical data including:
      a. Type and size of piling.
      b. Size, number, configuration, spacing and locations of all prestress strands, ties and other reinforcement.

D. Record of three of Contractor's past installations of required type of pile under similar soil conditions.

E. Submit design calculations with the shop drawings for the proposed piling. Completely show design for all required axial loads and moments. Calculations to be sealed by a Professional Structural Engineer registered in the State of California.

F. Results of pile load tests.

G. Pile report.

H. Concrete mix design proposed for pile production. See Section 03350, Testing for mix design submittal requirements.

I. Compression strength test results of concrete used for production of piling.

1.4 SITE CONDITIONS

A. Do not begin pile installation until the earthwork in the area where piles are to be driven has been completed as shown on the Plans and indicated in these Specifications.

PART 2 - PRODUCTS

2.1 PILE TYPE

A. Piles to be 14 IN square precast prestressed concrete with a minimum 28-day compressive strength of 7,000 psi, and minimum strength at transfer of prestress of 4,000psi.

2.2 PILE CAPACITY

A. Minimum allowable working downward load carrying capacity of all piles to be 60 tons minimum. Allowable uplift working capacity of piles 30 tons.

B. In addition to the allowable capacities noted above, the piles to also be capable of supporting an allowable working vertical moment as shown on Drawing 00S10.

2.3 MATERIALS

A. Concrete Materials and Properties:
   1. Minimum 28-day compressive strength: 7,000 psi.
   2. Aggregates: ASTM C33, Size No. 67.
   3. Water: Portable, clean, free of oils, acids, and organic matter.
   4. Cement: ASTM C150, Type V.
      a. Minimum cement content: Seven sacks per cubic yard (658 LBS/CY).
   5. Maximum water cement ratio by weight: 0.45.
   6. Slump: Maximum of 4 IN, minimum of 1 IN.
      a. Measure slump in accordance with ASTM C143.
   7. Air entrainment:
      a. Conform to ASTM C260.
      b. Air content: Maximum 7 percent, minimum 5 percent.
      c. Measure air content in accordance with ASTM C173 or C231.
   8. Admixtures: ASTM C494, chloride free.
   9. See Section 03308 for other requirements.

B. Reinforcement:
   1. Prestressing strands: Minimum of 6-1/2-IN diameter, either 250 K or 270 K high tensile strength uncoated seven-wire strand conforming to ASTM A416.
   2. Ties: Conform to ASTM A82.
   3. Deformed reinforcing: Conform to ASTM A615.
   4. All strands to be bonded to the concrete shall be free of dirt, loose rust, oil, grease or other deleterious substances and shall b accurately placed in position before concrete is poured. Minor surface corrosion of the strands due to exposure to the weather will be permitted as long as there is no pitting.
   5. Strands shall be accurately held in position and stressed uniformly by a hydraulic jack equipped with an accurate reading calibrated pressure gage to permit the stress in the strand to be computed at any time.
   6. Transfer of prestress shall be accomplished by the simultaneous gradual release of all strands by a hydraulic jack. Strands shall not be cut until prestress has been transferred.

7. Broken wires within individual strands will be permitted up to 2 percent of the total number of wires in each pile, providing there is not more than one broken wire per strand.
8. Certified test reports of ultimate strength and typical stress strain curves shall be furnished by the steel manufacturer and forwarded by the Contractor to the Engineer not less than 3 days prior to shipping.

C. Pile Tip Protection Device:
   1. Shape: "H" shaped specially manufactured for embedment into and protection of precast prestressed concrete pile tips.
   2. Steel with a minimum yield strength of 36,000 psi.
   3. Of sufficient thickness, strength and embedment into the pile to be able to be driven through soils encountered without deformation to the protection device and without being dislodged from the pile tip.

2.4 MIXES

A. Do not begin fabrication of piles until the proposed concrete mix design has been approved by Engineer.

2.5 PILE DESIGN

A. Design, reinforce and prestress the piles in accordance with the requirements of:
   1. 2013 California Building Code
   2. ACI 318
   3. PCI Design Handbook Precast and Prestressed Concrete
   4. ACI 543

B. The stricter requirements of the above four references to govern.

C. Piling to be designed not only to resist the stresses due to the required working capacities, but also to resist those stresses induced by transporting, handling, and driving.

2.6 FABRICATION

A. Manufacturer of production piles shall not proceed until the results of the indicator pile program and load tests have been reviewed, and any changes in length deemed necessary by Engineer can be incorporated into the production pile schedule.
   1. Casting Beds and Equipment. Casting beds for fabrication of pre-stressed members shall include jacking equipment at one end and a rigid reaction frame or block at the other end. Equipment for measuring stress and strain of the pre-stressing reinforcement shall be acceptable to Engineer.
      a. Casting beds shall be concrete or another suitable, rigid material. Forms shall be constructed of heave gauge steel or other rigid and smooth materials acceptable to Engineer. Forms shall be adequately braced and shall be free from dents, gouges, or other irregularities. Forms shall enclose all except the top horizontal surface. Maximum draft on side forms shall not exceed 1/4 IN per foot.
   2. Tolerances. Pile end surfaces shall be perpendicular to the long axis of the pile, within a tolerance of 1/8 IN per foot.
      a. The deviation from straightness measured along any two perpendicular faces of the pile, when not stressed, shall not exceed the following tolerances:
         1) 1/8 IN in any 10 FT
         2) 3/8 IN in any 40 FT
         3) 3/16 IN in any 20 FT
         4) 1 IN in entire length
   3. Concrete. All piling shall be solid concrete with no voids permitted. Small areas of honeycomb which extend to a depth of no more than one inch may be repaired in a manner satisfactory to Engineer. Piles with honeycomb deeper than 1-IN or extending to the plane of reinforcing shall be rejected and removed from the site.

a. Piles shall be kept continuously wet for at least 10 days after pouring. When removed from the forms, the piles shall be such that a line stretched from butt to tip on any face will not be more than 1 IN from the face of the pile at any point.
b. Lateral reinforcing of both ends of the pile shall be sufficiently close to resist the impact stresses due to driving and shall in no case be more than 3 IN on center within 40 IN of each end. Piles shall be furnished with a steel end bearing plate. The plate shall have a minimum thickness of 1-1/2 IN, shall have the same dimensions as the pile and shall be attached to the pile with dowels as indicated on the drawings.
c. A series of 12 cylinders shall be made for each trial concrete batch used in determining the design mixture.
d. Three cylinders each shall be tested at the age of 24 hours, 48 hours, 7 days and 28 days. When a trial mixture has been accepted by the Engineer, the average compressive strength at each age shall be used to determine the probably rate of strength increase for the concrete. These test results shall be used to determine when the concrete has reached the specified strength for applying the prestressed load to the concrete.

4. Pre-stressing. The effective prestress in the concrete after losses shall be as specified herein.
   a. Compressive strength for the purpose of determining the release of the prestress shall be determined first by examining the rate of increase of strength determined by the cylinder tests made during the establishment of the design mixture and the following procedures.

B. Do not fabricate piles until shop drawings and the proposed concrete mix design have been approved by Engineer and returned to Contractor.
   1. Piles may be cast in continuous lines with dividers placed at proper intervals on the pre-tensioning bed. Sufficient space shall be left between ends of units to permit access for cutting strand after concrete has attained the required strength and prestress transfer has been accomplished.
   2. Piling shall be cured in controlled steam chambers. Steam chambers shall be equipped with sufficient recording thermometers and automatic temperature regulators to insure even temperatures throughout the curing operation. Steam curing shall be in accordance with Caltrans Section 90-7.04 or with ACI 717, Chapter 3.

C. Chamfers and Corners: All corners of square piles to be chamfered to at least 3/4 IN or rounded to a minimum 1 IN radius.

D. Pick Up Points: Unless special lifting devices are attached for pick up, pick up points to be plainly marked on all piles.

E. Pile Splicing: Piles to be full length without splices. Do not manufacture piles until pile length has been determined from results of pile load tests or from other criteria.

F. Manufacture: Manufacture, quality and dimensional tolerances of piles to be in accordance with requirements of PCI MNL-116 and this Specification Section.

G. Provide concrete cover on pile reinforcing as required by ACI 318. Minimum concrete cover to be 1-1/2 IN.

H. Do not deliver piles to project site until piles have reached their 28-day required compressive strength.

2.7 SOURCE QUALITY CONTROL

A. Employ services of an independent testing laboratory to perform all required pile concrete testing.

B. Concrete testing may be performed by pile manufacturer if his testing facilities meet the requirements of ASTM E329.

C. During production of piles, make and test one set of three 6 IN DIA x 12 IN high concrete cylinders for each 15 CY of concrete placed.

1. Test one cylinder at 7 days and two cylinders at 28 days. Strength test result to be the average strength of the two cylinders tested at 28 days.
2. Make and test cylinders in accordance with ASTM C31 and C39.
3. With each set of three cylinders, make one test for air content in accordance with ASTM C173 or C231.
4. Send one copy of all test results to Engineer.

D. Make all tests using same concrete as employed in production of piles. Cure all test cylinders in same manner as used to cure production piles.
   1. The results of compressive strength tests performed on concrete cylinders cast during manufacturer of precast, prestressed piling shall be submitted to the Engineer within 10 days after testing and not less than 10 days prior to shipping.

PART 3 - EXECUTION

3.1 INSPECTION

A. Furnish and pay for inspection services indicated herein to be performed by the Soils Engineer.

3.2 PILE DRIVING SHALL MEET THE FOLLOWING SPECIFIC NOISE REQUIREMENTS

A. During pile driving, the pile and hammer shall be completely enclosed on all sides by an acoustical shroud. The shroud shall extend from the ground to a point at least 5' above the top of the pile to be driven. The acoustical shroud, held in place by a crane, shall surround the pile driving assembly during pile driving activities.

B. A 360° cylindrical metal framework shall be constructed for the shroud to support the weight of the attached acoustical blankets. The framework shall be centered on the pile to be driven, and shall have a diameter equal to the diameter of the pile plus 6'.

C. Acoustical blankets shall be firmly secured to the outside of the framework with the sound absorptive side of the blankets oriented towards the interior of the shroud (i.e., towards the pile). The blankets shall be overlapped by at least 6" at seams and taped so that no gaps exist in the shroud. The largest blankets available shall be used to form the shroud in order to minimize the number of seams. The blankets shall be draped on the ground to eliminate any gaps at the base of the shroud.

D. Acoustical blankets shall be firmly secured to the top of the shroud with the sound absorptive side of the blankets oriented towards the interior of the shroud (i.e., towards the pile). The number and size of gaps needed for the safe operation of the pile driver shall be kept to a minimum.

E. The acoustical blankets shall provide a minimum sound transmission class (STC) of 28 and a minimum noise reduction coefficient of 1.00. The acoustical blankets shall provide the following minimum octave-band sound transmission loss values:

63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
11 dB	11 dB	13 dB	28 dB	39 dB	40 dB	53 dB

F. The acoustical blankets shall be oil and UV resistant, anti-fungal and flame retardant.

G. A view window shall be incorporated into the acoustical blankets in order to facilitate the operation of the pile driver. The window shall be constructed of clear vinyl material that weighs at least 1 pound per square foot. The seams where the window attaches to the acoustical blankets shall be tightly sealed to eliminate gapes. The size of the window shall be kept to the minimum required for safe operation of the pile driver.

H. The noise control barrier curtain material shall be comprised of a quilted sound absorber liner material with a minimum sound transmission rating of an STC-I 8 and a minimum sound absorbent rating of an NR-.75 attached to a 1 pound per square foot reinforced mass loaded vinyl barrier backing having a minimum sound transmission rating of an STC-26. The composite panels will have grommets on 1-FT centers on all sides and will be designed to form a 15' wide x 60' high pile noise barrier. Ensure all seams are closed with no gaps or openings in the flexible barrier curtain.

I. The pile driving noise barrier shall be lifted into position with a crane with the flexible noise barrier panels connected to a spreader bar with optional articulated extensions added to the ends of a three-sided frame. The noise barrier shall completely cover the pile hammer and exposed pile to the height of 60' above ground level during the pile hammering operation.

3.3 OPREATING HOURS

A. Pile driving shall be limited to 9:00am to 4:00pm, Monday through Friday.

3.4 LINES AND LEVELS

A. Complete necessary excavation and furnish lines and levels as required to install piles at their indicated locations.

3.5 PILE CUT OFF ELEVATIONS

A. Obtain pile cut off elevations from foundation plans and details.

3.6 INDICATOR PILES

A. At least three (3) indicator piles shall be driven to length determined by the Engineer at the time of driving test piles. The indicator piles shall be used as production piles at locations shown on the drawings, with each pile either being driven to the proper butt elevation shown on the drawings or being cut off at that elevation.

B. Indicator pile testing shall be conducted utilizing a pile driving analyzer (PDA). All indicator piles shall be instrumented with a PDA during driving operations. The Engineer may request use of the PDA on additional piles if inconclusive results are obtained or unusual driving conditions are encountered.

C. The Contractor shall notify the Engineer at least (48) hours prior to conducting dynamic testing on driven piles. The Contractor shall coordinate the testing with the Engineer and facilitate the testing work by Engineer.

D. Indicator pile testing shall be performed for the entire length of the pile in a continuous manner during driving and during restriking. No interruption in the driving operations shall be allowed during testing so that records are continuous. Interruptions due the Contractor's operations shall require the Contractor to instrument and test an alternate pile at no additional cost to the Owner.

E. All piles monitored during driving shall also be monitored during dynamic restrike testing to determine the ultimate bearing capacity. Restriking on load bearing piles shall not occur prior to expiration of the setup period after initial driving of all piles within a 25-FT radius.

F. Piles with a questionable driving record may be damaged due to deviation during driving, faulty splicing, etc. These piles shall be checked by restriking as determined by the Engineer. Piles designated for restrike testing by the Engineer shall not be cut off until after the restrike testing has been completed. The pile shall be restruck with the same pile hammer used for the initial driving and shall be restruck an adequate number of times to allow accurate evaluation of the capacity and integrity of the pile. To restrike the pile, the hammer should be warmed up by restriking an adjacent pile with a minimum of 20 blows. All testing during restriking shall be done in the presence of the Engineer.

G. The setup period shall be defined be restriking the first indicator pile at intervals of 48 hours after the initial pile driving until the calculated increase in ultimate pile capacity within the 48-hour interval is less than 10 percent.

H. Engineer will reduce the indicator pile test data in both numerical and graphical form. Ultimate pile capacity will be calculated, for end-of-initial driving conditions and during restrike. The method utilized to calculate ultimate pile capacity will be indicated and reason for method selection described. Compression and tensile stresses induced due to pile driving stresses will be reported. The hammer system efficiency and the measured energy actually transmitted to the pile will also be reported. Pile bearing capacity will be calculated by post dynamic test analysis or soil resistance predictions of the dynamic test data through a CAPWAP analysis.

3.7 PREDRILLING

A. All indicator piles shall be predrilled per criteria established by Soils Engineer. Predrilling of production piles shall be performed if pile damage is occurring from hard driving through dense soil layers prior to reaching the required tip elevation or from high tensile stresses in driving. Predrilling shall also be performed as required to reduce ground vibrations and settlement during pile driving. Holes shall be predrilled as directed by Soils Engineer. Predrilling shall be performed in a manner that prevents caving of the hole. If the wet rotary slurry method is used, equipment shall be of such design that the slurry and cuttings will be readily removed from the holes under the action of the drilling operations. Drill cuttings and slurry shall be promptly disposed off the site. The slurry shall not be discharged into sewers or drainage courses. The diameter and depth of the predrilled hole shall be established by the Soils Engineer, and shall not be exceeded without permission of Engineer. The depth of predrilling shall be adjusted as required by the Engineer based on the results of vibration and settlement monitoring. However, predrilling alone may not be sufficient to mitigate the adverse effects of pile driving on surrounding facilities and other measures may be required. Such measures shall be implemented by the Contractor and predrilling shall not be relied on solely to mitigate adverse effects of pile driving.

B. All predrilling operations shall be conducted in a manner and using equipment as not to cause damage to existing facilities and will not cause excessive or unnecessary pile penetration, loss of pile bearing capacity, or loss of lateral support.

C. Pile shall be installed immediately after predrilling at each pile location and prior to any further predrilling.

3.8 PILE DRIVING EQUIPMENT

A. Equipment used shall be maintained in first-class condition and shall operate at the efficiency and capacity required herein at all times. All hammers used for this project shall be the products of one manufacturer, shall have identical model numbers, and shall have the same energy rating. All equipment shall be acceptable to the Engineer.

B. All hammers or other equipment required and furnished to drive piles shall be adequate in size, strength, and capacity to drive piles to the specified or otherwise required penetration and/or resistance without being subject to restrictions or other limitations of usage which will prevent compliance with the intent of this specification.

C. The pile hammer shall have a minimum energy rating of 40,000 foot-pounds. IN no case shall the weight of the striking parts of the hammer be less than one-third the weight of the pile. Hydraulic equipment shall have the capacity to operate the hammer at its rated capacity.

D. The same hammer shall be used for driving production piles as used to drive the indicator and test piles. If a different hammer is provided for any reason additional indicator pile testing shall be performed as determined by the Engineer at no additional cost to the Owner.

E. Driving heads shall be designed for use with the type of pile being driven and shall be of cast iron, cast steel, or structural steel construction.

1. Bottoms of driving heads shall be provided with conical recesses or grooves as required to fit the head of the pile being driven. The top surface of each driving head shall have a shallow recess to receive the cushion or cap block.

F. The head of piles shall be square cut and protected from deformation during driving by a steel follower or bonnet which shall fit closely and squarely over the butt end of the pile.

G. Pile driver leads shall be of the type to ensure support to the piles during driving and to keep the pile and hammer axially aligned. Leads shall be securely pinned to the crane boom and affixed by rigid bracing to the base of the crane.

1. The length of the leads shall be at least equal to the length of pile to be driven plus the length required to provide adequate space for the hammer and appurtenances.

3.9 PILE DRIVING REQUIREMENTS

A. All piles shall be driven to meet the criteria established by the Engineer. Piles may be driven below the tip elevation where driving criteria are met, provided damage to the pile will not occur.

B. If piles are overdriven below cutoff elevation, pile caps shall be deepened, as necessary, to provide the specified pile embedment, without cost to the Owner.

C. Pile driving equipment shall be in workable condition with piles properly held in correct position while being driven. Piles shall be driven with a hydraulic hammer. The equipment shall include an automatic printout of the energy per blow when driving piles. When used, a manufacturer's representative shall instruct the pile driving crew and the Engineer on the operation of the equipment and provide advice until completion of the second successful pile installation by the crew.

D. Heavily concentrated loads from piling equipment shall be distributed to prevent compressing or shearing of the soil in the area near the top of the pile. The equipment arrangement shall be acceptable to Engineer.

E. All piles shall be driven straight and true in the locations shown on the drawings.

F. Driving of piles shall begin and proceed in the areas selected by the Engineer.

G. Piles in each group shall be driven from one side to another.

H. Before driving is started, each pile shall be marked so that the depth of the point can be readily determined. Unless otherwise authorized by Engineer, the pile shall be marked by painting marks every 12 IN on each pile, with a number at each fifth mark.

I. Each pile shall be driven to develop the capacity as required. No pile shall be terminated before both the penetration resistance is met as required, and the pile is driven so the pile tip is below the bearing elevation as required by the established driving criteria. Engineer will establish the driving criteria for production piles based on the results of the indicator pile program, and static load tests.

J. It there is any difficulty attaining the specified resistance, Engineer shall be immediately informed, and an alternate procedure shall be submitted for Engineer's review and acceptance. Tensile driving stresses shall not exceed the capacity of the prestressing elements and compressive driving stresses shall not exceed 5,000psi. If dynamic monitoring during driving indicates excessive driving stresses, alternative installation methods and/or equipment shall be submitted to Engineer for acceptance.

K. Each pile shall be driven continuously from the first blow of the hammer until the required penetration per blow has been attained.

L. If an interruption of more than one hour occurs, the pile shall be overdriven as necessary to break the "freeze-up" and shall be driven to its final resistance.

M. Any pile initially started in a given day shall be completed in that day.

N. Driving of piles shall not be undertaken within 100 FT of concrete cured less than 7 days. Any damage made to concrete structures or piping, both new and existing, from pile driving shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

O. Heads of piles shall be protected during driving with an approved cushion head block, which shall be maintained in good condition during the entire driving operation.

P. Pile driving shall proceed only in the presence of a representative of the Engineer who shall make a continuous record of the pile identification number, the date driven, the hammer manufacturer, model number and rated energy, elevation of pile tip, the number of hammer blows for each foot of driving, final driving resistance in blows per inch for the last 10 IN, behavior during driving, and elevation of cutoff of every pile.

Q. Each pile shall be accurately located, spaced, and driven plumb at the locations indicated on the Drawings. Piles shall be driven with the center of the pile head more than 3 IN from the design location shown, or out of plumb by no more than 2 percent of the pile length. Damaged pile or piles that do not meet these requirements shall be corrected at the cost of the Contractor, including the cost of redesign and extra construction of the pile cap or replacement pile.

R. Cracking, splitting, distortion, bending, spalling or other damage sustained by piles during driving shall be corrected as directed by the Engineer without cost to the Owner.

S. Additional piles required by the Engineer to replace damaged or misaligned piles shall be driven and all changes in pile cap design and construction, including costs of form work, steel, concrete and labor, shall be accomplished without cost to the Owner.

T. Survey level readings shall be taken on individual piles during pile driving at locations designated by the Engineer. If it is determined that piles have become "unseated" or heaved in excess of 1/4-IN, redriving of affected piles and all subsequent piles so affected shall be accomplished at no cost to the Owner. Lateral movement of piles shall be carefully monitored to keep the piles within the specified tolerances and corrective action taken to correct the piles outside the tolerances.

U. Tops of all piles projecting above cutoff elevation after driving shall be cut off at the proper elevation, following approval of the Engineer, and ends removed from the job site. The top of each pile to be cut off shall be scored with a carborundum saw to mark the cutoff line to facilitate exposing reinforcing. The concrete at the top of the pile above the score line shall be broken away and removed to expose the reinforcing. The concrete shall be removed with equipment, which precludes cracking, or damaging the concrete below the score line. The reinforcing shall be cleaned and embedded in the concrete pile cap to anchor the pile to the cap as indicated on the Drawings. All work shall be accomplished without additional cost to the Owner.

V. After piles are driven and prior to placing slab reinforcing steel, Contractor shall prepare plan showing final location and butt elevation to an accuracy of 0.02 FT. Plan shall be certified by a surveyor licensed in the State of California and submitted to the Engineer.

W. Upon completion of pile driving, all equipment, excess materials and all miscellaneous materials not incorporated in the work shall be removed so as to leave the site clean and free of debris.

X. If cobbles or obstructions are encountered which require the pile to be relocated or redriven, the cost of the driven length of piles abandoned due to such obstructions will be borne by the Owner. Such piles shall be relocated as designated by the Engineer.

3.10 CUSHION OR CAP BLOCKS

A. Protect tops of piles during driving by means of cushion or cap blocks with loss of hammer energy held to a minimum.
   1. Do not provide continuous or frequent introduction of materials to cushion hammer blows.
   2. Provide cushion or cap blocks of solid block of hardwood or laminated softwood of proper shape and dimensions to fit hammer. Strength of laminated materials to be equal to or greater than one solid block.
   3. Position grain of block parallel to axis of pile.

3.11 DRIVING TOLERANCES

A. Drive Piles Vertical at Locations Shown on Drawings:
   1. Maximum horizontal deviation of any pile from its required location not to exceed 2 IN.
   2. Pile centerline not to deviate more than 1 IN in 10 FT of pile length from vertical.
   3. Contractor to pay for cost of foundation revision and/or additional driven piles due to piles being driven beyond indicated tolerance limits.

3.12 OBSTRUCTIONS

A. Should any obstruction including, but not limited to boulders, rocks, rubble, fill, existing foundations or timbers be encountered which prevent driving of pile to its required tip elevation and/or final driving resistance, threaten pile damage or cause pile to drift from required location horizontally and/or vertically, cease driving and take corrective action as directed by Engineer.

3.13 DAMAGED PILES

A. Replace damaged piles as directed by Engineer at no additional expense to Owner.

B. Each pile to be free from defects and damage due to construction, fabrication, delivery, installation or other causes.

C. Damaged piles include, but not necessarily limited to, piles bent, buckled, spalled, cracked, of insufficient 28-day compressive strength, with fabrication tolerances beyond those indicated, or with any other defect as determined by Engineer that would weaken the pile.

D. Should any pile as determined by Engineer be damaged, be too short to develop required final driving resistance or to reach required tip elevation or otherwise not conform to this Specification Section, withdraw pile and drive another pile in its place.
   1. If it is impossible to withdraw damaged or rejected pile, install another pile at location indicated by Engineer.
   2. Revise foundation, as directed by Engineer, as required by new location of pile.
   3. Additional pile and foundation to be at Contractor's expense.

E. Correct to satisfaction of Engineer at no additional cost to Owner any pile or other construction that has been damaged by pile installation.

3.14 PILE REPORT

A. Provide Engineer with a copy of a pile report for all driven pile providing following information:
   1. Pile location and number.
   2. Date driven.
   3. Length of pile (tip to cut off).
   4. Description of piles that were rejected (Pile number, location, reason for rejection).
   5. Pile tip elevation.
   6. Hammer blow count for last 5 FT.
   7. Strength test results.

END OF SECTION

SECTION 02444
CHAIN LINK FENCE AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chain link fencing and gates.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
      c. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence.
      d. F552, Standard Terminology Relating to Chain Link Fencing.
      e. F567, Standard Practice for Installation of Chain-Link Fence.
      f. F626, Standard Specification for Fence Fittings.
      g. F900, Standard Specification for Industrial and Commercial Steel Swing Gates.
      h. F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
      i. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
   2. American Welding Society (AWS).
   3. National Fire Protection Association (NFPA):
      a. NFPA 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL).

B. Qualifications:
   1. Installer bonded and licensed in the Project state.
   2. Installer shall have a minimum two (2) years experience installing similar fencing.
   3. Utilize only AWS certified welders.
   4. Electric gate operators to be UL listed.
   5. Grounding by an electrician licensed in Project state.

1.3 DEFINITIONS

A. See ASTM F552.

B. NPS: Nominal pipe size, in inches.

C. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.
3. Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
4. Mill certificates.
5. Source quality control test results.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Chain Link Fabric:
1. Fabric type:
a. ASTM A392 zinc-coated steel:
1) Coated before weaving, 2.0 OZ/SF.
2. Wire gage: 6.
3. Mesh size: 2 IN.
4. Selvage treatment:
a. Top: Knuckled.
b. Bottom: Knuckled.
5. PVC color per ASTM F934, Black.

B. Concrete: See Specification Section 03308.

C. Line Post:
1. ASTM F1083 pipe:
a. Schedule 80, NPS 2.
2. Fusion-bonded vinyl coating 10-14 mils thick; color to match fabric (black).

D. Corner or Terminal Posts:
1. ASTM F1083 pipe:
a. Schedule 80, NPS 2-1/2.
2. Fusion bonded vinyl coating 10-14 mils thick; color to match fabric (black).

E. Brace and Rails:
1. ASTM F1083 pipe:
a. Schedule 80, NPS 1-1/4.
2. Fusion bonded vinyl coating 10-14 mils thick; color to match fabric (black).

F. Tension Wire:
1. Top and bottom of fabric:
a. ASTM A824, galvanized steel, Class 3.
b. Vinyl coated galvanized steel, ASTM A641, Class 3.

G. Fence Fittings (Post and Line Caps, Rail and Brace Ends, Sleeves-Top Rail, Tie Wires and Clips, Tension and Brace Bands, Tension Bars, Truss Rods):
1. ASTM F626.
2. Fusion bonded vinyl coating 10-14 mils thick; color to match fabric (black).

H. Swing Gate:
1. ASTM F900.
2. Materials as specified for fence framework and fabric.
3. Hardware:
a. Galvanized per ASTM A153/A153M.
b. Hinges to permit 90-degree in and out gate opening.

2.2 SOURCE QUALITY CONTROL

A. Test related fence construction materials to meet the following standards:
1. Posts and rails: ASTM F1043, Heavy Industrial.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with:
   1. Manufacturer's instructions.
   2. Lines and grades shown on Drawings.
   3. ASTM F567.

B. Do not start fence installation before final grading is complete and finish elevations are established.

C. Drill holes in firm, undisturbed or compacted soil.

D. Place fence with bottom edge of fabric at maximum clearance above grade, as shown on Drawings.
   1. Correct minor irregularities in earth to maintain maximum clearance.

E. Space line posts at equal intervals not exceeding 10 FT OC.

F. Provide post braces for each gate, corner, pull and terminal post and first adjacent line post.

G. Install tension bars full height of fabric.

H. Rails:
   1. Fit rails with expansion couplings of outside sleeve type.
   2. Rails continuous for outside sleeve type for full length of fence.

I. Provide expansion couplings in top rails at not more than 20 FT intervals.

J. Anchor top rails to main posts with appropriate wrought or malleable fittings.

K. Install bracing assemblies at all end and gate posts, as well as side, corner, and pull posts.
   1. Locate compression members at mid-height of fabric.
   2. Extend diagonal tension members from compression members to bases of posts.
   3. Install so that posts are plumb when under correct tension.

L. Pull fabric taut and secure to posts and rails.
   1. Secure so that fabric remains in tension after pulling force is released.
   2. Secure to posts at not over 15 IN OC, and to rails at not over 24 IN OC, and to tension wire at not over 24 IN OC.
   3. Use U-shaped wire conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two (2) full turns.
   4. Bend ends of wire to minimize hazards to persons or clothing.

M. Install post top at each post.

N. Gates:
   1. Construct with fittings or by welding.
   2. Provide rigid, weatherproof joints.
   3. Assure right, non-sagging, non-twisting gate.
   4. Coat welds with rust preventive paint, color to match pipe.

END OF SECTION

SECTION 02513
ASPHALTIC CONCRETE VEHICULAR PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Asphaltic concrete vehicular paving.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Federal Specifications (FS):
      a. TT-P-115F, Paint, Traffic (Highway, White and Yellow).
   2. Construction standards: State of California, Department of Transportation, "Caltrans," as amended to date.

B. Miscellaneous:
   1. Should conflicts arise between standard specifications of government agencies mentioned herein and Contract Documents, Contract Documents shall govern.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Asphalt design mix.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphaltic Concrete: Per City of Pinole Standard.

B. Line Paint:
   1. Nonreflective.
   2. White.
   3. FS TT-P-115F.

2.2 MIXES

A. Comply with mix design per City of Pinole Standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Construct to line, grade and section as shown on Drawings and in accordance with referenced State Specifications.

B. Install a 6 IN compacted layer of asphaltic base course in accordance with the referenced State Specifications.

C. Install a 3 IN surface course, in accordance with State Specifications

D. Tolerance of Finished Grade: +0.10 FT from required elevations.

E. Line Painting:
   1. Thoroughly clean surfaces which are to receive paint.
   2. Make completely dry before paint is applied.
   3. Do not paint until minimum of five (5) days has elapsed from time surface is completed.
      a. A longer period may be required if directed by Engineer.
   4. Do not apply paint over wet surfaces, during wet or damp weather, or when temperature is below 40 DegF.
   5. Lay out markings and striping in accordance with Drawings.
      a. Width of painted lines: 4 IN.

END OF SECTION

SECTION 02515
PRECAST CONCRETE MANHOLE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast concrete manhole structures and appurtenant items.
      a. Sanitary sewer manholes and appurtenances.
      b. Drain manholes and appurtenances.
      c. Storm sewer manholes and appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 02221 - Trenching, Backfilling, and Compacting for Utilities.
   4. Section 03208 - Reinforcement.
   5. Section 03308 - Concrete Materials and Proportioning.
   6. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. C150, Standard Specification for Portland Cement.
      c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
      d. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
      e. D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
      f. D4022, Standard Specification for Coal Tar Roof Cement, Asbestos Containing.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Fabrication and/or layout drawings:
      a. Include detailed diagrams of manholes showing typical components and dimensions, reinforcements and other details.
      b. Itemize, on separate schedule, sectional breakdown of each manhole structure with all components and refer to drawing identification number or notation.
      c. Indicate knockout elevations for all piping entering each manhole.

1.4 SITE CONDITIONS

A. For this project, the established high groundwater elevation is established in the Geotechnical Report.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Manhole rings, covers and frames:
      a. Neenah Foundry.
      b. Deeter Foundry.
   2. Black mastic joint compound:
      a. Kalktite 340.
      b. Tufflex.
      c. Plastico.
   3. Premolded joint compound:
      a. Ram Nec.
      b. Kent Seal.
   4. Emulsified fibrated asphalt compound:
      a. Sonneborn Hydrocide 700B Semi-Mastic.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 SANITARY SEWER, STORM AND DRAIN MANHOLE STRUCTURE COMPONENTS

A. Manhole Components:
   1. Reinforcement: ASTM C478.
   2. Minimum wall thickness: 5 IN.
   3. Minimum base thickness: 12 IN.
   4. Provide the following components for each manhole structure:
      a. Base (precast) with integral bottom section or (cast-in-place).
      b. Precast bottom section(s).
      c. Precast barrel section(s).
      d. Precast eccentric transition section.
      e. Precast adjuster ring(s).
      f. Precast concrete transition section.
      g. Precast flat top.
   5. Unless dimensioned or specifically noted on Drawings, provide manhole section with minimum 48 IN inside dimensions.

B. Nonpressure Type Frames and Cover:
   1. Cast iron frame and covers: ASTM A48, Class 35 (minimum).
   2. Use only cast ductile iron of best quality, free from imperfections and blow holes.
   3. Furnish frame and cover of heavy-duty construction a minimum total weight of 450 LBS.
   4. Machine all horizontal surfaces.
   5. Furnish unit with solid nonventilated lid with concealed pickholes.
      a. Letter covers "SEWER" for all collection system manholes, "DRAIN" for all gravity unit drains returning flow to the headworks, and "STORM" for storm sewer systems.
   6. Ensure minimum clear opening of 24 IN DIA.

C. Pressure Type Frame and Cover:
   1. Provide covers meeting the requirements of the Nonpressure Type Frames and Cover paragraph above and as modified below.
   2. Furnish frame and bolted cover of heavy-duty construction.
      a. Equip unit with six (6) stainless steel countersunk 3/8 IN DIA by 1-1/2 IN long bolts with stainless steel washers.
   3. Provide solid lid and minimum 1/8 IN thick x 1/2 IN wide continuous strip neoprene gasket.
   4. Furnish unit with a minimum of six (6) anchorage holes and six (6) 6 IN long x 3/4 IN DIA stainless steel anchor bolts.

D. Special Coatings and Joint Treatment:
   1. Joints of precast sections:
      a. Black mastic compound: ASTM D4022.
   2. Aluminum components embedded in concrete:
      a. See Specification Section 09905 for protective coating for aluminum embedded in concrete.
   3. Vertical wall surfaces:
      a. Emulsified fibrated asphalt compound meeting ASTM D1227 Type I for all exterior and interior vertical wall surfaces.

E. Sanitary Sewer Manhole Concrete:
   1. Provide all sanitary manholes constructed with Portland ASTM C150, Type I or II cement with a tricalcium aluminate content not to exceed 8 percent.
   2. Mix aggregate shall be a minimum of 50 percent crushed limestone.
   3. Provide 3000 psi nonshrink grout.

PART 3 - EXECUTION

3.1 MANHOLE CONSTRUCTION

A. General:
   1. Construct cast-in-place concrete base slabs.
   2. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
   3. On all straight runs, lay pipe through manhole and cut out top half of pipe.
      a. See detail on Drawings.
      b. If pipes deflect at manhole, shape as specified in Paragraphs 2 and 4.
   4. Shape inverts accurately and steel trowel finish.
      a. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert using as large a radius as manhole inside diameter will permit.
      b. Pour base slab integral with bottom barrel section.

B. Build each manhole to dimensions shown on plans and at such elevation that pipe sections built into wall of manhole will be true extensions of line of pipe.

C. For all horizontal mating surfaces between concrete and concrete or concrete and metal, above established high groundwater elevation shown trowel apply to clean surface black mastic joint compound to a minimum wet thickness of 1/4 IN immediately prior to mating the surfaces.

D. For horizontal joints that fall below established high groundwater elevation shown, install a resilient O-ring type gasket or pre-molded joint compound.

E. Seal all pipe penetrations in manhole.
   1. Form pipe openings smooth and well shaped.
   2. After installation, seal cracks with, non shrink grout.
   3. After grout cures, wire brush smooth and apply two coats emulsified fibrated asphalt compound to minimum wet thickness of 1/8 IN to ensure complete seal.

F. Set and adjust frame and cover final 6 IN (minimum) to 18 IN (maximum) to match finished pavement or finished grade elevation using precast adjuster rings.

END OF SECTION

SECTION 03030
HYDRAULIC STRUCTURE TESTING

PART 1 - GENERAL

1.1 REQUIREMENT

A. Contractor shall perform cleaning, flushing, and testing of all hydraulic structures and appurtenant piping, of all hydraulic structures and appurtenant piping for wastewater, complete, including conveyance of test water from Owner-designated source to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Contractor shall submit a minimum 48-hour advance written notice of its proposed testing schedule for review and concurrence of Engineer.

B. Contractor's proposed plans for water conveyance, control, and disposal shall be submitted in writing.

C. The submittals shall indicate Contractor's proposed division of structures into sections for testing and the design of bulkheads, test heads, and other appurtenances required for testing.

PART 2 - PRODUCTS

2.1 MATERIALS REQUIREMENTS

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, or other water control equipment and materials shall be determined and furnished by Contractor subject to 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. Unless otherwise provided herein, water for flushing and testing structures will be furnished by Owner; however, Contractor shall make all necessary provisions for conveying the water for flushing and testing from Owner-designated source to the points of use.

B. All hydraulic structures shall be tested.

C. Release of water from structures, after testing has been completed, shall be in accordance with a written disposal plan reviewed by Engineer. Contractor shall not discharge water with a chlorine residual that exceeds the limits established by the appropriate regulatory agencies.

3.2 LEAKAGE TESTS FOR CONCRETE STRUCTURES

A. Leakage tests of wet wells, vaults, containment areas, and other retaining structures shall be performed following the requirements of ACI 350.1R and as specified herein.

B. Prior to start of leakage testing, the following requirements shall be met:
   1. All elements of the structure which resist any portion of the retained liquid pressure shall be in place and at specified strength levels. All concrete shall be fully cured.
   2. Structure walls shall not be backfilled prior to leakage testing. Groundwater levels shall be controlled so that the levels are at least 2 FT below the structure subgrade at its lowest point.

3. All valves, gates, blind flanges, and other non-concrete items which control the flow or otherwise retain the liquid contents of the structure, shall be checked for watertightness. If not watertight, means shall be taken to assure watertightness during the period of the leakage test.
4. The portions of the structure to be tested shall be cleaned of all construction debris, standing water, soil foreign materials and any other material which interferes with the exposed concrete surfaces of the structure.
5. Defective concrete shall be repaired.
6. The Contractor shall notify the Engineer a minimum of 24 hours prior to start of filling of structure for leakage testing. Leakage testing shall not start until the structure is inspected by the Engineer.
7. Testing shall be performed prior to application of coatings to the interior or exterior of concrete walls.

C. Filling the Structure with Water:
1. The portion of the structure to be tested shall be filled at a rate not to exceed 2 ft/hr.
2. The structure shall be filled to the normal operating depth of the structure as indicated on the Contract Drawings. Where no operating depth is indicated, the structure shall be filled to a depth of 6 IN below the top of wall elevation.
3. Water in the structure shall be maintained at the specified test elevation for a minimum of 7 days prior to the start of the leakage test.
4. Test water shall be conveyed and managed to prevent structure flotation due to leakage of water from conveyance pipelines, overflow, or other causes.
5. After filling and closure of an isolation valve, the water level in a connected conveyance pipeline shall be reduced to an elevation less than the water surface elevation in the structure.

D. After water has been brought to the test elevation, the structure shall be inspected for leakage. All locations which exhibit any amount of leakage flow shall be repaired prior to the start of leakage testing. Structures with walls exposed to view after backfilling or during operation shall be repaired to eliminate wet areas on wall surfaces. A wet area is defined as an area which seeps sufficient moisture at any time during a 24-hour period to dampen a paper towel when pressed against the seep area.

E. The leakage test duration shall be determined by the Engineer based on ACI 350.1R but shall not be less than 7 days.

F. Leakage Allowance:
1. For unlined concrete structures, the maximum allowable leakage rate shall be 0.075 percent of the structure water volume per 24-hour period.
2. For concrete structures with walls lined by a mechanically anchored sheet lining material, the maximum allowable leakage rate shall be 0.050 percent of the volume per 24-hour period. If walls are partially lined, the leakage rate shall be adjusted linearly between 0.050 percent and 0.075 percent in proportion to the area of lined surface area to total wall surface area.

G. Test Locations:
1. Structure cells which are less than 1,000 ft^2 in plan area shall have measurements of water level taken at two locations which are located approximately 180 degrees apart.
2. Structure cells which are greater than 1,000 ft^2 in plan area shall have measurements of water level taken at four locations which are located approximately 90 degrees apart.
3. Each test location shall be marked and given a reference number. A reference point shall be marked on the face of the wall above test water surface in a manner which will prevent its movement or deterioration during the period of the test.
4. Test locations must be approved by the Engineer.

H. Evaporation and Precipitation Measuring:
   1. In open structures, a clear plastic calibrated open-top container not less than 18 IN in diameter and depth shall be partially filled, floated in the tank, and held in position near each measurement location.
   2. The container shall be located so as not to be shaded by tank walls and away from any items passing over it such as beams or pipes.

I. Test Measurements:
   1. Leakage tests shall not be started when periods of severe weather conditions or major changes in average daily temperature are predicted.
   2. The following measurements shall be recorded at each test location at the start of the test period and at 24-hour intervals thereafter:
      a. Distance from reference point to test water surface
      b. Depth of water in the floating container
      c. Temperature of the test water at 18 IN below water surface
      d. Temperature of the water in the evaporation-precipitation container at mid-depth

J. Leakage Determination:
   1. The change in water surface elevation at each test location shall be averaged and adjusted as follows.
   2. The total change in test water surface elevation shall be adjusted by the average change in water surface elevation in the evaporation-precipitation containers.
   3. Where averaged water temperature measurements vary by more than 3 percent from start to completion of the test period, adjustment in tank volume shall be determined by change of water density resulting from the change in the average water temperature.

K. Retesting:
   1. The leakage test shall be considered as failed if the specific leakage allowance is exceeded or if any leakage is observed.
   2. If the test becomes unreliable due to excessive precipitation or other external factors, it shall be restarted.
   3. If a leakage test fails, it may be retested immediately without repairs if approved by the Engineer. If subsequent leakage tests fail, the Contractor shall repair all probable areas of leakage and the leakage test shall be repeated. The structure shall be retested until it meets the specific leakage criteria. Repairs shall be made to the probable leakage areas before each retest.

L. Repairs to concrete structures shall be in accordance with Section 03348.

END OF SECTION

SECTION 03108
FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Formwork requirements for concrete construction.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03311 - Concrete Mixing, Placing, Jointing, and Curing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 347R, Guide to Formwork for Concrete.
   2. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Formwork, shoring and reshoring to be designed by a professional structural engineer currently registered in the State of California and having a minimum of three (3) years experience in this type of design work.
      a. Above qualifications apply to slabs and beams not cast on the ground, wall and column pours over 15 FT high.

C. Miscellaneous:
   1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
   2. Design requirements:
      a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local Building Code.
         1) Where conflicts occur between the above two (2) standards, the more stringent requirements shall govern.
      b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
   3. For slabs and beams not cast on the ground, develop a procedure and schedule for removal of shores and installation of reshores where applicable and for calculating the loads transferred to the structure during this process.
      a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon.
      b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
         1) The structural system that exists.
         2) Effects of all loads during construction.
         3) Strength of concrete.

4) The Modulus of Elasticity (Young's Modulus) of the concrete at the time of shoring and form removal .
5) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
6) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
7) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for the requirements for the mechanics and administration of the submittal process.
   2. Formwork design conforming to Section 03108-1.2C
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer and type of proposed form materials.
      d. Manufacturer and type of proposed form ties.
      e. Manufacturer and type of proposed form coating material.
      f. Manufacturer and type of void forms including compressive strength.
   4. Certification displaying conformance to ACI 347R as follows:
      a. Specific forming system indicating of formwork capacity in PSF and where to be used
      b. Correlation of specific forming system submitted to wet concrete pressure on the form
      c. Correlation may be achieved by adjustment of pouring rates per ACI 347R. Provide schedule of rates correlated to specific pours when height of pour height is greater than 15 feet if pour rate adjustment is used.
   5. Structural calculations sealed by a Professional Engineer licensed in the State of California for the following:
      a. Designs prepared per 03108-1.2B.1
      b. Design calculations to be submitted for information only.
      c. Engineer will not review and will provide an action indicating Engineer's review not required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Stay-in-place forms:
      a. Alabama Metal Industries Corporation.
   2. Form ties for process liquid containing walls:
      a. Dayton Superior

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Forms for Surfaces Exposed to View:
   1. Wood forms:
      a. New 5/8 or 3/4 IN 5-ply structural plywood of concrete form grade.

b. Built-in-place or prefabricated type panel.
c. 4 x 8 FT sheets for built-in-place type except where smaller pieces will cover entire area.
d. When approved, plywood may be reused.

2. Metal forms:
a. Metal forms excluding aluminum may be used.
b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:
1. Wood or metal sufficiently tight to prevent leakage.
2. Do not use aluminum forms.

2.3 ACCESSORIES

A. Form Ties:
1. Commercially fabricated for use in form construction.
a. Do not use wire ties.
2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
3. 3/4 IN minimum diameter cones on both ends.
4. Embedded portion of ties to be not less than 1-1/2 IN from face of concrete after ends have been removed.
5. Provide ties with built-in waterstops in all walls that will be in contact with process liquid during plant operation. She-Bolt System by Dayton Superior or equal.
6. Through-wall ties that are designed to be entirely removed are not allowed in walls that will be in contact with process liquid during plant operation.

B. Stay-In-Place Forms:
1. Ribbed expanded metal leave-in-place concrete forms commercially fabricated to provide an intentionally rougher surface.
2. Hot-dipped galvanized.
3. Similar to "Stay-Form" by Alabama Metal Industries Corporation.

C. Chamfer Strips:
1. Clear white pine.
2. Surface against concrete to be planed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:
1. Before placing of either reinforcing steel or concrete, cover surfaces of forms with an approved coating material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
2. Do not allow excess form coating material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 FT apart.

C. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:
1. Variation from plumb:
   a. In lines and surfaces of columns, piers, walls, and in risers:
      1) Maximum in any 10 FT of height: 1/4 IN.
      2) Maximum for entire height: 1/2 IN.
   b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
      1) Maximum in any 20 FT length: 1/4 IN.
      2) Maximum for entire length: 1/2 IN.
2. Variation from level or from grades specified:
   a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
      1) Maximum in any 10 FT of length: 1/4 IN.
      2) Maximum in any bay or in any 20 FT length: 3/8 IN.
      3) Maximum for entire length: 3/4 IN.
   b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
      1) Maximum in any bay or in 20 FT length: 1/4 IN.
      2) Maximum for entire length: 1/2 IN.
3. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
   a. Maximum in any bay: 1/2 IN.
   b. Maximum in any 20 FT of length: 1/2 IN.
   c. Maximum for entire length: 1 IN.
4. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 IN.
5. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 IN.
6. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 IN, +1/2 IN.
7. Footings and foundations:
   a. Variations in concrete dimensions in plan: -1/2 IN, +2 IN.
   b. Misplacement or eccentricity:
      1) 2 percent of footing width in direction of misplacement but not more than 2 IN.
   c. Thickness:
      1) Decrease in specified thickness: 5 percent.
      2) Increase in specified thickness: No limit except that which may interfere with other construction.
8. Variation in steps:
   a. In a flight of stairs:
      1) Rise: +1/8 IN.
      2) Tread: +1/4 IN.
   b. In consecutive steps:
      1) Rise: +1/16 IN.
      2) Tread: +1/8 IN.
9. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
10. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.

11. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 IN chamfer strips in exposed to view corners of forms to produce 3/4 IN wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 IN.
   1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
   2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.

F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 FT wide.
   1. Brace and tie formwork to maintain correct position and shape of members.

G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
   1. Securely brace forms against lateral deflection.
   2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

K. Stay-In-Place Forms:
   1. Support stay-in-place forms as required to maintain the formwork in proper position.
   2. Hold the edge of stay-in-place forms back a minimum of 2 IN from all smooth formed concrete surfaces.
   3. Stay-in-place forms may be used at the Contractor's option at:
      a. Surfaces that will be backfilled with soil.
         1) Maintain a minimum of 3 IN of concrete cover over all reinforcing.
      b. Roughened construction joints.
      c. Other locations approved by Engineer.

3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.
   1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Section 03311.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28 day compressive strength and the concrete Modulus of Elasticity has reached a value of (57000 times square root of f'c) unless otherwise approved in writing by the Engineer.
   1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.
   1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
   2. Locate reshores directly under a shore position above.

H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

END OF SECTION

SECTION 03151
ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Description of Work:
   1. The Supplier shall provide anchor bolts and adhesive anchors as shown and specified in the Contract Documents for equipment provided by the Supplier. Expansion anchors will not be allowed.
   2. This Section includes all required bolts and anchors whether or not specified under other Sections of the Contract Documents. This section takes precedence.
   3. The types of work using the bolts and anchors include, but are not limited to, the following:
      a. Mechanical/Electrical/Process Equipment
      b. Pumps
      c. Compressors
      d. Tanks
      e. Structural steel

B. Reference Specifications:
   1. Section 05120, Structural Steel
   2. Section 05505, Metal Fabrications
   3. Division 11 – Equipment

1.2 QUALITY CONTROL/QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
      b. 350, Code Requirements for Environmental Engineering Concrete Structures.
      c. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary.
      d. 355.4, Acceptance Criteria for Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.
   2. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
      b. 360, Specification for Structural Steel Buildings.
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      e. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
      f. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      g. A484, Standard Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
      h. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      i. A563, Standard Specification for Carbons and Alloy Steel Nuts.
      j. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
      k. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

l. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
m. B695, Standard Specification for Coating of Zinc Mechanically Deposited on Iron and Steel.
n. C881, Standard Specification for Epoxy-Resin-Based Bonding Systems for Concrete.
o. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
p. E1512, Standard Test Methods for Testing Bond Performance of Bonded Anchors.
q. F436, Standard Specification for Hardened Steel Washers.
r. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
s. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

4. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
5. Building code:
   a. International Code Council (ICC):
      1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Post-installed anchors and related materials shall be listed by one or more of the following agencies, as applicable:
   1. ICC Evaluation Service (ICC-ES).

C. Qualifications:
   1. Engineer for contractor-designed post-installed anchors shall be a professional civil/structural engineer licensed in the State of California.

1.3 DEFINITIONS

A. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.

B. Anchor Rod: Any cast-in-place or post-installed anchorage that is made from unheaded, threaded rod material.

C. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.

D. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

E. Hardware: As defined in ASTM A153.

F. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

G. Post-installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Setting and template drawings and details:
      a. Submit drawings showing location and required installation instructions for anchorage devices.
      b. Identify materials of construction, shop coatings, and third party accessories.

B. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of referenced standards.

b. Manufacturer's installation instructions.

C. Contractor designed post-installed anchors:
   a. Certification that anchors meet all requirements indicated in this Specification.
   b. Shop drawings and engineering design calculations:
      1) Indicate design load to each anchor.
   c. Type of post-installed anchor system used.
      1) Provide manufacturer's standard allowable load tables for the following:
         a) Expansion anchorage.
         b) Adhesive anchorage.
         c) Screw anchorage.
         d) Concrete inserts
   d. Current ICC-ES report for each post-installed anchor system indicating the following:
      1) Performance data showing that anchor is approved for use in cracked concrete.
      2) Seismic design categories that the anchor system has been approved to be used in.
      3) Required installation procedures.
      4) Special inspection requirements for installation.
   e. Diameter and embedment depth of each anchor.
   f. Indicate compliance with ACI 350, Appendix D.
   g. Stamped and signed by contractor's professional civil/structural engineer.

D. Engineer will review all submitted documents for general compliance with Contract Documents.

E. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Certification of installer for post-installed anchors.
      a. Indicate manufacturer's certification of installer for each type of approved post-installed anchor to be used on the Project.

F. Samples:
   1. Representative samples of concrete anchors may be requested by Engineer. Review will be for type and finish only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

1.5 PRODUCT DELIVERY STORAGE AND HANDLING

A. Package all anchor bolts in a single shipping container.

B. Clearly identify in the shipment of anchor bolts the equipment that they are intended to be used for. Plastic bags, tape or wire ties may be used to group anchor bolts together.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. When the size, length, or load carrying capacity of a concrete anchor is not shown on the Drawings, provide the following:
   1. For cast-in-place concrete anchors, provide the material, nominal diameter, embedment length, and design capacity to resist the calculated load based on the requirements given in the Building Code.
   2. For post-installed concrete anchors and concrete inserts, provide the manufacturer's system name/type, nominal diameter, embedment length, and design capacity required to resist the calculated load based on requirements given in the current ICC-ES report for the anchor to be used.

B. Determine design loads as follows:
   1. For equipment concrete anchors, use the dead and operating loads recommended by the equipment manufacturer and approved by the Engineer.

2. For concrete anchors supporting architectural components, use the dead and operating loads recommended by the vendor and/or the Architect.
3. The Building Code shall be used to determine the design seismic loads for concrete anchorage of all nonstructural components including all Mechanical and Electrical equipment and all Architectural components.
4. For pipe hangers and pipe support steel, see the requirements listed in Specification Section 15090.

2.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following post-installed anchor manufacturers are acceptable:
   1. Headed studs and deformed bar anchors:
      a. Nelson Stud Welding Div., TRW Inc.
      b. Stud Welding Products, Inc.
   2. Expansion anchor bolts:
      a. “Kwik Bolt KB TZ” by Hilti Inc.
      b. ITW Ramset/Red Head.
      c. “Power-Stud+” by Powers Fasteners.
      d. “Strong-Bolt” by Simpson Strong-Tie.
   3. Epoxy adhesive anchor bolts:
      a. “RE 500-SD” by Hilti Inc.
      b. ITW Ramset/Red Head.
      c. “PE-1000+” by Powers Fasteners.
      d. “SET XP” by Simpson Strong-Tie.
   4. Screw concrete anchors:
      a. “HUS-H” by Hilti,
      b. “Wedge-Bolt+” by Powers Fasteners,
      c. “Titen HD” by Simpson Strong-Tie.
   5. Threaded Concrete Inserts:
      a. “Snake +” by Powers Fasteners
      b. “Vertigo +” by Powers Fasteners
      c. “Titen HD Rod Hanger” by Simpson Strongtie

B. Submit request for substitution in accordance with Specification Section 01640.

2.3 MATERIALS

A. Cast-in-place Concrete Anchors:
   1. Building, Nonbuilding Structures, and equipment:
      a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized or non-galvanized threaded rods or J-bolts.
      b. ASTM A307, Grade A for galvanized headed bolts.
   2. All other cast-in-place concrete anchors: ASTM F593, Type 316 stainless steel with matching nut and washer.

B. Expansion, Epoxy, and Adhesive Concrete Anchors:
   1. ASTM F593 Type 316 stainless steel with matching nut and washer.
   2. Provide minimum edge distance, cover, and spacing as recommended by manufacturer, or as indicated on Drawings, whichever is larger.
      a. Minimum embedment as recommended by manufacturer or twelve (12) diameters of anchor, whichever is larger.
      b. Notify Engineer if required depth of embedment cannot be achieved at a particular anchor location.
      c. Follow manufacturer’s recommendations for installation and torque.

C. Threaded Concrete Inserts:
   1. This specification shall govern and be required in lieu of all references to any other concrete insert anchors, drop-in anchors or other generic names for threaded concrete inserts in these project specifications.

D. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

E. Deformed Bar Anchors: ASTM A496 with a minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

F. Washers:
   1. ASTM F436 or minimum 1/2 IN thick fabricated ASTM A36 square plates for all cast-in-place anchorage.
   2. If stainless steel anchorage is being used for cast-in-place anchorage, washers shall be the same material and alloy as in the accompanying anchorage.
   3. Follow manufacturer's requirements for all post-installed anchorage.

G. Nuts:
   1. ASTM A563 for all cast-in-place anchorage.
   2. If stainless steel anchorage is being used for cast-in-place anchorage, nuts shall be the same material and alloy as in the accompanying anchorage.
   3. Follow manufacturer's requirements if using post-installed anchorage.

H. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92 percent in dry film.
   4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."
   5. Dissimilar Materials Protection: See Specification Section 09905.

PART 3 - EXECUTION

3.1 GENERAL

A. Cast-in-place Anchorage:
   1. Shall be used where a cast-in-place anchor rod or bolt is indicated on the Contract Drawings, unless another anchor type is approved by the Engineer.
   2. Provide concrete anchorage as shown on the Drawings or as required to secure structural steel to concrete.
   3. Special Inspection is required in accordance with the Building Code for all concrete anchorage. Contractor shall notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation). See Article 3.5 of this Section for additional requirements.

B. Epoxy and Adhesive Anchorage:
   1. May only be used where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. May be used where subjected to vibration or where buried or submerged.
   3. Shall not be used in overhead applications.
   4. Shall not be used for pipe hangers.

C. Expansion Anchorage:
   1. May only be used where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. Shall not be used where subjected to vibration.
   3. May be used in overhead applications.

D. Concrete Inserts:
   1. May only be used where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. May be used for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.
   3. See Specification Section 15090 for additional requirements.

E. Powder actuated fasteners and other types of bolts and fasteners not specified herein shall not be used unless approved by the Engineer.

3.2 PREPARATION

A. Provide cast-in-place concrete anchorage and applicable setting templates in time to allow for their proper installation prior to placing concrete.

B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed and notify Engineer, in writing, of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.3 INSTALLATION

A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
   1. Tack welding of anchorage is prohibited.
      a. Coat anchorage and nut threads with a heavy coat of clean grease.
   2. Anchorage location tolerance shall be in accordance with Section 7 of the AISC Code of Standard Practice for Steel Buildings and Bridges.
   3. Provide steel templates for all column and equipment anchorage.

B. Unless noted or specified otherwise:
   1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
      a. Provide dissimilar materials protection per Specification 09905.
   2. Provide washers for all anchorage.
   3. Where exposed, anchorage shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top of the nut.
      a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.

C. The following shall be done after nuts are snug-tightened down:
   1. Upset threads of ASTM A307 unfinished anchorage to prevent nuts from backing off,
   2. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn to prevent nuts from backing off,
   3. If two nuts are used per concrete anchor above the base plate, tighten the top nut an additional 1/8 turn to “lock” the two nuts together,
   4. If using post-installed anchorage, follow manufacturer’s nut tightening procedures.

D. Assure that embedded items are protected from damage and are not filled in with concrete.

E. Anchor work such that it will not be distorted nor fasteners overstressed from expansion and contraction.

F. Set beam and column base plates accurately on non-shrink grout as indicated on Drawings.
   1. See Specification Section 03308 for non-shrink grout.
   2. Set and anchor each base plate to proper line and elevation.
      a. Use metal wedges and/or shims for leveling and plumbing columns and equipment.
         1) Wedges and shims shall be of the same material as the base plate that they support.
      b. Use leveling or setting nuts under the base plates only if approved by Engineer.

c. Fill space between bearing surface and bottom of base plate with non-shrink grout.
   1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
   2) Use expansion joints in the grout in accordance with the grout manufacturer's requirements where large grout pours are required under equipment.
d. Do not remove wedges or shims.
   1) Where they protrude, cut off flush with edge of base plate before installing the grout.
e. Fill sleeves around anchorage solid with non-shrink grout.

G. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09905.

H. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

I. For post-installed anchors, comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar. Properly clean out the hole per the manufacturer's recommendations utilizing a non-metallic fiber bristle brush and compressed air to remove all loose material from the hole prior to installing the anchor.

J. Post-installed anchor manufacturer's representative shall observe and demonstrate the proper installation procedures for the anchors at no additional expense to the Owner.

3.4 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage and concrete inserts of all concrete, dirt, and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings specified in Specification Section 09905.

3.5 FIELD QUALITY CONTROL

A. Periodic or continuous Special Inspection of post-installed anchors shall be provided as required by the Building Code, ICC-ES Evaluation Reports, and as specified by the Engineer. Special Inspection shall be performed by personnel independent of the Manufacturer or Contractor.
   1. Contractor shall submit a statement of responsibility to the Owner acknowledging an awareness of the Special Inspection requirements for the Project. The statement shall specifically acknowledge that the Contractor has made provisions in the Project construction schedule to allow for completion of all Special Inspections.

B. Employ a testing laboratory to perform field quality testing of installed anchors. Engineer is to determine the level of testing which is required for the various types of post-installed and cast-in-place anchorage. A minimum of ten percent of the post-installed anchors and reinforcing bars are to be tested to 50 percent of the ultimate tensile capacity of the post-installed anchor or reinforcing bar.

C. If failure of any of the post-installed anchors or reinforcing bars occurs, testing the remaining 90 percent will be required and the Contractor will be responsible to pay for the costs associated with the additional testing. The Contractor will also be responsible to correct improper workmanship, remove and replace, or correct, as directed by the Engineer, all post-installed anchors or reinforcing bars found unacceptable or deficient at no additional cost to the Owner.

D. The independent testing and inspection agency shall complete a report on each area of the Project where concrete anchors are installed. The report shall summarize the observations made by the inspector and shall be submitted to the Engineer.

E. Contractor shall provide access for the testing agency to places where concrete anchors are being installed so that required inspection and testing can be accomplished.

END OF SECTION

SECTION 03208
REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bar requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. SP 66, ACI Detailing Manual.
      b. 318, Building Code Requirements for Structural Concrete.
      c. 350, Code Requirements for Environmental Engineering Concrete Structures.
   2. ASTM International (ASTM):
      a. A185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
      b. A497, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
      c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      e. A775, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
   3. American Welding Society (AWS):
      a. D1.4, Structural Welding Code - Reinforcing Steel.
   4. Concrete Reinforcing Steel Institute (CRSI):
      a. Manual of Standard Practice.

B. Qualifications:
   1. Welding operators, processes and procedures to be qualified in accordance with AWS D1.4.
   2. Welding operators to have been qualified during the previous 12 months prior to commencement of welding.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Mill certificates for all reinforcing.
      d. Manufacturer and type of proprietary rebar mechanical splices.
      e. Manufacturer and type of rebar adhesive anchor including installation instructions.
   3. Qualifications of welding operators, welding processes and procedures.
   4. Rebar number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and rebar supports.
   5. Sufficient rebar details to permit installation of reinforcing.

6. Rebar details in accordance with ACI SP 66.
7. Locations where proprietary rebar mechanical splices are required or proposed for use.
8. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
    a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Rebar adhesive anchors:
        a. “RE 500-SD” by Hilti, Inc.
        b. “PE-1000+” by Powers Fasteners.
        c. “SET XP” by Simpson Strong-Tie.
    2. Rebar mechanical splices:
        a. Lenton Rebar Splicing by Erico, Inc.
        b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
        c. Bar-Grip Systems by Barsplice Products, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.

B. Reinforcing Bars to be Welded: ASTM A706.

C. Welded Wire Reinforcement: ASTM A185 or ASTM A497.

D. Smooth Dowel Bars: ASTM A615, grade 60 with metal end cap to allow longitudinal movement equal to joint width plus 1 IN.

E. Rebar Adhesive Anchors:
    1. Manufactured for the specific purpose of embedding and developing 125 percent of the yield strength of rebars in hardened concrete with ICC report verification.

2.3 ACCESSORIES

A. Metal Chairs, Runners, Bolsters, Spacers, Hangers, and Other Rebar Supports:
    1. Plastic-coated tips in contact with forms.
    2. Plastic coating meeting requirements of CRSI Manual of Standard Practice.

B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

A. Tolerances:
    1. Sheared lengths: +1 IN.
    2. Overall dimensions of stirrups, ties and spirals: +1/2 IN.
    3. All other bends: +0 IN, -1/2 IN.

B. Minimum diameter of bends measured on the inside of the rebar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship rebars to jobsite with attached plastic or metal tags.
   1. Place on each tag the mark number of the rebar corresponding to the mark number indicated on the Shop Drawing.
   2. Mark numbers on tags to be so placed that the numbers cannot be removed.
   3. For epoxy-coated rebars, use only plastic tags secured to rebars by nylon or plastic ties.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:
   1. Rebar placement:
      a. Clear distance to formed surfaces: +1/4 IN.
      b. Minimum spacing between bars: -1/4 IN.
      c. Top bars in slabs and beams:
         1) Members 8 IN deep or less: +1/4 IN.
         2) Members between 8 IN and 2 FT deep: -1/4 IN, +1/2 IN.
         3) Members more than 2 FT deep: -1/4 IN, +1 IN.
      d. Crosswise of members: Spaced evenly within +1 IN.
      e. Lengthwise of members: +2 IN.
   2. Minimum clear distances between rebars:
      a. Beams, walls and slabs: Distance equal to rebar diameter or 1 IN, whichever is greater.
      b. Columns: Distance equal to 1-1/2 times the rebar diameter or 1-1/2 IN, whichever is greater.
      c. Beam and slab rebars shall be threaded through the column vertical rebars without displacing the column vertical rebars and still maintaining the clear distances required for the beam and slab rebars.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
   1. For rebars: Class B splice meeting the requirements of Paragraph 12.15 of ACI 318.
   2. For welded wire reinforcement:
      a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one (1) spacing of cross wires plus 2 IN, nor less than 1.5 x development length nor less than 6 IN.
      b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with Paragraph 12.8 of ACI 318.
   3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.
      a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

D. Welding:
   1. Obtain approval by the Engineer prior to welding reinforcing. In general, welding of reinforcing will not be allowed unless needed for an unexpected condition arising in the field. Do not base bids with plans to weld reinforcing.
   2. Perform welding of rebars in accordance with requirements of AWS D1.4.
   3. Have each welder place an approved identifying mark near each completed weld.

E. Placing Rebars:
   1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.

2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the rebar supplied.
3. Rebar support:
    a. Uncoated rebar:
        1) Support rebars and fasten together to prevent displacement by construction loads or placing of concrete.
            a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
            b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
        2) On ground, provide supporting concrete blocks or metal bar supports with bottom plate.
            a) Do not use concrete blocks to support slab-on-grade reinforcing.
        3) Over formwork, provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other rebar support.
            a) Only tips in contact with the forms need to be plastic coated.
4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, rebars in the upper layers shall be placed directly above rebars in the bottom layer with clear distance between layers to be 1 IN unless shown otherwise.
    a. Place spacer rebars at 3 FT maximum centers to maintain the required 1 IN clear distance between layers.
5. Extend reinforcement to within 2 IN of concrete perimeter edges.
    a. If perimeter edge is formed by earth or stay-in-place forms, extend reinforcement to within 3 IN of the edge.
6. To assure proper placement, furnish templates for all column vertical bars and dowels.
7. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.
    a. Do not bend reinforcing by means of heat.
8. Do not tack weld reinforcing.
9. Embed rebars into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
    a. Drill hole in concrete with diameter and depth as required to develop 125 percent of the yield strength of the bar according to manufacturer's requirements and ICC report.
    b. Clean holes per manufacturer's recommendations.
    c. Place adhesive in drilled hole.
    d. Insert rebar into hole and adhesive in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:
    1. Notify Engineer whenever the specified clearances between rebars cannot be met.
    2. Do not place any concrete until the Engineer submits a solution to rebar congestion problem.
    3. Rebars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
    4. If rebars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of rebars.
    5. No cutting of rebars shall be done without written approval of Engineer.

B. Employ a testing laboratory to perform and report following:
    1. Review and approve Contractor proposed welding procedures and processes for conformance with AWS D1.4.
    2. Qualify welders in accord with AWS D1.4.

3. Test three (3) samples of each bar size and each type of weld in accord with AWS D1.4.
   a. The tensile strength of each test shall be not less than 125 percent of the required yield strength of the rebar tested.
4. Conduct nondestructive field tests (radiographic or magnetic particle) on not less than one (1) random sample for each 10 welds.
   a. In addition if any welds are found defective, test five (5) previous welds performed by same welder.
5. Visually inspect each weld for presence of cracks, undercuts, inadequate size and other visible defects.

END OF SECTION

SECTION 03308
CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete materials, strengths and proportioning for concrete work.
   2. Grouting:
      a. Base plates for columns and equipment.
      b. Dowels and anchors into concrete.
      c. Patching cavities in concrete.
      d. As specified and indicated in the Contract Document.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03350 - Testing.
   4. Section 03431 - Precast Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
      c. 212.3R, Chemical Admixtures for Concrete.
      d. 318, Building Code Requirements for Structural Concrete.
      e. 350, Code Requirements for Environmental Engineering Concrete Structures.
   2. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. C94, Standard Specification for Ready-Mixed Concrete.
      d. C150, Standard Specification for Portland Cement.
      e. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
      f. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
      g. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
      h. C494, Standard Specification for Chemical Admixtures for Concrete.
      i. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   3. Corps of Engineers (COE):
      a. CRD-C621, Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (NonShrink).

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's instructions.
   c. Concrete mix designs as required by Specification Section 03350.
   d. Manufacturer and type of proposed admixtures.
   e. Manufacturer and type of proposed non-shrink grout and grout cure/seal compound.
3. Certifications:
   a. Certification of standard deviation value in psi for ready mix plant supplying the concrete.
   b. Certification that the fly ash meets the quality requirements stated in this Specification Section if fly ash is used.
   c. Fly ash supplier's certified test reports for each shipment of fly ash delivered to concrete supplier, if fly ash is used.
   d. Certification that all fly ash supplied in concrete delivered to the site is from the same source, if fly ash is used.
   e. Certification that the class of coarse aggregate meets the requirements of ASTM C33 for type and location of concrete construction and project requirements.
   f. Certification of aggregate gradation.
   g. Certification of percent of coarse aggregate not passing a 3/8 IN sieve that is crushed stone. A minimum of 50 percent of the coarse aggregate <u>not</u> passing a 3/8 IN sieve shall be crushed stone aggregate.
4. Test reports:
   a. Cement mill reports for all cement to be supplied.
   b. Compressive tests per Section 03350.
   c. Shrinkage tests per Section 03350.
   d. Percent of crushed coarse aggregate not passing a 3/8 IN sieve
5. Certification that the aggregates to be supplied for the project are from the same location as the aggregates represented in the following concrete mix design submittal documents:
   a. Compressive strength test reports.
   b. Certification document for the class of coarse aggregate meeting the requirements of ASTM C33 and project requirements for type and location of concrete construction
   c. Shrinkage test reports.
   d. Certification document for the aggregate gradation.
   e. Certification document for the percent of crushed stone coarse aggregate <u>not</u> passing a 3/8 IN sieve.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
   1. Store cement and pozzolan in weathertight buildings, bins, or silos which will exclude moisture and contaminants.
   2. Arrange aggregate stockpiles and use in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates.
   3. Allow natural sand to drain until it has reached a relatively uniform moisture content before use.
   4. Store admixtures in such a manner as to avoid contamination, evaporation, or damage.
      a. For those used in form of suspensions or non-stable solutions, provide agitating equipment to assure thorough distribution of ingredients.
      b. Protect liquid admixtures from freezing and temperature changes which would adversely affect their characteristics and performance.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Non-shrink Grout:
      a. BASF Admixtures, Inc.
      b. Euclid Chemical Corporation.
      c. U. S. Grout.
      d. Upco.
      e. Set Products, Inc.
      f. L & M Construction Chemicals, Inc.
      g. Sika Corporation
   2. Epoxy Grout:
      a. Ceilcote.
      b. Exxon Chemical Company.
      c. Sika Corporation.
      d. U. S. Grout.
      e. Euclid Chemical Corporation.
   3. Epoxy Adhesive:
      a. Sika Corporation.
      b. Euclid Chemical Corporation.
   4. Epoxy Bonding Adhesive:
      a. Sika Corporation
      b. Euclid Chemical Corporation
   5. Cementitious Polymer Modified Patch:
      a. Sika Corporation
      b. Euclid Chemical Corporation
   6. Cementitious Polymer Modified Finishing Mortar:
      a. Sika Corporation
      b. Euclid Chemical Corporation
   7. Bonding Agent:
      a. Euclid Chemical Corporation
      b. BASF Admixtures, Inc
      c. L & M Construction Chemicals, Inc
      d. Thoro System Products
   8. Anti-Corrosion Bonding Agent
      a. Sika Corporation
      b. Euclid Chemical Corporation

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Cement:
   1. ASTM C150, Type II.
   2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. Fly Ash:
   1. ASTM C618, Class F or Class C.
   2. Non-staining.
   3. Suited to provide hardened concrete of uniform light gray color.
   4. Maximum loss on ignition: 4 percent.
   5. Compatible with other concrete ingredients and having no deleterious effects on the hardened concrete.

6. Produced by source approved by the State Highway Department in the state where the Project is located for use in concrete for bridges.
7. Cement and fly ash type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:
1. Air entraining: ASTM C260.
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
4. Admixtures to be chloride free.
   a. Do not use calcium chloride.
5. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.

D. Water:
1. Potable.
2. Clean and free from deleterious substances.
3. Free of oils, acids and organic matter.

E. Aggregates for Normal Weight Concrete:
1. ASTM C33.
2. Fine and coarse aggregates to be regarded as separate ingredients.
3. Fine aggregate:
   a. Clean, natural sand.
   b. No manufactured or artificial sand.
4. Gradation of coarse aggregate:
   a. All concrete: ASTM C33, size #57 or size #67.
   b. A minimum of 50 percent of the coarse aggregate <u>not</u> passing a 3/8 IN sieve shall be crushed stone aggregate.
5. Provide aggregates approved for bridge construction by the California State Department of Transportation.
6. Pozzolan or other additives shall not be used to compensate for alkali reactivity of aggregates.

F. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement:
1. 0.06 for prestressed concrete.
2. 0.10 for all other concrete.

G. Sand Cement Grout:
1. Approximately three (3) parts sand, one (1) part Portland cement, 6 $\pm$1 percent entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
   a. Provide sand in accordance with requirements for fine aggregate for concrete.
2. Minimum 28 day compressive strength: 3000 psi.

H. Non-shrink Grout:
1. Non-shrink, non-metallic, non-corrosive, and non-staining.
2. Pre-mixed with only water to be added in accordance with manufacturer's instructions at Project site.
3. Grout to produce a positive but controlled expansion.
   a. Mass expansion shall not be created by gas liberation or by other means.
4. Minimum 28-day compressive strength: 6500 psi.
5. Acceptable Products:
   a. BASF Admixtures, Inc. "Masterflow 713 Plus"
   b. Euclid Chemical "NS Grout"
   c. Sauereisen Cements "F-100 Level Fill Grout"

d. U. S. Grout "Five Star Grout"
e. Set Products, Inc. "Set Non-Shrink Grout"
f. The Upco Corp "Upcon"
g. L & M "Crystex"
h. Sika Corporation "SikaGrout 212"
i. or equal.

6. In accordance with COE CRD-C621.
7. Non-shrink grout under this paragraph shall not be used for machine base grout applications. Use epoxy grout.

I. Epoxy Grout:
1. Three-component epoxy resin system:
   a. Two (2) liquid epoxy components.
   b. One (1) inert aggregate filler component.
2. Adhesive:
   a. BASF “Masterflow 648 CP”.
   b. Exxon Chemical Company "Escoweld 2505."
   c. Sika "Sikadur 32 Hi-Mod.", "Sikadur 32 Hi-Mod LPL”
   d. U. S. Grout "Five Start Epoxy Grout."
   e. Euclid Chemical "E3-G."
   f. Or equal.
3. Aggregate:
   a. BASF “Masterflow 648 CP”.
   b. Exxon Chemical Company "Escoweld 2510."
   c. Sika aggregate.
   d. U. S. Grout aggregate.
   e. Euclid Chemical "Euclid aggregate."
   f. Or equal.
4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
5. The aggregate shall be compatible with the adhesive.
6. Each component furnished in separate package for mixing at jobsite.
7. Epoxy Grout shall be used for machine base grout applications and others where specified.

J. Epoxy Adhesive:
1. For use with retrofit waterstops, as seal on water-bearing form-tie holes, and as otherwise specified.
   a. Sikadur 32 Hi-Mod LPL by Sika Corporation.
   b. Approved equivalent.

K. Epoxy Bonding Adhesive:
1. For use where bonding new concrete to existing concrete.
2. Two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.
   a. Sikadur 32, Hi-Mod LPL by Sika Corporation.
   b. Euco No. 452 MV by Euclid Chemical Corporation.

L. Cementitious Polymer Modified Patch:
1. Two Component polymer-modified Portland cement non-sag mortar for patching vertical and overhead concrete surfaces.
   a. SikaTop 123 Plus by Sika Corporation.
   b. Verticoat by Euclid Chemical Corporation.

M. Cementitious Polymer Modified Finishing Mortar:
1. SikaTop 121 Plus by Sika Corporation.
2. Tammscrete by Euclid Chemical Corporation.

N. Waterproofing Treatment:
1. Vandex Super White by Euclid Chemical Corporation.

2. SikaTop 107 (White in color) by Sika Corporation.

O. Bonding Agent:
1. For use only on concrete surfaces not receiving liquid water repellent coating:
   a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
   b. Acceptable Products:
      1) Euclid Chemical Co. "Flex-Con."
      2) BASF Admixtures, Inc. "Acryl-Set."
      3) L & M Construction Chemicals, Inc. "Everbond."
      4) Thoro System Products "Acryl 60."
2. For use only on concrete surface receiving liquid water repellent:
   a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.

P. Anti-Corrosion Bonding Agent:
1. Three component, moisture tolerant, cementitious bonding agent manufactured for the purpose of bonding fresh concrete to hardened concrete and providing an anti-corrosion coating to the embedded reinforcing.
   a. Sika Armatec 110 EpoCem by Sika Corporation.
   b. Duralprep A.C. by Euclid Chemical Corporation.

2.3 MIXES

A. General:
1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
2. Ready-mixed concrete shall conform to ASTM C94.
3. All concrete to be normal weight concrete weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Minimum 28 Day Compressive Strengths:

Normal weight concrete fill, lean concrete, and concrete encasement	3000 psi
Normal weight precast concrete	5000 psi
Normal weight all other concrete	4000 psi

C. Air Entrainment:
1. Provide air entrainment in all concrete resulting in a total air content percent by volume as follows:
   a. 1 IN or 3/4 IN maximum aggregate size: 5 to 7 percent total air content.
   b. Interior slabs and mats with power trowel finish: Maximum 3 percent total air content.

D. Slump:
1. Concrete with high range water reducer (superplasticizer):
   a. Prior to introducing superplasticizer: 4 IN maximum
   b. After addition of superplasticizer: 7 IN maximum measured at the point of discharge into the concrete member.
   c. Slump shall be obtained by use of mid-range or high-range water reducer in accordance with ASTM C494.
2. All other concrete: 4 IN maximum, 3 IN minimum measured at point of discharge into the concrete construction member.
3. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
4. Provide additional water-reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.

a. Provide only enough additional water-reducing admixture so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified so that the maximum specified water-cement ratio is not exceeded.

5. Slump may be adjusted in the field through the use of water reducers.
   a. Coordinate dosage and mixing requirements with concrete supplier.
   b. Slump may not be adjusted on concrete that has exceeded the batching to placement time limit in Section 03311. Reject if not workable.

E. Proportioning:
1. General:
   a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
   b. Proportion ingredients to produce proper workability, durability, strength and other required properties.
2. Normal weight concrete minimum cement contents and maximum water cement ratios:

SPECIFIED STRENGTH (PSI)	MINIMUM CEMENT (LBS/CY)	MAXIMUM WATER CEMENT RATIO BY WEIGHT
3000	517*	0.45
4000	564*	0.45
5000	611*	0.45

* If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall equal these values.

3. Fly ash:
   a. For cast-in-place concrete only, a maximum of 15 percent by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
   b. If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.
   c. Concrete containing fly ash shall not be used in the construction of the precast concrete units specified in Specification Section 03431.
4. Water reducing, retarding, and accelerating admixtures:
   a. Use in accordance with manufacturer's instructions.
   b. Do not use unless required by these specifications or approved for use by Engineer.
5. High range water reducers (superplasticizers, Super-P):
   a. Use in accordance with manufacturer's instructions.
   b. Do not use unless required by these Specifications or approved for use by Engineer.
   c. Limit water/cement ratio to 0.38
6. Concrete mix proportioning methods for normal weight concrete:
   a. Method 1:
      1) Used when combination of materials proposed is to be evaluated and proportions selected to be on a basis of trial mixes.
      2) Produce mixes having suitable proportions and consistencies based on ACI 211.1, using at least three (3) different water cement ratios or cement contents which will produce a range of compressive strengths encompassing the required average strength.
      3) Design trial mixes to produce a slump within 0.75 IN of maximum specified, and for air entrained concrete, air content within 0.5 percent specified.
      4) For each water cement ratio or cement content, make at least three (3) compression test cylinders for specified test age, and cure in accordance with ASTM C192.
         a) Test for strength at 28 days in accordance with ASTM C39.

5) From results of these tests, plot a curve showing relationship between water cement ratio or cement content and compressive strength.
6) From this curve select water cement ratio or cement content to be used to produce required average strength.
7) Use cement content and mixture proportions such that maximum water cement ratio is not exceeded when slump is maximum specified.
8) Base field control on maintenance of proper cement content, slump, air content and water cement ratio.
9) See paragraph hereafter for definition of required average strength.

b. Method 2:
1) In lieu of trial mixes, field test records for concrete made with similar ingredients may be used.
2) Use of proposed concrete mix proportions based on field test records subject to approval by Engineer based on information contained in field test records and demonstrated ability to provide the required average strength.
3) Field test records to represent materials, proportions and conditions similar to those specified.
a) Changes in the materials, proportions and conditions within the test records shall have not been more restricted than those for the proposed concrete mix.
b) Field test records shall meet the requirements of ACI 350 Paragraph 5.3.1.
4) Required concrete proportions may be established by interpolation between the strengths and proportions of two (2) or more test records each of which meets the requirements of this Specification Section.

7. Required average strength to exceed the specified 28 day compressive strength by the amount determined or calculated in accordance with Section 5.3 of ACI 350 using the standard deviation of the proposed concrete production facility as described in Paragraphs 5.3.1 and 2 of ACI 350.

F. Allowable Shrinkage: 0.038 percent at 28 days per ASTM C157 and Section 03350.

G. Pan stair fill:
1. Coarse aggregate: 100 percent passing a 1/2 IN sieve.
2. Proportions:
a. 1 sack cement.
b. 150 LBS coarse aggregate.
c. 150 LBS fine aggregate.
3. Adjust mix to obtain satisfactory finishing.

2.4 SOURCE QUALITY CONTROL

A. To assure stockpiles are not contaminated or materials are segregated, perform any test for determining conformance to requirements for cleanness and grading on samples secured from aggregates at point of batching.

B. Do not use frozen or partially frozen aggregates.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Perform concrete tests per Specification Section 03350.

B. Perform strength test on any concrete to which water has been added at the jobsite.

END OF SECTION

SECTION 03311

CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mixing, placing, jointing, and curing of concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03108 - Formwork.
   4. Section 03208 - Reinforcement.
   5. Section 03308 - Concrete, Materials and Proportioning.
   6. Section 03348 - Concrete Finishing and Repair of Surface Defects.
   7. Section 03350 - Testing.
   8. Section 07900 - Joint Sealants.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
      b. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
      c. 304.2R, Placing Concrete by Pumping Methods.
      d. 305R, Hot Weather Concreting.
      e. 306R, Cold Weather Concreting.
      f. 308, Standard Practice for Curing Concrete.
      g. 309R, Guide for Consolidation of Concrete.
   2. ASTM International (ASTM):
      a. C94, Standard Specification for Ready-Mixed Concrete.
      b. C156, Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete.
      c. C171, Standard Specification for Sheet Materials for Curing Concrete.
      d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      e. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
      f. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
      g. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   3. Corps of Engineers (COE):
      a. CRD-C572, Specifications for Polyvinylchloride Waterstops.
   4. National Ready Mixed Concrete Association (NRMCA):
      a. Checklist for Certification of Ready Mixed Concrete Production Facilities.
   5. National Sanitation Foundation International (NSF).

B. Qualifications:
   1. Ready Mixed Concrete Batch Plant: Certified by NRMCA.

1.3 DEFINITIONS

A. Words and terms used in this Specification Section are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Drawings showing all proposed construction slab joint layouts and any proposed wall joints not shown on the drawings for approval by the Engineer prior to constructing.
      a. Construction joint spacing shall conform to the joint spacing criteria indicated in Paragraph 03311-3.4.B. Submit proposed construction joint locations in conformance with this Specification Section.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
         1) Procedure for adding high-range water reducer at the jobsite.
      c. Scaled (minimum 1/8 IN per foot) drawings showing proposed locations of construction joints and joint keyway dimensions.
      d. Manufacturers and types:
         1) Joint fillers.
         2) Curing agents.
         3) Construction joint bonding adhesive.
         4) Waterstops.
            a) Provide, as applicable for this project, sample of Vertical Ell, Flat Ell, Flat Cross and Flat T prefabricated waterstop joints with 6” extensions beyond joint on all ends.
   4. Certifications:
      a. Ready mix concrete plant certification.
      b. Waterstops: Products shipped meet or exceed the physical properties specified.

B. Miscellaneous:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Copies of concrete delivery tickets.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Concrete:
      a. Prepare a delivery ticket for each load of ready mixed concrete.
      b. Truck operator shall hand ticket to Contractor at the time of delivery.
      c. Ticket to show:
         1) Mix identification.
         2) Quantity delivered.
         3) Amount of material in each batch.
         4) Outdoor temperature in the shade.
         5) Time at which cement was added
         6) Time of delivery.
         7) Time of discharge.
         8) Amount of water that may be added at the site without exceeding the specified water-cement ratio.
         9) Amount of water added at the site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 COMPONENTS

A. Evaporation Retardant:
   1. Acceptable Manufacturers:
      a. BASF.
      b. Euclid Chemical Corporation.

B. Neoprene Expansion Joint Fillers:
   1. Acceptable manufacturers:
      a. Permaglaze.
      b. Rubatex.
      c. Williams Products.
   2. Materials:
      a. Closed cell neoprene.
      b. ASTM D1056, Class SC.
      c. Compression deflection: As required to limit deflection to 50 percent of joint thickness under pressure from concrete pour height.

C. Asphalt Expansion Joint Fillers:
   1. Acceptable manufacturers:
      a. W R Meadows.
      b. J and P Petroleum Products.
   2. Materials: ASTM D994.

D. Fiber Expansion Joint Fillers:
   1. Materials: ASTM D1751.

E. Waterstops, PVC Type:
   1. Acceptable manufacturers:
      a. Greenstreak Plastics Products.
      b. W R Meadows.
   2. Materials:
      a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
      b. Standard: COE CRD-C572.
   3. In expansion joints:
      a. 9 IN wide by 3/8 IN thick tear web type waterstop.
      b. 2 IN minimum horizontal movement without rupturing.
      c. Similar to Greenstreak Plastic Products Style #700.
   4. In construction joints:
      a. 6 IN wide by 3/8 IN thick with ribs and center bulb.
      b. Similar to Greenstreak Plastics Products Style #705.
   5. In all other joints:
      a. 6 IN wide by 3/8 IN thick with ribs.
      b. Similar to Greenstreak Plastics Products Style #679.
   6. Provide hog rings or grommets at maximum 12 IN OC along the length of the waterstop.
   7. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field.
   8. Do not avert factory-made ells and T's in thicker walls.

F. Waterstops, Preformed Strip type:
   1. Acceptable manufacturers:
      a. Hydrotite CJ by Greenstreak Plastics, Inc.
      b. Adeka Ultra Seal USA.
      c. Or equal.
   2. Materials:
      a. Hydrophilic type waterstop manufactured solely for the purpose of preventing water from traveling through construction joints.
      b. Hydrotite type Cj-0725-3K or equal.

G. Sand cement grout, non-shrink grout and epoxy grout: See Specification Section 03308.

PART 3 - EXECUTION

3.1 PREPARATION

A. General:
   1. Complete formwork.
      a. See Specification Section 03108.
   2. Remove earth, snow, ice, water, and other foreign materials from areas that will receive concrete.
   3. Secure reinforcement in place.
      a. See Specification Section 03208.
   4. Position expansion joint material, anchors and other embedded items.
   5. Obtain approval of reinforcement erection and placement prior to placing concrete.
   6. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and approval is obtained.
      a. Plan size of crews with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
      b. Do not allow rainwater to increase mixing water nor to damage surface finish.
   7. Prepare all construction joints for proper bond per Paragraph 3.4C of this Specification Section.
   8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
   9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
      a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs On Ground:
   1. Subgrade drained and of adequate and uniform load-bearing nature.
   2. Obtain approval of subgrade compaction density prior to placing slabs on ground.
   3. Maintain subgrade at a temperature above 32 DegF before concrete placing begins for a sufficient amount of time to remove frost.
   4. Moisten subgrade to eliminate absorption.
      a. Keep subgrade moist at time of concreting.
      b. Allow no free-standing water on subgrade or soft or muddy spots when concrete is placed.

C. Edge Forms and Screeds:
   1. Set accurately to produce designated elevations and contours of finished surface.
   2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
   3. Use strike off templates, or approved vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.2 CONCRETE MIXING

A. General:
   1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
   2. Batch, mix, and transport in accordance with ASTM C94.

B. Control of Admixtures:
   1. Charge admixtures into mixer as solutions.
      a. Measure by means of an approved mechanical dispensing device.
      b. Liquid considered a part of mixing water.
      c. Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
   2. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
   3. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

C. Tempering and Control of Mixing Water:
   1. Mix concrete only in quantities for immediate use.
   2. Discard concrete which has set.
   3. Discharge concrete from ready mix trucks within time limit and drum revolutions stated in ASTM C94.
   4. Addition of water at the jobsite:
      a. See Specification Section 03308 for specified water cement ratio and slump.
      b. Do not exceed maximum specified water cement ratio or slump.
      c. Incorporate water by additional mixing equal to at least half of total mixing required.
      d. Perform strength test on any concrete to which water has been added at the jobsite.
         1) See Specification Section 03350.

3.3 PLACING OF CONCRETE

A. General:
   1. Comply with ACI 304R and ACI 304.2R.
   2. Deposit concrete:
      a. Continuously to avoid cold joints.
      b. In layers of 12 to 18 IN.
   3. Locate construction joints at locations approved by Engineer.
      a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
   4. Place slabs in checker board pattern and/or to allow a minimum of 7 days between pours on both sides of the same joint.
   5. Place concrete at such a rate that concrete, which is being integrated with fresh concrete, is still workable.
   6. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
   7. Spreaders:
      a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
      b. Embedded:
         1) Obtain approval of Engineer.
         2) Materials: Concrete or metal.
         3) Ends of metal spreaders coated with plastic coating 2 IN from each end.
   8. Do not begin placing of concrete in supported elements until concrete previously placed in supporting members is no longer plastic and has been in place at least a minimum of 2 HRS.

9. Deposit concrete as nearly as practicable in its final position to avoid segregation.
   a. Maximum free fall: 4 FT.
   b. Free fall exceeding 4 FT: Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface placed upon.
10. Perform the following operations before bleeding water has an opportunity to collect on surface:
   a. Spread.
   b. Consolidate.
   c. Straightedge.
   d. Darby or bull float.
11. Use Evaporation Retardant to reduce surface moisture evaporation of slabs during concrete placement. Strict adherence to the manufacturer's instructions of use are essential for intended results.
   a. Confilm by BASF.
   b. Eucobar by Euclid Chemical Corporation.
   c. Or approved equivalent.

B. Admixtures:
   1. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.

C. Cold Weather Concrete Placement:
   1. Comply with ACI 306R.
   2. Do not place concrete on substrates that are below 32 DegF or contain frozen material.
   3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
   4. Temperature of concrete when discharged at site:

AIR TEMPERATURE DEGF	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION LESS THAN 12 IN	MINIMUM CONCRETE TEMPERATURE, DEGF FOR SECTIONS WITH LEAST DIMENSION 12 IN OR GREATER
30 to 45	60	55
0 to 30	65	55
below 0	70	60

   5. Heat subgrade, forms, and reinforcement so the temperature of the subgrade, forms, and reinforcement will be between 45 and 70 DegF, when temperature of surrounding air is 40 DegF or below at time concrete is placed.
      a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
   6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DegF.
   7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DegF.
   8. Do not place slabs on ground if temperature is below 40 DegF or if temperature surrounding the slab will be below 40 DegF before structure is enclosed and heated.

D. Hot Weather Concrete Placement:
   1. Comply with ACI 305R.
   2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
   3. Temperature of concrete when placed:
      a. Not to exceed 90 DegF.
      b. Not so high as to cause:
         1) Shrinkage cracks.
         2) Difficulty in placement due to loss of slump.

        3) Flash set.
    4. Temperature of forms and reinforcing when placing concrete:
        a. Not to exceed 90 DegF.
        b. May be reduced by spraying with water to cool below 90 DegF.
            1) Leave no standing water to contact concrete being placed.

E. Consolidating:
    1. Consolidate in accordance with ACI 309R except as modified herein.
    2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms. Pay particular attention to consolidation around waterstops.
        a. Eliminate:
            1) Air or stone pockets.
            2) Honeycombing or pitting.
            3) Planes of weakness.
    3. Internal vibrators:
        a. Minimum frequency of 8000 vibrations per minute.
        b. Insert and withdraw at points approximately 18 IN apart.
            1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
        c. Use in:
            1) Beams and girders of framed slabs.
            2) Columns and walls.
        d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
    4. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
    5. Do not use vibrators to transport concrete within forms.
    6. Provide spare vibrators on jobsite during all concrete placing operations.
    7. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
    8. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
    9. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

F. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
    1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
    2. Horizontal belt conveyors:
        a. Mount at a slope which will not cause segregation or loss of ingredients.
        b. Protect concrete against undue drying or rise in temperature.
        c. Use an arrangement at discharge end to prevent segregation.
        d. Do not allow mortar to adhere to return length of belt.
        e. Discharge conveyor runs into equipment specially designed for spreading concrete.
    3. Metal or metal lined chutes:
        a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
        b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
        c. Provide end of each chute with a device to prevent segregation.
    4. Pumping or pneumatic conveying equipment:
        a. Designed for concrete application and having adequate pumping capacity.
        b. Control pneumatic placement so segregation is avoided in discharged concrete.
        c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.

d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
e. Provide pumping equipment without Y sections.

G. Placing of Concrete on Metal Deck:
1. Prior to concrete placement, the metal deck shall be free of soil, debris, standing water, loose mill scale, and all other foreign matter.
2. Care shall be exercised when placing concrete so that the deck will not be subject to construction loads or impact that exceed the design capacity of the deck.
3. Concrete shall be placed in a uniform manner and spread toward the center of the deck span.
4. If buggies are used to place concrete, runways shall be planked, and the buggies shall only operate on planking.
   a. Planks shall be of adequate stiffness to transfer loads to the steel supports without damaging the deck.
5. Deck damage caused by careless placement of concrete shall be repaired or replaced.

3.4 JOINTS AND EMBEDDED ITEMS

A. Construction Joints – General:
1. Not all joint locations are shown on the design drawings for this project. Contractor shall provide shop drawings showing all proposed construction joint layouts for approval by the Engineer prior to constructing.
   a. Construction joint spacing shall conform to the joint spacing criteria indicated in Paragraph B. below. Submit proposed construction joint locations in conformance with this Specification Section.
2. Unplanned construction joints will not be allowed.
   a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
   a. At Contractor's option, beam pockets may be formed into concrete walls.
   b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
5. Place beams, girders, column capitals and drop panels at same time as slabs.
6. Place corbels monolithically with walls.
   a. Locate wall vertical construction joints midway between corbels.
   b. Where only a single corbel is located place it also monolithically with wall and locate wall vertical construction joint a minimum of 3 FT from face of corbel.
7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
8. Provide roughened construction joints at all construction joints unless indicated otherwise on Drawings.
   a. Clean the previously hardened concrete interface and remove all laitance including curing compound where applicable.
   b. Intentionally roughen the interface to a full amplitude of ¼ IN.
9. Provide continuous keyways only where indicated on Drawings.
   a. Construction joint keyways shall have the following dimensions, unless shown otherwise on Drawings or directed otherwise by Engineer.
   b. Construction joint keyways in walls:
      1) Keyway width, not less than 1/3 and not more than ½ the wall thickness measured perpendicular to wall faces.
      2) Keyway depth to be not less than 1-1/2 IN.
      3) Place keyway in center of wall thickness unless shown otherwise on Drawings.
   c. Construction joint keyways in footings, foundations, base slabs, and structural or elevated slabs:
      1) Keyways only allowed where shown on the drawings.

2) Keyway height not less than 1/3 and not more than ½ the footing or slab thickness.
3) Keyway depth not less than 1-1/2 IN.
4) Keyway in center of slab or footing thickness unless shown otherwise on Drawings.

d. Construction joint keyways in beams:
1) Keyway height not less than 1/3 and not more than ½ the beam depth.
2) Keyway depth not less than 1-1/2 IN.
3) Keyway in center of beam section unless shown otherwise on Drawings.

10. Allow a minimum of 7 days before placement of adjoining concrete construction.

B. Construction Joints – Spacing, unless shown otherwise on the Drawings or approved by the Engineer:

1. General – Structures <u>not</u> intended to contain liquid:
a. Wall vertical construction joints:
1) 30 FT maximum centers.
2) At wall intersections, 15 FT maximum and 2 feet minimum from corners.

b. Wall horizontal construction joints: 20 to 25 FT centers.

c. Walls that are thicker than 18 IN may be poured up to 32 FT tall in one (1) pour provided the following requirements of 03311-3.4B.2b are satisfied:

d. Base slab, floor, and roof slab construction joints:
1) Placements to be approximately square and not to exceed 1600 SF.
2) Maximum side dimension of a slab pour to be less than:
a) Twice the length of the short side.
b) 40 FT.
3) No re-entrant corners will be allowed in any concrete slab pour unless approved by the engineer. All pours shall be square or rectangular.

2. Structures intended to contain liquids, unless shown otherwise on the Drawings or approved by the Engineer:
a. Wall vertical construction joints:
1) 24 FT maximum centers.
2) At wall intersections, 12 FT maximum and 2 feet minimum from corners.

b. Wall horizontal construction joints: 12 to 18 FT centers.
1) Walls that are thicker than 18 IN may be poured up to 32 FT tall in one (1) pour provided the following requirements are satisfied:
a) A test wall of similar size, height and thickness will be poured to demonstrate the quality of the concrete work.
b) The test wall will be located as a portion of a non-water bearing wall.
(1) The test wall will include a waterstop at the bottom of the wall.
(2) Alternatively, a separate test wall with waterstop at bottom, not part of the final work, may be constructed.
c) The concrete placement and concrete quality of the test wall will be observed by the Engineer.
(1) Concrete will be judged on the following:
(a) Ability to keep bottom of the pour clean and free from trash and debris.
(b) Ability to protect the waterstop from folding over due to the force of falling concrete.
(c) Ability to properly consolidate all concrete in the wall pour, including below formed openings.
2) Engineer will evaluate the Contractor's work and may recommend taller concrete wall pours if concrete quality is acceptable.
3) Preparation for all subsequent wall pours over 18 FT tall must be the same as the preparation of the test wall.
4) Should the quality of concrete work on subsequent wall pours be judged inadequate, the Contractor may be directed to limit wall pour heights to 18 FT as originally specified.

5) Should the quality of concrete work on the test wall be judged inadequate, additional test walls will not be observed and judged to allow pour heights greater that 18 FT unless allowed by Engineer.

c. Base slab, floor, and roof slab construction joints:
   1) Placements to be approximately square and not to exceed 1200 SF.
   2) Maximum side dimension of a slab pour to be less than:
      a) One and one half times the length of the short side.
      b) 40 FT.
   3) No re-entrant corners will be allowed in any concrete slab pour unless approved by the engineer. All pours shall be square or rectangular

C. Construction Joints – Bonding:
   1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance, and curing compound where applicable, from construction joints.
      a. Before new concrete is placed, all construction joints shall be coated with an approved bonding adhesive applied in accordance with manufacturer's instructions.
   2. Roughened construction joints:
      a. Roughen the surface of the concrete to expose the aggregate uniformly
      b. Remove laitance, loosened particles of aggregate or damaged concrete at the surface, or at the Contractor's option, use an approved chemical retarder which delays but does not prevent setting of the surface of the mortar in accordance with the manufacturer's recommendations.
         1) Retarded mortar shall be removed within 24 HRS after placing to produce a clean exposed aggregate bonding surface.
      c. Cover the hardened concrete of horizontal joints with a coat of cement grout of similar proportions to the concrete, except substitute fine aggregate for coarse aggregate.
      d. Place 1 IN layer of grout in bottoms of wall or column lifts immediately before placing concrete.
         1) Vibrate grout and first layer of concrete simultaneously.
      e. Place fresh concrete before the grout has attained its initial set.
   3. Other keyed construction joints:
      a. Thoroughly clean construction joints and remove all laitance.
      b. Dampen the hardened concrete (but do not saturate) immediately prior to placing of fresh concrete.

D. Locate control joints in slabs on grade as indicated on Drawings.
   1. Time cutting properly with set of concrete, if saw cut joints are required or permitted.
      a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
      b. Complete before shrinkage stresses become sufficient to produce cracking.

E. Expansion Joints:
   1. Do not permit reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
      a. If dowels are used, provide method to positively prevent movement during concrete placement
      b. Grease for greased dowels to be waterproof wheel bearing grease in paste form. Spray-on grease not allowed. Dowels to be completely covered with grease by manual method.
   2. Use neoprene expansion joint fillers, unless noted otherwise on Drawings.
   3. Seal expansion joints as shown on Drawings.
      a. See Specification Section 07900 for requirements.

F. Waterstops:
   1. Preformed strip type:

a. Install on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
b. Waterstop to be continuous with splices in accordance with manufacturer's instructions.
c. Use in joints against existing concrete, where indicated on Drawings.

2. PVC type:
   a. Position waterstop accurately in forms.
   b. Secure waterstops in correct position using hog rings or grommets spaced along the length of waterstop and tie wire to adjacent reinforcing.
   c. Hold horizontal waterstops in place with continuous supports.
   d. Install according to manufacturer's instructions.
      1) Do not displace reinforcement from required location.
   e. Waterstops to be continuous.
   f. Splice ends with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
   g. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.

G. Other Embedded Items:
1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
2. Do not place electrical conduit, drains, or pipes in or thru concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.

H. Placing Embedded Items:
1. Position expansion joint material, waterstops, and other embedded items accurately.
2. Support against displacement.
3. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
4. Provide adequate means for anchoring waterstop in concrete.
   a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.
   b. Work concrete under the waterstops by hand, so as to avoid the formation of air and rock pockets, when placing roof and floor slab concrete around waterstops.

3.5 FINISHING

A. See Specification Section 03348.

B. Coordinate mixing and placing with finishing.

3.6 INSTALLATION OF GROUT

A. Grout Schedule of Use:
1. Sand cement grout:
   a. General use.
2. Non-shrink grout:
   a. Filling form tie holes.
   b. Under column and beam base plates.
   c. Other uses indicated on the Drawings.
3. Epoxy grout:
   a. Patching cavities in concrete.
   b. Grouting of equipment base plates where driving motor is 100 HP and above.
   c. Other uses indicated on the Drawings.

B. Grout Installation:
1. Sand cement grout:
   a. Fill keyways between precast concrete hollow core slabs with sand cement grout.
   b. Consolidate grout by rodding or by other means to assure complete filling of keyways.

c. Cure grout by one of methods specified.

2. Non-shrink grout:
   a. Clean concrete surface to receive grout.
   b. Saturate concrete with water for 24 HRS prior to grouting.
   c. Mix in a mechanical mixer.
   d. Use no more water than necessary to produce flowable grout.
   e. Place in accordance with manufacturer's instructions.
   f. Provide under beam, column, and equipment base plates, in joints between precast concrete filter slabs, and in other locations indicated on the Drawings.
   g. Completely fill all spaces and cavities below the top of base plates.
   h. Provide forms where base plates and bed plates do not confine grout.
   i. Where exposed to view, finish grout edges smooth.
   j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
   k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
3. Epoxy grout:
   a. Mix and place in accordance with manufacturer's instructions.
   b. Apply only to clean, dry, sound surface.
   c. Completely fill all cavities and spaces around dowels and anchors without voids.
   d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
   e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.7 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
   1. Follow recommendations of ACI 308 except as modified herein.
   2. Use Evaporation Retardant to reduce surface moisture evaporation of slabs during concrete placement. Strict adherence to the manufacturer's instructions of use are essential for intended results.

B. General Curing Intent:
   1. Concrete shall be cured for a minimum of fourteen (14) days. The first seven (7) days of curing shall comply with the moist curing procedures listed in Paragraph 3.7C of this Specification Section. The second seven (7) days of curing may be performed using the requirements of either Paragraph 3.7C or 3.7D of this Specification Section, at the Contractor's option.

C. Apply one of the following moist curing procedures immediately after completion of placement and finishing, for concrete surfaces not in contact with forms.
   1. Ponding or continuous sprinkling.
   2. Application of absorptive mats or fabric kept continuously wet.
   3. Application of sand kept continuously wet.
   4. Continuous application of steam (not exceeding 150 DegF) or mist spray.
   5. Ponding and Sprinkling in conjunction with application of waterproof sheet materials, conforming to ASTM C171 and only with a program as approved by the Engineer that will keep the surface continuously wet.
   6. Ponding and Sprinkling in conjunction with application of other moisture retaining covering as approved and only with a program as approved by the Engineer that will keep the surface continuously wet.

D. After seven (7) full days of moist curing, application of a curing compound conforming to ASTM C309 may be substituted for moist curing, at the Contractor's option.

1. Apply curing compound in accordance with manufacturer's recommendations immediately after any water sheen which may develop during moist curing has disappeared from concrete surface.
2. Do not use on any surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
3. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two (2) coats of the curing compound with a coverage rate of 400 SQ FT per gallon each coat.
    a. Apply the first coat of curing compound to a vertical surface immediately after form removal and before the surface displays water loss. Apply in one direction only, covering uniformly to a minimum coverage rate of 400 SQ FT per gallon.
    b. The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
    c. Allow the preceding coat to completely dry prior to applying the next coat.
    d. Apply second coat in direction perpendicular to the first coat application direction, covering uniformly to a minimum coverage rate of 400 SQ FT per gallon.
    e. A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
4. Curing compounds used in water treatment plant construction shall be non-toxic and taste and odor free.
    a. Curing compound to be NSF approved and have a moisture loss of not more than 0.62 kg/SQ meter per ASTM C156, similar to Atlas Quantum-Cure by Atlas Tech Products.

E. Curing Concrete In Contact with Forms:
1. Minimize moisture loss of concrete placed in forms by keeping forms wet and cool until they can be safely removed.
2. Moist cure the top surface of concrete placed in forms according to paragraph 03311-3.7C
3. After form removal, cure concrete until end of time prescribed.
    a. Use one of methods listed above.
    b. When approved by the Engineer, placement of the second pour at joints may occur prior to the end of the curing period.
4. Forms left in place shall not be used as a method of curing in hot weather.
5. The term "hot weather," where used in these specifications, is defined in ACI 305R.
6. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete and commence moist curing according to paragraph 03311-3.7C.

F. Cold Weather:
1. Follow recommendations of ACI 306R.
2. Maintain temperature of concrete between 50 and 70 DegF for required curing period, when outdoor temperature is 40 DegF, or less.
3. Use heating, covering, insulating, or housing of the concrete work to maintain required temperature without injury due to concentration of heat.
4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

G. Hot Weather:
1. Follow recommendations of ACI 305R.
2. Make provision for cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.

H. Rate of Temperature Change:
1. Keep changes in temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing period.

2. Do not exceed a temperature change of 5 DegF in any 1 HR or 50 DegF in any 24 HR period.

I. Protection from Mechanical Injury:
   1. Protect concrete from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration.
   2. Protect finished concrete surfaces from damage by construction equipment, materials, or methods, and by rain or running water.
   3. Do not load self supporting structures in such a way as to overstress concrete.

3.8 FIELD QUALITY CONTROL

A. Tests in accordance with Specification Section 03350.
   1. Perform a strength test on all concrete to which water or superplasticizer, above the amount stated in the approved concrete mix design, has been added.
      a. Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

B. Field samples of fabricated waterstop fittings (crosses, tees, etc.) will be selected at random by the Engineer for testing by a laboratory at the Owner's expense.
   1. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

END OF SECTION

SECTION 03348

CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete finishing and repair of surface defects.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03108 - Formwork.
   4. Section 03308 - Concrete, Materials and Proportioning.
   5. Section 03311 - Concrete Mixing, Placing, Jointing and Curing.
   6. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 116R, Cement and Concrete Terminology.
   2. ASTM International (ASTM):
      a. C150, Standard Specification for Portland Cement.
      b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
      d. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      e. D4259, Standard Practice for Abrading Concrete.
   3. Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Applicator of acrylics, epoxy products, and surfacer/fillers must be approved, in writing, by manufacturer.
   2. Manufacturer of acrylics, epoxy products, and surfacer/fillers shall have minimum of ten (10) years experience in manufacturing of same with documented performance history for similar installations.
   3. Installer/applicator of acrylics, epoxy products, and surfacer/fillers shall have minimum of ten (10) years experience installing similar coatings and shall be licensed or approved in writing by manufacturer to install/apply this product.
   4. Applicator of concrete sealers shall be factory trained and approved, in writing, by the manufacturer to apply the product.
      a. Applicator shall have a minimum of ten (10) years experience successfully applying materials specified. Provide references for minimum of three (3) different projects completed in last five (5) years with similar scope of work.
      b. Include name and address of project, size of project in value (product application) and contact person.

1.3 DEFINITIONS

A. Vertical Surface Defects:
   1. Any void in the face of the concrete deeper than 1/8 IN, such as:
      a. Tie holes.

b. Air pockets (bug holes).
c. Honeycombs.
d. Rock holes.

2. Scabbing:
   a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
3. Foreign material embedded in face of concrete.
4. Fins 1/16 IN or more in height.

B. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

C. SSD: Saturated, surface dry.

D. Other words and terms used in this Specification Section are defined in ACI 116R.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Certifications:
   a. Certification of aggregate gradation.
   b. Certification that products being used will not interfere with bonding of future floor or wall finishes.

B. Miscellaneous Submittals:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

1.6 WARRANTY

A. Provide warranty equal to specified manufacturer's standard warranty for all products used.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Chemical floor sealer CS-1:
   a. L & M Construction Chemicals, Inc.
   b. Euclid Chemical Co.
   c. Dayton Superior.
2. Bonding agents:
   a. Euclid Chemical Co.
   b. BASF Admixtures, Inc.
   c. L & M Construction Chemicals, Inc.
   d. Sika Corporation

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Chemical Floor Sealer CS-1:
   1. Colorless low VOC water-based solution containing acrylic copolymers.
      a. ASTM C1315, Class B, minimum 30 percent solids.
      b. ASTM C309, Type 1.
      c. Non-yellowing UV resistant.
      d. Capable of being painted after cured.
   2. Similar to L & M Construction Chemicals, Inc., Dress and Seal WB 30.

B. Bonding Agent:
   1. See Section 03308
      a. All bonding agents and adhesives shall have a pot life that allows proper placement of new material against existing material as prescribed by manufacturer
      b. Use Epoxy Modified Bonding Adhesive.

C. Aggregate:
   1. Sand: Maximum size #30 mesh sieve.
   2. For exposed aggregate finish surfaces: Same as surrounding wall.

D. Water: Potable.

E. Non-Shrink Grout: See Specification Section 03308.

F. Cementitious Polymer Modified Patch: See Specification Section 03308.

2.3 MIXES

A. Bonding Grout: One (1) part cement to one (1) part aggregate.

B. Patching Mortar:
   1. One (1) part cement to two and one-half (2-1/2) parts aggregate by damp loose volume.
      a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. For methods of curing, see Specification Section 03311.

B. Preparation of Bonding Grout Mixture:
   1. Mix cement and aggregate.
   2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
   3. Add bonding agent/water mixture to cement/aggregate mixture.
   4. Mix to consistency of thick cream.
   5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.

C. Preparation of Patching Mortar Mixture:
   1. Mix cement and aggregate.
   2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
   3. Add only enough bonding agent/water mixture to cement/aggregate mixture to allow handling and placing.
   4. Let stand with frequent manipulation with a trowel, until mix has reached stiffest consistency to allow placement.

D. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
   1. Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
      a. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
      b. No featheredges will be permitted.
   2. Rinse surface with clean water and allow surface water to evaporate to SSD condition prior to repairing surface defects or bonding new concrete.

E. Repairing Surface Defects at Surfaces Not in Contact With Liquid:
   1. This method of repairing surface defects is to be used only on vertical concrete surfaces above finished grade, only on exterior surfaces of structures containing liquid unless the surface is below finished grade, and on surfaces to receive liquid water repellent.
   2. At small voids and surface defects:
      a. Use Patching Mortar mix.
      b. Use Bonding Grout.
      c. Match color of surrounding wall.
      d. Do not use acrylic bonding agent in patching mortar for filling defects in surfaces to be treated with liquid water repellent.
   3. At voids larger than (4) four square IN at surface and deeper than ½ IN:
      a. Use non-shrink grout.
      b. Use Epoxy Bonding Adhesive.
      c. Cut perimeter of patch to ¼ IN minimum depth at entire perimeter, with edge perpendicular to the surface to eliminate feathered edges.
      d. If applicable gouge void to eliminate thin patch areas less than ½ IN deep that are surrounded by deeper patch areas.
      e. Patch may gradually taper from maximum depth to a minimum of ¼ IN depth at the perimeter.
      f. When reinforcing is exposed gouge void at exposed reinforcing to a depth of ½ IN beyond the reinforcing to allow patch material to lock around reinforcing.
      g. Where exposed to view and scheduled to receive concrete Finish #2 or #6, hold grout ¼ IN below surface of concrete and fill with patching mortar to match surrounding concrete.
   4. At tie holes:
      a. Use non-shrink grout.
      b. Where exposed to view and scheduled to receive concrete Finish #2 or #6, hold grout ¼ IN below surface of concrete and fill with patching mortar to match surrounding concrete.
   5. If required by bonding agent manufacturer, etch surfaces with a muriatic acid solution followed by a thorough rinse with clean water.
      a. Test concrete to determine pH level and continue flushing with clean water until surface pH is within acceptable limits.
   6. Dampen area to be patched and an area at least 6 IN wide surrounding it prior to application of bonding grout.
   7. Brush bonding grout into the surface after the surface water has evaporated.
   8. Allow bonding grout to set for period of time required by bonding agent manufacturer before applying premixed patching mortar.
   9. Consolidate grout or mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
   10. Leave undisturbed for at least 60 minutes before finishing level with surrounding surface.
      a. Do not use metal tools in finishing a patch in a formed wall which will be exposed or coated with other materials.
   11. Keep areas damp in accordance with grout manufacturer or bonding agent manufacturer's directions

F. Repairing Surface Defects at Surfaces in Contact With Liquid:

1. This method of repairing surface defects is to be used on exterior vertical concrete surfaces below finished grade and on surfaces in direct contact with liquid.
2. At form tie holes and small voids:
   a. Use Cementitious Polymer Modified Patch
   b. Use Epoxy Bonding Adhesive.
   c. Apply a seal coat of Epoxy Adhesive over the tie hole patch, on the face in contact with the liquid within 72 hours of patching and after initial curing of the non-shrink grout. Extend the seal coat to one (1) IN beyond the tie hole patch on all sides.
3. At voids larger than (4) four square IN at surface and deeper than ½ IN when no reinforcing is exposed:
   a. Use Cementitious Polymer Modified Patch
   b. Use Epoxy Bonding Adhesive.
   c. Cut perimeter of patch to ¼ IN minimum depth at entire perimeter, with edge perpendicular to the surface to eliminate feathered edges.
   d. If applicable gouge void to eliminate thin patch areas less than ½ IN deep that are surrounded by deeper patch areas.
   e. Patch may gradually taper from maximum depth to a minimum of ¼ IN depth at the perimeter.
   f. Apply a seal coat of Epoxy Adhesive over the tie hole patch, on the face in contact with the liquid within 72 hours of patching and after initial curing of the patch. Extend the seal coat to one (1) IN beyond the patch on all sides.
4. At voids larger than (4) four square IN at surface and deeper than ½ IN when reinforcing is exposed:
   a. Use Cementitious Polymer Modified Patch
   b. Use Anti-Corrosion Bonding Agent.
   c. Cut perimeter of patch to ¼ IN minimum depth at entire perimeter, with edge perpendicular to the surface to eliminate feathered edges.
   d. If applicable gouge void to eliminate thin patch areas less than ½ IN deep that are surrounded by deeper patch areas.
   e. Patch may gradually taper from maximum depth to a minimum of ¼ IN depth at the perimeter.
   f. Gouge void at exposed reinforcing to a depth of ½ IN beyond the reinforcing to allow patch material to lock around reinforcing.
   g. Apply a seal coat of Epoxy Adhesive over the tie hole patch, on the face in contact with the liquid within 72 hours of patching and after initial curing of the patch. Extend the seal coat to one (1) IN beyond the patch on all sides.

3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 DegF.
   1. If necessary, enclose and heat area to between 50 and 70 DegF during repair of surface defects and curing of patching material.
      a. Use only clean fuel, indirect fired heating apparatus.

B. Chemical Floor Sealer CS-1 Application:
   1. Apply to floor areas indicated on the Drawings in accordance with manufacturer's recommendations.
   2. Apply at rate recommended by manufacturer.
   3. After final coat of material is applied, remove surplus in accordance with manufacturer's recommendations.
   4. Do not apply sealer to floors scheduled to receive epoxy floor finish.

C. Concrete Finishes for Vertical Wall Surfaces:
   1. General: Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
   2. Finish #1 - As cast rough form finish:

a. Selected forming materials are not required.
b. Prepare surface in accordance with Article 3.1 and repair the following surface defects:
1) Tie holes.
2) Honeycombs deeper than 1/4 IN.
3) Air pockets deeper than 1/4 IN.
4) Rock holes deeper than 1/4 IN.
c. Chip or rub off fins exceeding 1/4 IN in height.
d. Use at unexposed surfaces such as foundations and backfilled surfaces of walls not to be waterproofed.

3. Finish #2 - As cast form finish:
a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03108.
b. Prepare surface in accordance with Article 3.1 and repair the following surface defects:
1) Tie holes.
2) Honeycombs deeper than 1/4 IN or larger than 1/4 IN DIA.
3) Air pockets deeper than 1/4 IN or larger than 1/4 IN DIA.
4) Rock holes deeper than 1/4 IN or larger than 1/4 IN DIA.
5) Scabbing.
c. Chip or rub off fins exceeding 1/8 IN in height.
1) Finish shall provide uniform color and texture.
d. Provide this finish for All exposed interior surfaces.

4. Finish #6 - Cork floated finish:
a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03108.
b. Prepare surface in accordance with Article 3.1 and repair all surface defects.
c. Remove formwork as soon as possible, within 2 to 3 days of placement where possible.
d. Mix one (1) part Portland cement and one (1) part fine sand with bonding agent/water mixture to produce a stiff mortar.
e. Dampen wall surface.
f. Apply mortar with rubber float or trowel, filling all surface voids.
g. Compress mortar into voids using slow speed grinder or stone.
h. If the mortar surface dries too rapidly to permit compaction and finishing, apply a small amount of water using a fog spray.
i. Produce the final texture with a cork float using a swirling motion.
j. Construct mock-up per Article 1.2.
k. Provide this finish on all exterior exposed surfaces.

D. Related Unformed Surfaces (Except Slabs):
1. Strike smooth and level tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
2. Float surface to a texture consistent with that of formed surfaces.
a. If more than one (1) finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
3. Continue treatment uniformly across unformed surfaces.

E. Concrete Finishes for Horizontal Slab Surfaces:
1. General:
a. Tamp concrete to force coarse aggregate down from surface.
b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
c. Dusting of surface with dry cement or sand during finishing processes not permitted.
2. Unspecified slab finish:
a. When type of finish is not indicated, use following finishes as applicable:
1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.

2) Surfaces intended to receive roofing except future floors, or waterproofing membranes: Floated finish.
3) Floors and roof surfaces which are future floors intended as walking surfaces or for reception of floor coverings: Troweled finish.
4) Garage floors and ramps: Broom or belt finish.
5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom or belt finish.
6) All slabs to receive a floated finish before final finishing.

3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
4. Floated finish:
   a. After concrete has been placed, consolidated, struck off, and leveled, do no further work until ready for floating.
   b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.
      1) Use wood or cork float.
   c. During or after first floating, check planeness of entire surface with a 10 FT straightedge applied at not less than two (2) different angles.
   d. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
   e. Refloat slab immediately to a uniform texture.
5. Troweled finish:
   a. Float finish surface to true, even plane.
   b. Power trowel, and finally hand trowel.
   c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
   d. Perform additional trowelings by hand after surface has hardened sufficiently.
   e. Final trowel when a ringing sound is produced as trowel is moved over surface.
   f. Thoroughly consolidate surface by hand troweling.
   g. Leave finished surface essentially free of trowel marks, uniform in texture and appearance and plane to a Class A tolerance.
   h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering by grinding.
6. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
7. Underside of concrete slab finish:
   a. Match finish as specified for adjacent vertical surfaces.
   b. If more than one (1) finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

A. Horizontal slab finishes will be accepted provided:
   1. Applicable specification requirements are satisfied.
   2. Water does not pond in areas sloped to drain.
   3. Gap between a 10 FT straightedge placed anywhere and the finished surface does not exceed:
      a. Class A tolerance: 1/8 IN.
      b. Class B tolerance: 1/4 IN.
      c. Class C tolerance: 1/2 IN.
   4. Accumulated deviation from intended true plane of finished surface does not exceed 1/2 IN.
   5. Accuracy of floor finish does not adversely affect installation and operation of movable equipment, floor supported items, or items fitted to floor (doors, tracks, etc.).

B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.
   1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

3.4 PROTECTION

A. All horizontal slab surfaces receiving chemical floor sealer shall be kept free of traffic and loads for minimum of 72 HRS following installation of sealer.

END OF SECTION

SECTION 03350
TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Contractor requirements for testing of concrete and grout.
   2. Definition of Owner provided testing.
   3. Acceptance criteria for concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03208 - Reinforcement.
   4. Section 03308 - Concrete, Materials and Proportioning.

1.2 RESPONSIBILITY AND PAYMENT

A. Owner will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Engineer and Contractor.
   1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
   2. Additional testing or retesting of materials occasioned by their failure, be test or inspection, to meet requirements of the Contract Documents.
   3. Strength testing on concrete required by the Engineer or Special Inspector when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
   4. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
   5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may re removed.
   6. Owner will pay for services defined in Paragraph 1.2A.1.
   7. See Specification Section 01060.

B. Contractor shall hire a qualified testing agency to perform the following testing and provide test results to the Engineer.
   1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
   2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
   3. Contractor shall pay for services defined in Paragraphs 1.2B.1. and 1.2B.2.
   4. Contractor shall reimburse Owner for testing services defined in Paragraphs 1.2A.2., 1.2A.3., 1.2A.4. and 1.2A.5.
   5. See Specification Section 01060.

C. Duties and Authorities of Testing Agency/Service Provider:
   1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
   2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.

3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.
    a. All test reports to include exact location in the work at which batch represented by a test was deposited.
    b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
1. American Association of State Highway and Transportation Officials (AASHTO):
    a. T260, Standard Method of Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials.
2. American Concrete Institute (ACI):
    a. 318, Building Code Requirements for Structural Concrete.
    b. 350, Code Requirements for Environmental Engineering Concrete Structures.
3. ASTM International (ASTM):
    a. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
    b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
    c. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
    d. C138, Standard Method of Test for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
    e. C143, Standard Test Method for Slump of Hydraulic Cement.
    f. C172, Standard Practice for Sampling Freshly Mixed Concrete.
    g. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
    h. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
    i. E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.

B. Qualifications:
1. Contractor's Testing Agency:
    a. Meeting requirements of ASTM E329.
    b. Provide evidence of recent inspection by Cement and Concrete Reference Laboratory (CCRL) of National Bureau of Standards (NBS), and correction of deficiencies noted.

C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Concrete materials and concrete mix designs proposed for use.

1) Include results of all testing performed to qualify materials and to establish mix designs.
2) Place no concrete until approval of mix designs has been received in writing.
3) Submittal for each concrete mix design to include:
   a) Sieve analysis and source of fine and coarse aggregates.
   b) Test for aggregate organic impurities.
   c) Proportioning of all materials.
   d) Type of cement with mill certificate for the cement.
   e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03308.
   f) Slump.
   g) Brand, type and quantity of air entrainment and any other proposed admixtures.
   h) Shrinkage test results.
   i) Total chloride ion content per cubic yard of concrete determined in accordance with AASHTO T260.
   j) 28-day compression test results of at least 10 tests made no longer than 12 months prior to the date of submittal and any other data required by Specification Section 03308 to establish concrete mix design.

3. Certifications:
   a. Testing Agency qualifications.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED BY OWNER

A. The following concrete testing will be performed by the Owner's Service Provider:
   1. Concrete strength testing:
      a. Secure concrete samples in accordance with ASTM C172.
         1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
      b. For each strength test mold and cure four (4) cylinders from each sample in accordance with ASTM C31.
         1) Record any deviations from requirements on test report.
         2) Cylinder size: Per ASTM C31.
      c. Field cure one cylinder for the seven (7) day test.
         1) Laboratory cure the remaining.
      d. Test cylinders in accordance with ASTM C39.
         1) Test two (2) cylinders at 28 days for strength test result and one (1) at seven (7) days for information.
         2) Hold remaining cylinder in reserve.
      e. Strength test result:
         1) Average of strengths of two (2) cylinders from the same sample tested at 28 days.
         2) If one (1) cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder; average strength of remaining cylinders shall be considered strength test result.
         3) Should all cylinders in a test show any of above defects, discard entire test.
      f. Frequency of tests:
         1) Concrete sand cement grout: One (1) strength test for each 4 HR period of grout placement or fraction thereof.

2) Precast concrete, concrete topping, concrete fill and lean concrete: One (1) strength test for each 10 CY of each type of concrete or fraction thereof placed.
3) All other concrete:
a) One (1) strength test consisting to be taken not less than once a day, nor less than once for each 60 CY or fraction thereof placed in any one (1) day.
b) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five (5) strength tests for each concrete mix, tests shall then be made from at least five (5) randomly selected batches or from each batch if fewer than five (5) batches are provided.

2. Slump testing:
a. Determine slump of concrete sample for each strength test.
1) Determine slump in accordance with ASTM C143.
b. If consistency of concrete appears to vary, the Engineer shall be authorized to require a slump test for each concrete truck.
1) This practice shall continue until the Engineer deems it no longer necessary.
3. Air content testing: Determine air content of concrete sample for each strength test in accordance with either ASTM C231, ASTM C173, or ASTM C138.
4. Temperature testing: Determine temperature of concrete sample for each strength test.
5. In-place concrete testing (if required).

3.2 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

A. To facilitate testing and inspection, perform the following:
1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 HRS as required by ASTM C31.

B. Notify Engineer, Owner's Testing Agency, and Contractor’s Testing Agency sufficiently in advance of operations (minimum of 24 HRS) to allow completion of quality tests for assignment of personnel and for scheduled completion of quality tests.

3.3 ACCEPTANCE

A. Completed concrete work which meets applicable requirements will be accepted without qualification.

B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.

C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
1. In this event, modifications may be required to assure that concrete work complies with requirements.
2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.

D. Dimensional Tolerances:
1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.

4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
    a. Repair or remove and replace if required.
5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
    a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

E. Appearance:
1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the strength or function of the member.

F. High Water-Cement Ratio:
1. Concrete with water in excess of the specified maximum water-cement ratio will be considered potentially deficient in durability.
2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.

G. Strength of Structure:
1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
    a. Low concrete strength:
        1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
            a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
            b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three (3) strength tests.
            c) A strength test shall be the average of two (2) cylinders from the same sample tested at 28 days.
        2) Acceptance:
            a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
                (1) Average of all sets of three (3) consecutive strength tests equal or exceed the required specified 28 day compressive strength.
                (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 psi.
    b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03208 or requirements of the Contract Drawings or approved Shop Drawings.
    c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
    d. Curing time and procedure not meeting requirements of this Specification Section.
    e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
    f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
    g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.

a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.
   1) Such tests shall not be used as a basis for acceptance or rejection.
b. Core tests:
   1) Where required, test cores will be obtained in accordance with ASTM C42.
      a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 DegF, relative humidity less than 60 percent) for seven (7) days before test then test dry.
      b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 HRS and test wet.
      c) Testing wet or dry to be determined by Engineer.
   2) Three (3) representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
      a) Location of cores shall be determined by Engineer so as least to impair strength of structure.
      b) If, before testing, one (1) or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
   3) Concrete in area represented by a core test will be considered adequate if average strength of three (3) cores is equal to at least 85 percent of specified strength and no single core is less than 75 percent of specified strength.
   4) Fill core holes with nonshrink grout and finish to match surrounding surface when exposed in a finished area.

4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 20.
5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

H. Shrinkage Tests:

1. Drying shrinkage tests shall be performed for the trial batches, the first placement of each class of concrete, and at 1/3 points of the concrete construction schedule during construction or when requested by the Engineer (3 times during construction) for concrete or hydraulic structures to insure continued compliance with these Specifications. Additional shrinkage tests reimbursed by the Contractor may be called for at the sole judgment of the Engineer if cracking or other shrinkage related symptoms occur during construction.
2. Drying shrinkage specimens shall be 4-IN by 4-IN by 11-IN prisms with an effective gauge length of 10-IN; fabricated, cured, dried, and measured in accordance with ASTM C 157.
3. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21 day drying age or at 28 day drying age shall be 0.034 percent or 0.040 percent, respectively. Standard deviation will not be considered. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to 4000 psi and 4000 psi Super-P (superplasticized) structural concrete.
4. The maximum concrete shrinkage for specimens cast in the field and cured for the initial 14 days with the same curing methods used in the field shall not exceed the trial batch maximum shrinkage requirement by more than 20 percent on the initial placement of each class of concrete. Subsequent shrinkage specimens taken during the construction period as specified shall use the initial placement of each class of concrete shrinkage results as a base line for acceptance. Subsequent shrinkage specimens shall not exceed the base line shrinkage by more than 0.001 percent shrinkage.

5. If the required shrinkage limitation is not met during construction, the Contractor shall take any or all of the following actions to reestablish compliance. These actions may include changing the source of aggregates or the amount of crushed stone rock in the aggregates; changing cement and/or admixtures; use of a shrinkage reducing admixture, reducing water/cement ratio; or other actions designed to minimize shrinkage.

END OF SECTION

SECTION 03431
PRECAST CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast concrete.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03208 - Reinforcement.
   4. Section 03308 - Concrete, Materials and Proportioning.
   5. Section 03350 - Testing.
   6. Section 09905 – Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   2. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
      b. 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      c. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      d. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      e. C33, Standard Specification for Concrete Aggregates.
      f. C150, Standard Specification for Portland Cement.
      g. E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
   4. American Welding Society (AWS):
      a. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
      b. A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
      c. D1.1, Structural Welding Code - Steel.
      d. D1.4, Structural Welding Code - Reinforcing Steel.
   5. Occupational Safety and Health Administration (OSHA).
   6. Precast/Prestressed Concrete Institute (PCI):
      a. MNL 116, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
      b. PCI Design Handbook - Precast and Prestressed Concrete.
   7. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Provide precast concrete units produced by an active member of PCI.
   2. Provide units manufactured by plant which has regularly and continuously engaged in manufacture of units of same type as those required for a minimum of three (3) years.

3. Assure manufacturer's testing facilities meet requirements of ASTM E329.
4. Welding operators and processes to be qualified in accordance with:
   a. AWS D1.1 for welding steel shapes and plates.
   b. AWS D1.4 for welding reinforcing bars.
5. Welding operators to have passed qualification tests for type of welding required during the previous 12 months prior to commencement of welding.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Hardware to be utilized to support suspended appurtenances.
   3. Shop Drawings and erection plans for precast units, their connections and supports showing:
      a. Member size and location.
      b. Size, configuration, location and quantity of reinforcing bars.
      c. Size and location of openings verified by Contractor.
      d. Size, number, and locations of embedded metal items and connections.
      e. Required concrete strengths.
      f. Identification of each unit using same standard marking numbers as used to mark actual units.
   4. Calculations for members and connections designed by fabricator.
      a. Calculations to be sealed by a Professional Engineer registered in the State of California.
   5. Submit test results, when so required on Drawings, showing that embedded connection items will adequately support the indicated loads.
      a. Connection items to have an ultimate load capacity of at least two (2) times the required indicated load.
   6. Concrete mix design(s) including submittal information defined in Section 03350.
   7. Copies of source quality control tests.
   8. Certification of manufacturer's testing facility qualifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Headed studs and deformed bar anchors:
      a. Nelson Stud Welding Div., TRW, Inc.
      b. KSM Division, Omark Industries.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Embedded Steel Plates and Shapes: ASTM A36.

B. Cement:
   1. Comply with ASTM C150, Type I, II, or III.

C. Aggregates for Normal Weight Concrete:
   1. ASTM C33 with coarse aggregate meeting the gradation for size #67 or size #7 as stated in ASTM C33.
   2. All fine aggregate to be natural not manufactured.

D. Water:
   1. Potable, clean.
   2. Free of oils, acids, and organic matter.

E. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement and admixtures measured as a weight percent of cement to not exceed 0.06 for prestressed concrete and 0.10 for all other precast concrete.

F. Reinforcing Steel and Welded Wire Reinforcement: See Section 03208.

G. Headed Studs:
   1. ASTM A108.
   2. Minimum yield strength: 50,000 psi.
   3. Minimum tensile strength: 60,000 psi.

H. Deformed Bar Anchors:
   1. ASTM A496.
   2. Minimum tensile strength: 80,000 psi.
   3. Minimum yield strength: 70,000 psi.

I. Electrodes:
   1. E70 series conforming to AWS A5.1 or AWS A5.5 for welding steel shapes and plates.
   2. E90 series conforming to AWS A5.5 for welding rebar.

2.3 MIXES

A. See Section 03308.

B. Do not begin fabrication of units until concrete mix design(s) have been approved by Engineer.

2.4 DESIGN

A. General Design Requirements:
   1. Design units and connections in strict accordance with ACI 318 and the PCI Design Handbook - Precast and Prestressed Concrete.
   2. Design units taking into account reduced cross section at openings and penetrations.
   3. Provide all reinforcing in units as indicated.
      a. Where not indicated, design and provide all reinforcing subject to approval of Engineer.

2.5 FABRICATION

A. Do not fabricate units until Shop Drawings have been approved by Engineer and returned to Contractor.

B. Manufacture, quality, dimensional and erection tolerances of all units to be in accordance with both PCI MNL 116 and PCI Design Handbook - Precast and Prestressed Concrete.

C. Cast all members in smooth rigid forms which will provide straight, true members of uniform thickness and uniform color and finish.

D. Use sand cement grout mixture to fill all air pockets and voids, and to repair chipped edges.

E. Finish all repairs smooth and to match adjacent surface texture and color.

F. Incorporate any required embedded plates, angles, and miscellaneous embedded items into members at time of manufacture.
   1. Cast lifting handles into units at or near support points.
      a. Remove lifting handles after units are erected.

G. Cast openings larger than 6 IN SQ or 6 IN DIA in units at time of manufacture.
   1. Make smaller openings by neat cutting or neat drilling by trades requiring them.
   2. Coordinate sizes and locations of all openings before fabrication of units.

H. Automatically weld headed studs and deformed bar anchors to members to provide full penetration weld between studs, bar anchors and members they are attached to.

I. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

J. Mark each unit as indicated on the erection plans.
   1. Place mark on non-exposed-to-view surface.

K. Fabricate the following types of precast and prestressed units (all units to be made with normal weight concrete unless noted otherwise on Drawings):
   1. Precast junction boxes and precast vaults as shown on Electrical Drawings or as noted in Specifications.
   2. Precast utility vaults, precast manholes, and other miscellaneous precast items as shown on Civil Drawings or as noted in Specifications.

2.6 SOURCE QUALITY CONTROL

A. During production of precast concrete units, conduct strength tests of concrete placed in units as required in Specification Section 03350 for concrete placed during fabrication.
   1. Results of strength tests to be sent immediately to Engineer, Contractor and Owner.
   2. Test reports to indicate units they represent.

B. When approved by Engineer, strength tests may be made by precast manufacturer after he has submitted certification that his testing facilities meet the requirements of ASTM E329.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify acceptability and location of supports to receive units.
   1. Check bearing surfaces to determine that they are level and uniform.

B. Verify compressive strengths of concrete and masonry supports.
   1. Do not start erection of units until supports have reached their 28 day required compressive strengths.

3.2 INSTALLATION

A. Sequence installation to provide a balance of loads across precast elements.

B. Use only erection equipment adequate for placing units at lines and elevations indicated on Drawings.
   1. Do not damage units or existing construction during erection.
   2. Erect units using lifting handles cast into the units.

C. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

D. After all precast units are erected and all precast unit connections have been made, coat all exposed surfaces of the connections with the same prime and finish paint as required on the adjacent precast concrete units.
   1. See Section 09905.

3.3 FIELD QUALITY CONTROL

A. Causes for rejection of units include, but are not necessarily limited to the following:
   1. Cracked units.
   2. Chipped, broken, or spalled edges.
   3. Units not within allowable casting tolerances.
   4. Voids or air pockets which, in opinion of Engineer, are too numerous or too large.
   5. Non-uniform finish or appearance.
   6. Low concrete strength.

7. Improperly placed embedded items and/or openings.
8. Exposed wire mesh, reinforcing or prestressing strands.

END OF SECTION

SECTION 03510
LOW DENSITY CELLULAR CONCRETE FILL (LDCCF)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Low Density Cellular Concrete Fill (LDCCF), as indicated, in accordance with provisions of Contract Documents.

B. Work consists of batching, mixing, and placing Low Density Cellular Concrete Fill of density indicated by specifications or as directed by Engineer.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):
   1. ASTM C495 Standard Test Method for Compressive Strength of Lightweight Insulating Concrete
   2. ASTM C796 Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam
   3. ASTM C869 Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete

B. Applicator:
   1. Manufacturer trained and approved, experienced, and familiar with requirements and methods for performance of Work.
   2. Responsible for developing mix design based on site conditions, batching, mixing, handling, and placing material.

1.3 SUBMITTALS

A. Product data:
   1. Manufacturer's specifications and engineering data required to demonstrate compliance with specified requirements.
   2. Product list and approved applicator qualifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Low Density Cellular Concrete Fill (LDCCF).
   1. Cellular Concrete Solutions.
   2. Geofill Cellular Concrete.

2.2 MATERIALS

A. Impervious LDCCF:
   1. For use in the headwork structure as indicated in the Contract Drawings.
   2. Base product:
      a. Mearl Geofoam, Impervious type.
      b. Or approved equal.
   3. Portland cement: Comply with ASTM C150, Type I, II, or III.
   4. Expansion material:
      a. Cast Density: 42 PCF.

b. Minimum Compressive Strength: 60 PSI.
c. Minimum Coefficient of Permeability: 1.0E-6 cm/sec.

5. Water: Potable.

PART 3 - EXECUTION

3.1 PRELIMINARY

A. Examine area and condition under which work is to be preformed.

B. Do not place in standing water.

C. Do not place at temperatures lower than 32 DegF or when freezing conditions are expected within 24 HRS.

D. Verify items to be embedded, if any, are secure.

E. Correct conditions detrimental to completion of Work.

F. Do not proceed until satisfactory conditions are established.

3.2 INSTALLATION

A. Follow approved job site proportioning, mixing, and placing equipment as recommended by manufacturer.

B. Blend materials according to mix design and convey promptly to location of placement.
1. Avoid excessive handling.

C. Place in lifts not to exceed 60 IN in depth, or as directed by manufacturer, or underpinning contractor.

D. Do not backfill or load Work until compressive strength of 20 PSI, minimum, is attained.

3.3 TESTING

A. Wet Density:
1. Check density hourly and adjust mix as required to maintain specified cast density at point of placement.
2. Test compressive strength in accordance with ASTM C495.
a. Test four (4) 3 IN x 6 IN cylinders for each 100 cubic yards placed.

END OF SECTION

SECTION 03740
CONCRETE CRACK REPAIR INJECTION

PART 1 - GENERAL

1.1 DEFINITIONS

A. Large Cracks: Wider than 0.015 IN.

B. Small Cracks: Width equal to 0.015 IN or less.

1.2 SUBMITTALS

A. Shop Drawings:
   1. Physical and chemical properties for epoxy adhesives.
   2. Technical data for metering, mixing, and injection equipment.

B. Quality Control Submittals:
   1. Manufacturer's recommended surface preparation procedures and application instructions for epoxy adhesives.
   2. Installation instructions for repairing core holes with epoxy grout.
   3. Manufacturer's Certificate of Compliance: Certified test results for each batch of epoxy adhesive.
   4. Statements of Qualification for Epoxy Adhesive:
      a. Manufacturer's site representative.
      b. Injection applicator.
      c. Injection pump operating technician.

C. Contract Closeout Submittals:
   1. Epoxy adhesive two component ratio and injection pressure test records for concrete crack repair work.

1.3 QUALITY ASSURANCE

A. Qualifications for Epoxy Adhesive:
   1. Manufacturer's Site Representative:
      a. Capable of instructing successful methods for restoring concrete structures utilizing epoxy injection process.
      b. Current theories on nature and causes of cracking in concrete.
      c. Methods for repairing damaged concrete structure.
      d. Technical aspects of correct material selection and use.
      e. Operation, maintenance, and troubleshooting of application equipment.
   2. Injection Applicator:
      a. Licensed and certified by epoxy manufacturer.
      b. Minimum 3 years' experience in successful epoxy adhesive injection for at least 10,000 lineal feet of crack repair.
   3. Injection Pump Operating Technician: At least 1 years' experience consisting of minimum of 3,000 lineal feet of crack injection.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Package adhesive material in new sealed containers and label with following information:
   1. Manufacturer's name.
   2. Product name and lot number.
   3. ANSI Hazard Classification (formerly SPI Classification).
   4. ANSI recommended precautions for handling.
   5. Mix ratio by volume.

B. Storage and Protection: Store adhesive containers at ambient temperatures below 120 DegF and above 32 DegF.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Materials specified in this section shall be products of:
1. Harry S. Peterson Co., Berea, OH.
2. Sika Corp., Lyndhurst, NJ.
3. Euclid Chemical Co., Cleveland, OH.
4. Or equal.

2.2 EPOXY ADHESIVE

A. Two-component A and B structural epoxy adhesive for injection into cracks or other voids in concrete structures for bonding or grouting.

B. Component A Properties
1. Blend of modified epoxy resins as follows:

TEST CRITERIA	TEST METHOD	LARGE CRACKS (CLEAR AMBER LIQUID)	SMALL CRACKS* (LIGHT AMBER LIQUID)
Viscosity at 40, plus or minus 3 DegF	Brookfield RVT Spindle 4 at 200 rpm	8,000 cps, maximum	850 cps, maximum
Viscosity at 77, plus or minus 3 DegF	Brookfield RVT Spindle 2 at 20 rpm	700 cps, maximum	375 cps maximum at 50 rpm
**Small crack epoxy blend shall meet requirements for large cracks except as shown.*			

C. Component B Properties: Modified amine curing agent as follows:

TEST CRITERIA	TEST METHOD	LARGE CRACKS (CLEAR AMBER LIQUID)	SMALL CRACKS* (LIGHT AMBER LIQUID)
Viscosity at 40, plus or minus 3 DegF, cps	Brookfield RVT Spindle 2 at 20 rpm	1,400 cps, maximum	550 cps, maximum
Viscosity at 77, plus or minus 3 DegF, cps	Brookfield RVT Spindle 2 at 20 rpm	240 cps, maximum	150 cps maximum using Spindle 1 at 50 rpm
**Small crack epoxy blend shall meet requirements for large cracks except as shown.*			

D. Uncured Adhesive Properties: When mixed in ratio specified on adhesive container label:

TEST CRITERIA	TEST METHOD	LARGE CRACKS	SMALL CRACKS
Pot Life (60-gram mass) at plus or minus 4 DegF	As specified in Article SOURCE QUALITY CONTROL	13 to 25 minutes	15 to 30 minutes
Pot Life (60-gram mass) @ 100, plus or minus 3 DegF	As specified in Article SOURCE QUALITY CONTROL	3 to 10 minutes	10 to 20 minutes
Viscosity @ 40, plus or minus 3 DegF	Brookfield RVT Spindle No. 4 @ 20 rpm	4,400 cps	600 cps
Viscosity @ 75 to	Brookfield RVT	375 to 350 cps	175 to 140 cps

TEST CRITERIA	TEST METHOD	LARGE CRACKS	SMALL CRACKS
77 DegF	Spindle No. 2 @ 20 rpm		

E. Adhesive Properties: When cured for 7 days at 77, plus or minus 3 DegF and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

TEST TYPE	AS PERr	LARGE CRACKS	SMALL CRACKS
Ultimate Tensile Strength, psi	ASTM D638	8,000 min	5,000 minimum
Tensile Elongation at Break, percent	ASTM D638	4.2 maximum	3.0 maximum
Flexural Strength, psi	ASTM D790	10,000 minimum	10,000 minimum
Flexural Modulus, psi	ASTM D790	$5.5x10^5$ minimum	$4.5x10^5$ minimum
Compressive Yield Strength, psi	ASTM D695*	15,000 minimum	12,000 minimum
Compressive Modulus, psi	ASTM D695*	4.0x105 minimum	4.0x105 minimum
Heat Deflection Temperature	ASTM D648 E2*	130 DegF minimum	140 DegF minimum
Slant Shear Strength	AASHTO T 237**	5,000 psi Compressive Strength Concrete	5,000 psi Compressive Strength Concrete
General Strength Requirements			
Cured 3 days at 40 DegF -- Wet Concrete			3,500 psi minimum
Cured 1 day at 77 DegF Dry Concrete			5,000 psi minimum
Cured 3 days at 77 DegF plus or minus 3 DegF			5,000 psi minimum

* *Cure test specimens so that peak exothermic temperature of adhesive does not exceed 100 DegF*

** *See referenced specifications for preparation method of test specimens.*

2.3 SURFACE SEAL

A. Sufficient strength and adhesion for holding injection fittings firmly in-place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection adhesive has cured.

2.4 SOURCE QUALITY CONTROL

A. Test Requirements:
   1. Perform tests for each batch of adhesive.

B. Pot Life Test:
   1. Condition Components A and B to required temperature.
   2. Measure components in ratio of Component B as stated on manufacturer's label into an 8 fluid ounce paper cup.
   3. Start stopwatch immediately and mix components for 60 seconds using wooden tongue depressor, take care to scrape sides and bottom of cup periodically.
   4. Probe mixture once with tongue depressor every 30 seconds, starting 2 minutes prior to minimum specified pot life.
   5. Pot Life Definition:
      a. Time at which a soft stringy mass forms in center of cup.

C. Fabrication of Slant Shear Specimens for Testing Bond of Injectable Adhesives to Wet Concrete at 40 DegF:
   1. Scope:

a. Test method for preparation of diagonal concrete mortar blocks used in determining slant shear strength of low viscosity injectable adhesives in accordance with AASHTO T 237 when concrete is wet.

2. Materials:
   a. Diagonal concrete mortar blocks prepared in accordance with AASHTO Test Method T 237 and cured to produce a mortar with compressive strength of 5,000 psi or greater.
   b. Paraffin wax.
   c. Masking Tape: 3/4-IN wide.
   d. Suitable 20 mil thick shim stock.
3. Preparation:
   a. Place a 20 mil shim between diagonal faces of two blocks and align so ends and sides are square.
   b. Bind block with masking tape covering gap between blocks.
   c. Leave a gap between blocks on one face uncovered for removal of shim and application of adhesive.
   d. Paint melted paraffin wax over masking tape.
   e. Shallow dam may be built up around opening using paraffin wax or modeling clay to help retain adhesive.
   f. Apply suitable capping compound to each end of specimen producing smooth surfaces perpendicular to longitudinal axis of block.
   g. Remove shim stock from gap opening.
   h. Soak specimen in water at 40 DegF, plus or minus 3 DegF for at least 24 hours.
   i. After soaking, remove specimen, shake free water from surface and gap opening.
   j. Prepare liquid adhesive.
   k. Within 5 minutes after removing specimen from water, start flowing adhesive into crack without entrap air bubbles.
   l. Place specimen in 40 DegF, plus or minus 3 DegF ambient for curing within 15 minutes after removing specimen from water for bonding.
      1) Do not expose specimen to temperatures beyond 77 DegF during the 15 minute period.
      2) Cure specimen for 72 hours, plus or minus 4 hours at 40 DegF, plus or minus 3 DegF.

PART 3 - EXECUTION

3.1 GENERAL

A. Structurally repair cracks in structures as specified in Division 03, Concrete.

B. Cracks:
   1. Repair by injection of epoxy adhesive.
   2. Repair all cracks.

3.2 PREPARATION

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with epoxy adhesive manufacturer's instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of epoxy adhesive surface seal system.

D. Do not use acids and corrosives for cleaning, unless neutralized prior to injecting epoxy.

3.3 APPLICATION

A. Sealing:
   1. Apply surface seal adhesive in accordance with manufacturer's instructions to designated crack face prior to adhesive injection.
   2. Seal surface of crack to prevent escape of injection adhesive.

B. Entry Ports:
   1. Establish openings for adhesive entry in surface seal along crack.
   2. Determine space between entry ports equal to thickness of concrete member.
   3. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy adhesive to soil at locations where:
      a. Cracks extend entirely through wall.
      b. Backfill of walls on one side.
      c. Difficult to excavate behind wall to seal both crack surfaces.

C. Adhesive Injection:
   1. Start injection into each crack at lowest elevation entry port.
   2. Continue injection at first port until adhesive begins to flow out of port at next highest elevation.
   3. Plug first port and start injection at second port until adhesive flows from next port.
   4. Inject entire crack with same sequence.

D. Finishing:
   1. Cure epoxy adhesive after cracks have been completely filled to allow surface seal removal without draining or runback of epoxy material from cracks.
   2. Remove surface seal from cured injection adhesive.
   3. Finish crack face flush with adjacent concrete.
   4. Indentations or protrusions caused by placement of entry ports not acceptable.
   5. Remove surface seal material and injection adhesive runs and spills from concrete surfaces.

3.4 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two adhesive components, and inject mixture into crack.

B. Pumps:
   1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
   2. Primary injection pump for each material of different mix ratio, including a standby backup pump of similar ratio.
   3. Capable of immediate compensation for changes in resins.
   4. Do not use batch mix pumps.

C. Discharge Pressure:
   1. Automatic pressure controls capable of discharging mixed adhesive at pressures up to 200 psi, plus or minus 5 percent, and able to maintain pressure.

D. Automatic Shutoff Control:
   1. Provide sensors on both Component A and B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance:
   1. Maintain epoxy adhesive manufacturer's prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:
   1. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
   2. Pressure gauge capable of sensing pressure behind each valve.

3.5 FIELD QUALITY CONTROL

A. Epoxy Adhesive Two Component Ratio Tests:
   1. Disconnect mixing head and pump two adhesive components simultaneously through ratio check device.
   2. Adjust discharge pressure to 160 psi for both adhesive components.
   3. Simultaneously discharge both adhesive components into separate calibrated containers.

4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work is stopped for more than 1 hour.
7. Document and maintain complete accurate records of, ratios and pressure checks.

B. Injection Pressure Test:
1. Disconnect mixing head of injection equipment and connect two adhesive component delivery lines to pressure check device.
2. Pressure check device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure test for each injection equipment unit:
   a. Beginning and end of each injection work day.
   b. When injection work is stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Crack Injection Tests:
1. Initial cores:
   a. 4-IN diameter for full crack depth taken from Engineer-selected locations.
   b. Take three cores in first 100 lineal feet of crack repaired and one core sample for each 500 lineal feet thereafter.
2. Provide suitable containers for storage, curing, and transportation of test specimens.
3. Methods of testing cores:
   a. Penetration:
      1) Visual examination.
   b. Bond Strength/Compression Test:
      1) Concrete failure prior to adhesive failure.
4. Test Requirements:
   a. Penetration:
      1) Minimum of 90 percent of crack shall be full of epoxy adhesive.
   b. Bond Strength/Compression Test:
      1) Concrete failure before adhesive failure, or 6,500 psi with no failure of either concrete or adhesive.
5. Evaluation and acceptance of tests:
   a. If initial cores pass tests as specified, epoxy adhesive injection Work at area represented by cores will be accepted.
   b. If initial cores fail either by lack of penetration or bond strength, crack repair Work shall not proceed further until areas represented by cores are reinjected and retested for acceptance.
   c. Obtain verifying core samples, number and location as selected by Engineer, after rework of areas represented by failed initial cores is complete.
6. Core hole repair:
   a. Correct Work as result of testing upon notification from Engineer.
   b. Refill initial and verifying core holes with an epoxy grout tamped and rodded in-place to form a dense fill.
   c. Finish surface to blend with adjacent concrete.

END OF SECTION

SECTION 04050
COLD AND HOT WEATHER MASONRY CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cold weather protection.
   2. Hot weather protection.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute/American Society of Civil Engineers/The Masonry Society (ACI/ASCE/TMS):
      a. ACI 530.1/ASCE 6/TMS 602, Specifications for Masonry Structures.
   2. International Masonry Industry All-Weather Council (IMIAWC):
      a. Recommended Practices and Guide Specifications for Masonry Construction.
   3. National Concrete Masonry Association (NCMA).
      a. TEK 3-1C, All Weather Concrete Masonry Construction.

1.3 DEFINITIONS

A. Hot Weather Construction: Per ACI 530.1/ASCE 6/TMS 602, hot weather construction is defined as occurring when ambient temperatures exceed 100 DegF or 90 DegF when the wind velocity is greater than 8 mph.

B. Cold Weather Construction: Per ACI 530.1/ASCE 6/TMS 602, cold weather construction is defined as occurring when ambient temperature falls below 40 DegF or when the temperature of the masonry units is below 40 DegF.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 ERECTION AND APPLICATION

A. General:
   1. Comply with NCMA TEK 3-1C recommendations and practices.
   2. Do not use frozen or ice coated materials.
   3. At end of each day or at shutdown, cover tops of all walls not enclosed or sheltered with clear polyethylene minimum 6 mil thick.
      a. Extend down each side of wall minimum of 16 IN and secure.

B. Temporary Facilities:
   1. Construct and maintain temporary protection required to permit continuous and orderly progress of work.
   2. Provide and maintain heat sufficient to assure temperature above 32 DegF within protected areas.

3. Remove all temporary facilities after completion of work.

C. Cold Weather Construction and Protection Requirements:
1. Prior to and during installation:
   a. Air temperature 32 to 40 DegF: Heat mixing water or aggregate to produce mortar temperatures between 40 and 120 DegF.
   b. Air temperature 25 to 32 DegF:
      1) Heat mixing water or aggregate to produce mortar temperatures between 40 and 120 DegF.
      2) Maintain mortar temperatures above freezing until used.
   c. Air temperature below 25 DegF:
      1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 DegF.
      2) Maintain mortar temperatures above freezing until used.
      3) Maintain temperature of units until laid at not less than 40 DegF.
      4) Provide heat on both sides of walls under construction to maintain air temperature above freezing.
      5) Provide windbreaks or shelters when wind is in excess of 15 mph.
         a) Wind breaks or shelters shall be translucent.
2. After installation:
   a. Air temperature 32 to 40 DegF: Protect from rain or snow for not less than 24 HRS by covering with weather-resistive translucent membrane.
   b. Air temperature 25 to 32 DegF: Completely cover with translucent weather-resistive membrane for not less than 24 HRS.
   c. Air temperature 20 to 25 DegF: Completely protect with insulating blankets for not less than 24 HRS or provide other protection approved by Engineer.
   d. Air temperature below 20 DegF:
      1) Provide enclosed translucent shelters and heating to maintain air temperature on each side of wall above 32 DegF for 24 HRS.
      2) Do not allow rapid drop in temperature after removal of heat.
   e. Promptly repair all tears, holes, etc., to translucent membrane and shelter using compatible patching material and tape as recommended by membrane manufacturer.

D. Hot Weather Construction and Protection Requirements:
1. Comply with requirements of IMIAWC, NCMA and ACI/ASCE/TMS.
2. Storage and preparation of materials.
   a. Cover or shade masonry units and mortar materials from direct sun.
   b. Maintain sand in a damp loose condition.
      1) Sand moisture shall be maintained at minimum 8 percent.
      2) Sprinkle with cool water as required to maintain moisture content.
   c. Use cool water for mixing mortars.
   d. Avoid using tools and equipment that have been sitting in the sun.
      1) Sprinkle mortar boards, mortar pans, wheel barrows, mixers, etc., with cool water.
   e. Do not wet concrete masonry units prior to use.
3. Installation:
   a. Place masonry units within one minute of the spreading of the mortar.
      1) Mortar beds shall not be spread more than 4 FT ahead of the masonry unit being placed.
   b. Provide wind screens and shading partitions as required to eliminate direct sunlight exposure.
   c. Wet installed units using fog spray of clean water.
   d. Cover installed work immediately after installation to slow rate of loss of moisture from units.
   e. Fog-spray new masonry work until damp.
      1) Repeat fog spraying minimum of three (3) times per day until masonry work has cured for 72 HRS.

2) In high humidity conditions, Engineer reserves the right to discontinue fog spraying if operation is found to be introducing excessive amounts of moisture into the Work.

END OF SECTION

SECTION 04110
CEMENT AND LIME MORTARS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cement and lime mortars and masonry grout.
   2. Integral water repellent admixture.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 04220 - Concrete Masonry.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute/American Society of Civil Engineers/The Masonry Society (ACI/ASCE/TMS).
      a. ACI 530.1/ASCE 6/TMS 602, Specifications for Masonry Structures.
   2. ASTM International (ASTM):
      a. C143, Standard Test Method for Slump of Hydraulic Cement Concrete.
      b. C144, Standard Specification for Aggregate for Masonry Mortar.
      c. C150, Standard Specification for Portland Cement.
      d. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
      e. C270, Standard Specification for Mortar for Unit Masonry.
      f. C404, Standard Specification for Aggregates for Masonry Grout.
      g. C476, Standard Specification for Grout for Masonry.
      h. C1019, Standard Test Method for Sampling and Testing Grout.
      i. C1093, Standard Practice for Accreditation of Testing Agencies for Unit Masonry.
      j. C1384, Standard Specification for Admixtures for Masonry Mortars.

B. Qualifications:
   1. Testing Laboratory shall be an independent agency qualified in accordance with ASTM C1093 for performing the testing indicated.
      a. Testing Laboratory shall have a minimum of 10 years experience in the testing of mortar and grout.
   2. Technician conducting tests shall have minimum of five (5) years experience in the testing of mortar and grout.

C. Mock-Ups:
   1. Provide mortar for mock-up panels specified in Specification Section 04220.

1.3 DEFINITIONS

A. Coarse grout and fine grout are defined by the aggregate size used in accordance with ASTM C476.

B. Coarse aggregate and fine aggregate are defined in ASTM C404, Table 1.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Proposed mortar mix design, including proposed pre-blended, prepackaged dry mortar mixes.
      1) Proposed mortar mix for fire rated construction.
      2) Proposed mortar mix design to include brand, type and manufacturer of all cementitious materials and source or producer of aggregate.
      3) Provide integral water repellent manufacturer's certified recommended dosage rate for mortar batched each day during masonry construction.
   c. Proposed masonry grout mix design.
3. Test results:
   a. Preconstruction mortar test results.
   b. Preconstruction masonry grout test results.
   c. Strength test results for all mortar and masonry grout (both coarse and fine grout) placed during construction.
   d. Slump test results of all masonry grout placed during construction.

B. Samples:
   1. Actual colored mortar samples for color selection by Engineer.
      a. Color card and plastic simulations are not acceptable.

C. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Qualifications of testing lab and technician.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store cementitious materials on elevated platforms, under cover, and in a dry location.
   1. Do not use cementitious materials that have become damp.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

C. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo.
   1. Store pre-blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement:
   1. ASTM C150, Type I or II.
   2. No air entrainment.
   3. Natural color.
   4. Maximum percent of alkalis: 0.60 in accordance with ASTM C150, Table 1A.

B. Hydrated Lime:
   1. ASTM C207, Type S.
   2. Type SA not acceptable.
   3. Lime substitutes are not acceptable.

C. Mortar Aggregate: ASTM C144, free of gypsum.

D. Masonry Grout:
   1. ASTM C476.
   2. No admixtures allowed.

E. Grout Aggregate: ASTM C404.

F. Water: Potable.

G. Mortar Pigments:
   1. Commercial colorants suitably compounded for use in mortar mixes.
   2. Do not exceed manufacturer's recommended pigment-to-cement ratios.

H. Integral Water Repellent Admixture:
   1. Liquid polymeric admixture: ASTM C1384.
   2. Verify compatibility with liquid water repellent admixture being used in the fabrication of concrete masonry units.

2.2 MIXES

A. Type "S" mortar shall be used:
   1. Wherever a fire-resistance classification or rating is shown for unit masonry construction provide mortar of type which has been tested and listed for construction indicated.
   2. Comply with ASTM C270, Table No. 1.
   3. Do not use masonry cement.
   4. Mix materials minimum of three (3) minutes and maximum of five (5) minutes.
   5. Adjust consistency to satisfaction of mason.
   6. Do not use admixtures unless otherwise indicated.
   7. Provide integral water repellent admixture in all mortar used for both interior and exterior masonry work.

B. Masonry Grout:
   1. Comply with ASTM C476.
   2. Use no anti-freeze additives.
   3. No fly ash additives will be accepted.
   4. Mix 5 minutes minimum.
   5. Slump: 8 to 11 IN.
   6. Do not add integral water repellent admixture to masonry grout mix.
   7. At Contractor's option, manufactured grout meeting the above minimum requirements may be used.
   8. Minimum 28-day compressive strength: 2,000 psi.

2.3 SOURCE QUALITY CONTROL

A. Perform preconstruction laboratory tests on proposed masonry grout mix prior to start of masonry work.
   1. Perform tests far enough in advance so that any necessary retesting can be accomplished before masonry construction begins.
      a. Test grout per ASTM C1019.

B. Source Limitations for Mortar Materials:
   1. Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one (1) source or producer for each aggregate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and ACI 530.1/ASCE 6/TMS 602.

B. Use coarse grout in spaces with least dimension over 2 IN.

C. Use fine grout for grouting door frames.

1. Grout all steel door frames in masonry and concrete wall construction unless specifically noted not to be grouted.
2. Do not grout aluminum door frames.
3. Do not grout door frames in stud wall construction.

D. Consolidate all grout while installing.
1. Consolidate grout pours 12 IN or less in height by mechanical vibration or by puddling.
2. Consolidate grout pours exceeding 12 IN in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.

E. Use colored mortar for pre-colored unit masonry.

3.2 FIELD QUALITY CONTROL

A. Mortar:
1. If standard gray mortar begins to stiffen, it may be retempered by adding water and remixing unless prohibited by water repellent admixture manufacturer.
   a. Standard gray mortar shall not be retempered more than one (1) time.
2. Colored mortar shall not be retempered.
3. All mortar and pointing grout must be used within 1-1/2 HRS maximum after initial mixing.

B. Engineer reserves right to alter mix design based on initial rate of absorption of masonry units.

C. Masonry Grout:
1. Use grout within 1-1/2 HRS maximum after initial mixing.
2. Use no grout after it has begun to set.
3. Do not retemper grout after initial mixing.
4. Place grout in lifts not exceeding 4 FT.

D. Masonry Grout Testing:
1. Testing and inspection services will be provided by the Owner's special masonry inspector.
   a. Do not include in the bid price the cost of these services.
2. Conduct compressive strength tests and slump tests on all masonry grout used during masonry construction.
3. Perform all compressive strength test sampling, testing and reporting per ASTM C1019.
4. Perform all slump test sampling, testing, and reporting per ASTM C143.
5. Frequency of sampling: One (1) sample (three (3) specimens) collected each grouting operation during masonry construction.
6. Compressive strength testing:
   a. One (1) strength test shall be the average of three (3) specimens from the same sample, tested at 28 days.

END OF SECTION

SECTION 04155
MASONRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Masonry accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 04210 - Brick Masonry.
   4. Section 04220 - Concrete Masonry.
   5. Section 05505 - Metal Fabrications.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. A480, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      d. A580, Standard Specification for Stainless Steel Wire.
      e. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      f. A951, Standard Specification for Steel Wire for Masonry Joint Reinforcement.
      g. A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
      h. D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
      i. D638, Standard Test Method for Tensile Properties of Plastics.
      j. D2240, Standard Test Method for Rubber Property—Durometer Hardness.
      k. D2287, Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
   2. Building code:
      a. International Code Council (ICC):
         1) California Building code, 2013 Edition, based on the International Building code, associated standards, and all amendments, referred to herein as Building Code.

B. Mock-Ups:
   1. Provide specified products for inclusion into mock-up panels required by Specification Section 04210 and Section 04220.
   2. Coordinate with built-in items and veneer coursing.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

c. Detailed drawings of all factory or field formed stainless steel thru wall flashing.
d. Tear resistance of flashing material.
e. Manufacturer's recommendations for flashing adhesive.
f. Manufacturer's data sheet on each product.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Weep vents for cavity wall construction:
   a. Heckman Building Products Inc.
   b. Hohmann & Barnard, Inc.
   c. Wire Bond.
   d. Mortar Net USA, Ltd.
2. Reglets:
   a. Hohmann & Barnard, Inc.
   b. W. P. Hickman Co.
   c. Superior Concrete Accessories, Inc.
3. Masonry anchors, horizontal joint reinforcing veneer anchors and miscellaneous anchors:
   a. Heckman.
   b. Hohmann & Barnard, Inc.
   c. Wire Bond.
4. Thru wall flashing:
   a. EPDM:
      1) Carlisle Syntech Systems, Inc.
      2) Firestone Building Products Co.
   b. Stainless steel:
      1) Heckman Building Products.
      2) Hohmann & Barnard, Inc.
5. Weep joint mortar protection system:
   a. Mortar Net USA, Ltd.
   b. Hohmann & Barnard, Inc.
   c. Wire Bond.
6. Preformed control joint inserts:
   a. Hohmann & Barnard, Inc.
   b. Wire Bond.
   c. Illinois Products Corporation (IPCO).
7. Grout screen:
   a. Wire Bond.
   b. Heckman Building Products.
   c. Hohmann & Barnard, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Thru Wall Flashing and Stainless Steel Drip:
1. 40 mil EPDM manufactured specifically for thru wall flashing.
   a. Tear resistance: ASTM D624, 150 LB/IN minimum.
   b. Width as required.
      1) Provide single piece full width, no horizontal joints will be allowed unless approved in writing by Engineer.
   c. Factory precut wherever possible.
   d. Factory fabricated inside and outside corners when available.

2. Stainless steel drip:
    a. ASTM A666, Type 316.
        1) Finish: ASTM A480, 2D.
        2) Minimum 26 GA.
    b. Maximum lengths of 10 FT.
    c. Factory fabricated.
    d. Factory fabricated inside and outside corners with a minimum return of 16 IN on each leg.
        1) Weld all joints and grind smooth.
    e. Provide 1/2 IN drip leg on exterior side of wall.
    f. Refer to the Drawings for profile.
    g. Lap sealant: VULKEM 922.

B. Flashing Adhesive: As recommended by flashing manufacturer for sealing laps, sealing to vertical masonry and concrete surfaces and sealing to stainless steel surfaces.

C. Weep Vent:
    1. 90 percent open mesh vent designed to be placed in vertical mortar joint.
    2. Mortar Net USA, Ltd. "Mortar Net Weep Vents."
    3. Color: Match existing weep vent colors.

D. Reglets:
    1. Products specified are manufactured by Hohmann & Barnard, Inc.
    2. For masonry construction: Type #MR - Masonry Reglet.
    3. For concrete construction: Type #CR - Concrete Reglet.

E. Veneer Anchorage System for New Concrete Back-up:
    1. Anchors, dovetail:
        a. Hot-dipped galvanized, ASTM A153/A153M.
        b. 16 GA corrugated steel with dovetail.
            1) 1 IN wide x 5 1/2 IN long minimum or as required by Project conditions.
                a) Provide minimum 2 IN embedment into veneer mortar joint.
    2. Dovetail slots:
        a. Hot-dipped galvanized, ASTM A153/A153M.
        b. 22 GA steel.
        c. 1 IN wide, 1 IN deep, nominal 5/8 IN throat with filler.

F. Horizontal Joint Reinforcing:
    1. General:
        a. Conform to ASTM A951.
        b. Cold drawn steel wire, ASTM A82.
        c. 9 GA side rods.
        d. 9 GA cross rods.
        e. Hot-dipped galvanized, ASTM A153/A153M.
        f. Prefabricated corner and tee sections with minimum length of 30 IN from point of intersection.
    2. Single wythe wall joint reinforcing:
        a. Ladder design at walls with vertical reinforcing.
        b. Truss design at walls without vertical reinforcing.
    3. Composite wall joint reinforcing: Ladder design with double side rod.

G. Rigid Steel Masonry Anchors:
    1. 1 IN by 1/4 IN with ends turned up 2 IN.
    2. Hot-dipped galvanized steel, ASTM A153/A153M.
    3. Length:
        a. 24 IN unless noted otherwise.
        b. Where wall conditions such as jambs or other obstructions preclude the use of 24 IN anchors, shorter anchors may be used.

H. Mesh Wall Ties:
   1. Hot-dipped galvanized steel, ASTM A153/A153M.
   2. 16 GA, 1/2 IN square mesh.
   3. Width: 2 IN less than nominal wall thickness.
   4. Length: As necessary to embed minimum 6 IN into each wall.

I. Grout Screen:
   1. Polypropylene monofilament.
   2. 1/4 x 1/4 IN mesh.
   3. Width of grout screen to be 2 IN less than nominal width of CMU.

J. Weep Joint Mortar Protection System:
   1. 100 percent recycled polyester.
   2. 90 percent minimum open weave mesh.
   3. Minimum 10 IN high by full width of air cavity.

K. Preformed PVC Control Joint Inserts:
   1. ASTM D2287.
   2. Hardness: ASTM D2240, Shore A Durometer, 85 +/-5.
   3. Ultimate elongation: 350 percent ASTM D638.
   4. Tensile strength: 2000 psi, ASTM D638.
   5. Hohmann & Barnard #VS Series.

L. Channel Slots and Anchors:
   1. Minimum 16 GA galvanized steel, ASTM A153/A153M.
   2. Hohmann & Barnard #D/A 901 channel slot with #913 anchor.

M. Corrugated Wall Ties:
   1. Hot-dipped galvanized per ASTM A153/A153M.
   2. Minimum: 18 GA steel.
   3. Length to be 2 IN less than wall thickness.
   4. Hohmann & Barnard D/A CWT.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Thru Wall Flashing and Stainless Steel Drip:
   1. Install to provide positive drainage of cavity moisture.
   2. Extend stainless steel drip beyond the exterior face of the wall to minimum distance possible while still allowing drip to perform intended purpose.
   3. Extend flashing horizontally beyond each edge of lintel or sills to next vertical mortar joint but not less than 4 IN and turn up edge one (1) full veneer course.
      a. Seal all joints.
   4. Where thru wall flashing and stainless steel drip steps up or down in the wall, provide end dam at step.
      a. End dam shall extend up or down to tie into thru wall flashing step.
      b. Seal all joints for continuous watertight barrier.
   5. Lap stainless steel drip minimum of 2 IN and bond two (2) pieces together using stainless steel pop rivets and two (2) beads of lap sealant.
   6. Adhere vertical surface of flashing to back-up wall with adhesive recommended by flashing manufacturer.
   7. Extend flashing minimum of 6 IN above top of weep joint mortar protection system when possible.
   8. Lap and seal flashing at all inside and outside corners to provide continuous uninterrupted barrier.

C. Weeps:
   1. Provide open weep joints at maximum 16 IN OC in head joint of first course of veneer immediately above thru wall flashing.
      a. Omit mortar bed on top of thru wall flashing at each open weep joint location to allow moisture an unobstructed path to the exterior.
      b. Weep joints shall be not more than one (1) brick course high.
   2. Provide weep vents maximum 16 IN OC in top of head joint of top course of veneer or as indicated on Drawings.
      a. Do not use weep vents in weep joints at the bottom of the wall.
      b. Set weep vents back away from face of veneer slightly so the front edge of the vent is contained within the mortar joint.

D. Weep Joint Mortar Protection System:
   1. Install continuous row(s) of material.
   2. Provide multiple thicknesses of material compressed as required to completely fill the entire air cavity.
      a. Thickness to be at least 10 percent wider than air cavity being filled.
   3. Set material directly on top of thru wall flashing.

E. Butt joints of preformed control joint inserts tightly together and secure with adhesive or sealant acceptable to insert manufacturer.

F. Anchoring Veneer:
   1. Veneer with concrete back-up:
      a. Anchor veneer to new construction using dovetail anchors and slots.
      b. Anchor veneer to existing construction using adjustable pintle and plate.
      c. Provide veneer anchorage at not more than 16 IN OC vertically and 16 IN OC horizontally.
   2. In cavity wall construction, where required for seismic design, provide single continuous wire horizontal joint reinforcing permanently attached to veneer anchorage system as required by the Building Code.

G. Reinforcing Masonry:
   1. General:
      a. Provide continuous horizontal joint reinforcing in all concrete masonry wall construction.
         1) Embed longitudinal side rods in mortar for entire length with minimum cover of 5/8 IN on exterior side of walls and 1/2 IN at other locations.
            a) For interior partitions, the "exterior" side of the wall is considered the side having the most corrosive atmosphere or the corridor side of the wall.
         2) Lap reinforcement minimum of 12 IN at ends.
            a) Remove cross wires on one (1) side of the lap splice and bend the side rods slightly so the lap is provided with 12 IN of uninterrupted wire lap occurring in the same plane.
         3) Do not bridge control joints with horizontal joint reinforcing.
         4) Do not bridge expansion joints with horizontal joint reinforcing.
         5) At corners and wall intersections use prefabricated "L" and "T" horizontal joint reinforcing sections.
         6) Cut and bend as required.
      b. Install reinforcing at 16 IN OC vertically unless noted otherwise on Drawings.
      c. Install reinforcing 8 IN OC vertically for a minimum of 24 IN at starter courses.
         1) Do not install horizontal joint reinforcing in veneer mortar joint having through-wall flashing.
      d. In concrete back-up construction, install veneer horizontal joint reinforcing 8 IN OC and install dovetail anchors at 8 IN OC in courses on each side of vertical control joints and on each jamb of openings for full height of joint or opening.
         1) Extend reinforcing minimum 32 IN beyond the edge of the dovetail anchors.

2) Cut veneer horizontal joint reinforcing around dovetail anchors but do not completely separate joint reinforcing into individual pieces.
3) Locate dovetail anchors within 4 IN of the edge of the opening.
4) Terminate horizontal joint reinforcing at edge of dovetail anchors at opening.

2. Reinforcing concrete masonry:
   a. Install reinforcing bars where indicated on Drawings.
      1) Provide means necessary to ensure position of vertical steel reinforcing meets requirements of Building Code.
   b. At intersecting load-bearing walls, provide rigid steel anchors 16 IN OC vertically, embed ends in grout filled cores.
      1) Alternate rigid steel anchors with horizontal joint reinforcing.
   c. At intersecting non-load bearing walls or at intersecting load bearing/non-load bearing walls provide mesh wall ties in mortar joint at 16 IN OC vertically.
      1) Extend minimum 6 IN into each wall.
      2) Alternate mesh wall ties with horizontal joint reinforcing.
   d. Anchor intersecting concrete masonry to intersecting cast-in-place or precast concrete using dovetail slots and anchors.
      1) Provide dovetail anchors at 16 IN OC.
3. Repair all galvanized coatings damaged as a result of welding.
   a. See Specification Section 05505 for galvanizing repair system.
4. Reinforcing veneer:
   a. Reinforce veneer with joint reinforcement placed in veneer mortar joints:
      1) In new concrete back-up construction alternate veneer horizontal joint reinforcing with dovetail anchors.
   b. In concrete back-up construction, reinforce masonry veneer openings over 12 IN wide with single wall wythe horizontal joint reinforcing and dovetail anchors placed in two (2) horizontal joints above lintel and below sill.
      1) Extend reinforcing minimum 32 IN beyond the jambs of openings.
      2) Locate dovetail anchors within 4 IN of the edge of the opening.
      3) Cut veneer horizontal joint reinforcing around dovetail anchors but do not completely separate joint reinforcing into individual pieces.
      4) Terminate horizontal joint reinforcing at edge of dovetail anchors at opening.

H. Install reglets as walls are being constructed.
   1. Set reglets true with wall, plumb and at consistent depth.

I. Remove all excess mortar and grout from reglets as walls are being constructed and protect reglet openings from filling with mortar, grout and other construction debris.

END OF SECTION

SECTION 04210
BRICK MASONRY AND VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Brick masonry and veneer.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).

B. Mock-Ups:
   1. After final brick selection has been made and prior to permanent wall construction, construct mock-up, minimum 4 FT high x 8 FT long, utilizing all specified components of exterior wall for Engineer review and acceptance.
   2. Mock-up shall constitute minimum standard of quality for actual construction.
      a. Maintain mock-up during construction.
   3. If not acceptable, construct additional mock-ups as required.
   4. Remove when directed.
   5. Build mock-up in conjunction with mock-up required for concrete and concrete masonry construction.
   6. Mock-up to include all special corners and other special brick detailing including all special shapes.
      a. Step construction of mock-up to allow observation of all specified components.
      b. Mock-up shall include as a minimum all special shapes, all types of brick coursing, cavity insulation, veneer horizontal joint reinforcing, composite wall horizontal joint reinforcing, thru wall flashing and stainless steel drip, weep joints, weep joint mortar protection system and weep vents, minimum 12 IN long brick support angle properly flashed, typical control joint construction and liquid water repellent.
         1) Mock-up shall include inside and outside corner showing thru wall flashing lapping, jointing and sealing.
         2) Mock-up shall include example of flashing condition at bearing end of lintels as outlined in Specification Section 04155.
         3) Cavity wall flood test:
            a) Mock-up cavity shall be dammed at each end and all weep joints shall be plugged.
            b) Cavity shall be flooded with water minimum 16 IN deep.
            c) Weep joints shall then be unplugged and cavity shall be allowed to drain to demonstrate effectiveness of weep joints.
            d) Engineer shall witness demonstration.
            e) Test will be considered acceptable if no standing water remains in cavity after a period of 15 minutes.
            f) Correct deficiencies identified by Engineer and retest until acceptable to Engineer.

C. All brick provided on this Project shall be from same production run.
   1. Produce special shapes and solid units in manner which will ensure matching of color and texture with field brick.
      a. Solid units shall be 100 percent solid.

2. Special shapes shall be factory fabricated unless noted otherwise.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Results of cavity wall flood test.

B. Samples:
1. Minimum 12 x 12 IN banded brick sample incorporating actual brick and mortar color being used on Project for Engineer review.
2. Samples of all special shapes prior to incorporating into mock-up.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver units on pallets with tight covers or deliver in cubes and store on dunnage.

B. Inspect masonry upon delivery to assure color match with mock-up and dimensional quality and trueness of brick units.

C. Remove unacceptable units from the Project Site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Brick: Match existing.
   a. Contact H.C. Muddox in Sacramento, California.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Brick:
1. ASTM C216, Grade SW.
2. Include in bid special shaped, sized or cut brick units required for complete installation.
   a. Special shaped brick shall be fabricated in manufacturing plant and shall not be field fabricated by saw cutting unless otherwise noted.
3. Size and color range shall match existing brick.

B. Accessories: See Specification Section 04155.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Verify that all required accessory items are correct.

C. General:
1. Build cavity walls to thickness indicated.
2. Build composite walls to thickness indicated.
3. Build in flashing, reinforcing, weeps, vents and related accessory items.

    a. See Specification Section 04155 for installation of accessory items.
4. Install field brick in running bond.
    a. Provide special coursing where indicated on the Drawings.
5. Perform all cutting with masonry saws using saw blades as recommended by masonry unit manufacturer.
6. Drill holes with power drill using drill bits as recommended by masonry unit manufacturer.
7. Holes made by chipping not acceptable.
8. Cut as required to provide pattern required.
9. Use 100 percent solid units where cutting or laying would expose holes.
    a. Fill solid with mortar all units in first course directly below thru wall flashing.
    b. Miter all brick at corners.
10. Avoid use of less than half size units whenever possible.
11. Do not install damaged units.
12. Wet brick having absorption rates greater than 0.025 OZ/SI/MIN.
    a. Wet brick in accordance with manufacturer's instructions.
13. Install brick work in conjunction with concrete work.

D. Laying and Tooling:
1. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints.
    a. Properly locate openings, movement type joints, returns and offsets.
2. Lay brick with completely filled bed and head joints except at weep locations.
    a. Omit mortar from head joint at weep joint locations.
    b. Butter ends with sufficient mortar to completely fill head joints and shove into place.
    c. Do not slush head joints.
    d. See Specification Section 04110 for mortar and grout.
    e. In cavity wall construction, taper mortar on inside edge of veneer to prevent mortar from falling into cavity.
    f. Protect cavity during laying of brick as required to prevent mortar droppings from filling cavity.
    g. Install weep joint mortar protection system in cavity per Specification Section 04155.
3. Maintain nominal 3/8 IN joint widths.
    a. Cut joints flush where concealed.
    b. Tool exposed joints concave.
    c. Compress mortar in below grade joints.
    d. Provide wider joints where noted on the Drawings.
    e. Where brick sets on top of steel support, omit the mortar joint on top of the support under the brick and set the brick directly on the thru wall flashing or the steel support member unless a mortar joint is required to maintain coursing.
4. During tooling of joints, enlarge any voids or holes, except weep joints, and completely fill with mortar.
5. Point-up all joints at corners, openings and adjacent work to provide neat, uniform appearance.
6. Remove brick units disturbed after laying.
    a. Clean and relay in fresh mortar.
    b. Do not pound units to fit.
    c. If adjustments are required, remove units, clean and reset in fresh mortar.
7. Where work is stopped and later resumed, rake back 1/2 brick unit length in each course.
    a. Wet units lightly.
    b. Remove loose units and mortar prior to laying fresh masonry.
8. As work progresses, build-in items indicated and specified.
    a. Fill in solidly with mortar around built-in items.

E. Control Joints and Sealants:
1. Provide vertical expansion, control and isolation joints where indicated.
    a. Where not indicated provide at maximum 16 FT OC.
    b. Rake out all mortar from joint.

1) Exercise care not to damage thru wall flashing when cleaning mortar from vertical joints.

c. Locate control joints at points of natural weakness in masonry.

2. See Specification Section 07900 for sealant installation requirements.

3.2 FIELD QUALITY CONTROL

A. Protect against weather when work is not in progress.
   1. Cover top of walls with waterproof translucent membrane, extend at least 4 FT down both sides of wall and anchor in place.

B. Protect against cold and hot weather as specified in Specification Section 04050.

C. Remove and replace loose, stained, or damaged bricks.
   1. Provide new units to match.
   2. Install in fresh mortar.
   3. Point to eliminate evidence of replacement.

D. Tolerances:
   1. Maximum variation from plumb in vertical lines and surfaces of columns, walls and arises:
      a. 1/4 IN in 10 FT.
      b. 3/8 IN in a story height not to exceed 20 FT.
      c. 1/2 IN in 40 FT or more.
   2. Maximum variation from plumb for external corners, expansion joints and other conspicuous lines:
      a. 1/4 IN in any story or 20 FT maximum.
      b. 1/2 IN in 40 FT or more.
   3. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines:
      a. 1/4 IN in any bay or 20 FT.
      b. 1/2 IN in 40 FT or more.
   4. Maximum variation from plan location of related portions of columns, walls and partitions:
      a. 1/2 IN in any bay or 20 FT.
      b. 3/4 IN in 40 FT or more.
   5. Maximum variation in cross-sectional dimensions of columns and thicknesses of walls from dimensions shown on Drawings:
      a. Minus 1/4 IN.
      b. Plus 1/2 IN.
   6. Maximum variation in mortar joint width:
      a. Bed joints: 3/32 IN in 10 FT.
      b. Head joints:
         1) Minus 1/8 IN.
         2) Plus 1/4 IN.

E. Inspect wall to ensure that mortar droppings have not plugged weep joints or weep vents.

3.3 CLEANING

A. Clean brick masonry as wall is being constructed using fiber brush, wooden paddles and scrapers.
   1. After all brick construction is complete, wash wall using specified brick cleaning solution.
   2. Refer to Specification Section 04510.

END OF SECTION

SECTION 04220
CONCRETE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete masonry construction (CMU) including all standard concrete, masonry ground face, and pre-colored units.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03208 - Reinforcement.
   4. Section 04050 - Cold and Hot Weather Masonry Construction.
   5. Section 04110 - Cement and Lime Mortars.
   6. Section 04155 - Masonry Accessories.
   7. Section 04510 - Masonry Cleaning.
   8. Section 07900 - Joint Sealants.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI)/American Society of Civil Engineers (ASCE)/The Masonry Society (TMS):
      a. ACI 530.1/ASCE 6/TMS 602, Specifications for Masonry Structures.
   2. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   3. National Concrete Masonry Association (NCMA):
      a. TEK 2-3A, Architectural Concrete Masonry Units.
      b. TEK 3-4B, Bracing Concrete Masonry Walls During Construction.
   4. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Mock-Ups:
   1. Prior to permanent wall construction, construct mock-up:
      a. Mock-up shall be as large as required to properly display all components required by the building masonry construction; however, the mock-up shall be a minimum 4 FT high x 8 FT long.
      b. Utilize all specified components for Engineer review and acceptance.
   2. Mock-up shall constitute minimum standard of quality for actual construction:
      a. Maintain mock-up during construction.
   3. If not acceptable, construct additional mock-ups as required.
   4. Remove when directed by Engineer.
   5. Mock-up to include all special corners and other special CMU detailing including ground face, and pre-colored masonry units:
      a. Step construction of mock-up to allow observation of all specified components.
      b. Mock-up shall include, as a minimum, all types of masonry and all special shapes vertical wall reinforcing with grouted cell, all types of horizontal joint reinforcing, typical control joint construction, and typical bond beam construction. .

C. All masonry units of any one (1) particular type, color or face style shall be from the same production run:
   1. Special shapes shall be factory fabricated unless noted otherwise.

1.3 DEFINITIONS

A. Definitions to be in accordance with Standard Unit Nomenclature Table 1, NCMA TEK 2-3A.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Manufacturer's information on aggregate and cement type used in manufacture.
   3. Certifications:
      a. Certification that concrete masonry units meet or exceed requirements of standards referenced.
   4. Qualifications of testing lab and technician.
   5. Test results for all masonry testing.

B. Samples:
   1. Minimum two (2) 2 x 8 x 8 IN samples of ground face and pre-colored masonry units of each color selected or specified:
      a. Samples shall show color range and texture range to be expected in the Project.

C. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver units on pallets with tight covers or deliver in cubes and store on dunnage.

B. Protect units from damage.

C. Inspect units upon delivery for damage, to assure color match with mock-up or approved samples, dimensional quality, and trueness of unit:
   1. Remove damaged or otherwise unacceptable units from the Project Site.

D. Store units in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ground face masonry units:
      a. Concrete Materials.
      b. Clayton Concrete Block.
      c. Dillon and Co.
      d. Mutual Materials.
      e. Oldcastle.
      f. Trenwyth Industries, Inc.

2.2 MATERIALS

A. Concrete Masonry Units:
   1. Modular units, ASTM C90:

a. Provide aggregate in accordance with ASTM C33.
b. Total linear drying shrinkage: ASTM C90.
c. Weight: Minimum of 135 LB/CF.
d. Use normal weight units.

2. Face shell and web thickness: ASTM C90, Table 1.
3. Water absorption: ASTM C90 Table 2.
4. Concrete bricks of same material, texture and quality.
5. Compressive strength: ASTM C90, Table 2.
6. Dimensional tolerance: ASTM C90.

B. Ground Face Masonry Units (GFMU):
1. ASTM C90.
2. Total linear drying shrinkage: ASTM C90.
3. Weight: Minimum of 125 LB/CF.
4. Face shell and web thickness prior to face grinding: ASTM C90, Table 1.
5. Manufacture all ground face masonry units using integral water repellent admixture.

C. Reinforcing Bars: Refer to Specification Section 03208 and as indicated on Drawings.

D. Mortar: Refer to Specification Section 04110.

E. Masonry Grout: Refer to Specification Section 04110.

F. Masonry Accessories: Refer to Specification Section 04155.

G. Sealants: Refer to Specification Section 07900.

2.3 FABRICATION

A. Concrete Masonry Units:
1. Color:
a. Interior units: Standard gray.
b. Exposed exterior units: As selected by Engineer from manufacturer’s standard color selection.
2. Design compressive strength: f'm=1,500 psi minimum:
a. Determine in accordance with unit strength method per ACI 530.1/ASCE 6/TMS 602.
3. Fire resistive units: Fabricate to meet the Building Code.
4. Fabricated in the manufacturing plant.
5. Provide square corners.

B. Ground Face Masonry Units (GFMU):
1. Factory ground faces on modular concrete block.
2. Manufacturer's standard factory applied clear sealer.
3. Provide single or double face units as noted on Drawings with special ground face lintels, corners, caps, jamb returns as indicated on the Drawings or as required for wall conditions.
4. Provide square corners.
5. Sizes as indicated on the Drawings.
6. Color: As selected by Engineer from manufacturer’s standard color selection.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that anchors and flashings are correct.

B. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints:
1. Properly locate openings, movement type joints, returns, and offsets.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
   1. Build in flashing, reinforcing, reglets, and related accessory items:
      a. See Specification Section 04155 for installation of accessory items.
   2. Perform all cutting with masonry saws using saw blades as recommended by masonry unit manufacturer.
   3. Drill holes with power drill using drill bits as recommended by masonry unit manufacturer.
   4. Holes made by chipping unit will not be accepted.
   5. Install field units in running bond:
      a. Provide special coursing where indicated on the Drawings.
   6. Cut as required to maintain bond pattern.
   7. Use solid units where cutting or laying would expose holes and as noted on Drawings.
   8. Avoid use of less than half size units, whenever possible.
   9. Do not use chipped, cracked, spalled, stained or imperfect units exposed in finish work.
   10. Do not wet concrete masonry units.
   11. Build chases and recesses as indicated and required for work of other trades:
      a. Provide not less than 8 IN of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses unless detailed otherwise on the Drawings.
   12. In fire rated wall construction, install fire resistive units in accordance with the Building Code.

C. Concrete Masonry Units:
   1. Install grouted hollow units under lintel bearing points:
      a. Refer to Specification Section 04110 for grouting.

D. Laying and Tooling:
   1. Lay masonry units with completely filled bed and head joints:
      a. Provide full mortar bed on all block cross webs and completely fill head joints:
         1) Do not slush head joints.
         2) Protect cells requiring grout fill from mortar droppings.
   2. Maintain nominal 3/8 IN joint widths:
      a. Cut joints flush where concealed.
      b. Tool exposed joints concave.
      c. Compress mortar in below ground joints.
      d. Provide wider joints where noted on Drawings:
         1) In no case shall any mortar joint be more than 3/4 IN wide.
      e. Where masonry sits on top of steel support omit the mortar joint on top of the support and sit masonry directly on top of the steel support member unless a mortar joint is required to maintain coursing.
   3. During tooling of joints, enlarge any voids or holes, and completely fill with mortar.
   4. Point-up all joints at corners, openings, and adjacent work to provide neat, uniform appearance.
   5. Remove masonry disturbed after laying:
      a. Clean and relay in fresh mortar.
      b. Do not pound units to fit.
      c. If adjustments are required, remove units, clean, and reset in fresh mortar.
   6. Where work is stopped and later resumed, rack back 1/2 masonry unit length in each course:
      a. Remove loose units and mortar prior to laying fresh masonry.
   7. As work progresses, build in items indicated on Drawings and specified:
      a. Fill in solidly with mortar around built-in items.
      b. Where built-in items are to be embedded in cores of hollow masonry units, place grout screen in joint below and fill core solid with mortar.

E. Control Joints and Sealants:
   1. Provide vertical expansion, control and isolation joints where indicated on Drawings:
      a. Where not indicated on Drawings, provide control joints at maximum 30 FT OC or at natural point of weakness.
      b. Provide at all T intersections.
      c. Rake out mortar in joint.
   2. Refer to Specification Section 07900 for sealant installation requirements:
      a. Seal control and expansion joints.

F. Tolerances:
   1. Maximum variation from plumb in vertical lines and surfaces of columns, walls, and arises:
      a. 1/4 IN in 10 FT.
      b. 3/8 IN in a story height not to exceed 20 FT.
      c. 1/2 IN in 40 FT or more.
   2. Maximum variation from plumb for external corners, expansion joints, and other conspicuous lines:
      a. 1/4 IN in any story or 20 FT maximum.
      b. 1/2 IN in 40 FT or more.
   3. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
      a. 1/4 IN in any bay or 20 FT.
      b. 1/2 IN in 40 FT or more.
   4. Maximum variation from plan location of related portions of columns, walls, and partitions:
      a. 1/2 IN in any bay or 20 FT.
      b. 3/4 IN in 40 FT or more.
   5. Maximum variation in cross-sectional dimensions of columns and thicknesses of walls from dimensions shown on Drawings:
      a. Minus 1/4 IN.
      b. Plus 1/2 IN.

G. Protect against weather when work is not in progress:
   1. During inclement weather conditions, cover top of walls with translucent waterproof membrane.
   2. See Specification Section 04050.

H. Protect against cold/hot weather as specified in Specification Section 04050.

3.3 FIELD QUALITY CONTROL

A. Bracing Concrete Masonry Walls During Construction:
   1. At a minimum, provide bracing in accordance with NCMA TEK 3-4B.
   2. Contractor is responsible for adequately bracing all masonry during construction.

B. Remove and replace loose, stained, damaged and other unacceptable units as directed by Engineer:
   1. Provide new units to match.
   2. Install in fresh mortar.
   3. Point to eliminate evidence of replacement.

C. Special Masonry Inspection:
   1. Masonry inspection services will be provided during the following construction activities:
      a. Cost of masonry inspection services will be paid by Owner.
      b. During laying of units:
         1) During the first day of the masonry construction, inspect proportions of site prepared mortar, construction of mortar joints, location of all reinforcing and connectors, size and location of structural elements, type, size and location of anchors, protection of masonry during cold weather.

2) Inspection to be continuous the first full day of masonry construction which requires special inspection:
   a) Thereafter, a minimum of 3 HRS every third day of construction until the concrete masonry work is complete.
3) Inspection while laying masonry units may be made concurrently with other inspection duties provided all inspection duties are adequately performed.
4) When deficiencies are found, additional inspection shall be provided as required until deficiencies have been corrected.
5) If masonry crews change, an additional full day of inspection is required during the first day the new crew is on-site.

c. Placement of reinforcing steel:
   1) Verification of all reinforcing including size, grade, lap lengths, and type.
   2) Inspection may be periodic as required to verify all reinforcing.
   3) Inspector to be present during the concrete pour in which any dowels connecting concrete to masonry are cast to verify proper location of dowels.

d. Prior to each grouting operation, verify that grout space is clean, reinforcing is clean and connectors are properly placed, proportions of site-prepared grout are correct and mortar joints have been properly constructed:
   1) Inspection may be periodic as required to verify proper grout space.
   2) Inspector to be present during the grouting in which any steel embedded (insert) plates or anchor bolts are grouted to verify proper location of inserts and anchor bolts.

e. Verify compliance with Building Code and Specifications continuously during all grouting operations.

f. Provide special inspection in accordance with the Building Code Table 1704.5.1 including observation of masonry work for conformance to the Contract Documents:
   1) Provide inspection reports to the Engineer, Building Official and Owner:
      a) Notify Contractor of discrepancies for correction.
      b) Notify Engineer, Building Official and Owner, in writing, when discrepancies have been satisfactorily corrected.
   2) Submit final signed report stating that work requiring special inspection was, to the best of the inspector's knowledge, in conformance to the Contract Documents and the applicable workmanship previsions of the Building Code.

3.4 CLEANING

A. Clean concrete masonry as the wall is being constructed using fiber brushes, wooden paddles and scrapers:
   1. No acid-based cleaning solutions shall be used unless approved in writing by Engineer.
   2. Clean ground faced and pre-colored masonry units as wall is being constructed using fiber brushes, wooden paddles and scrapers.
   3. DO NOT USE METAL TOOLS FOR CLEANING WALL.
   4. Ground Masonry Units:
      a. Maintain walls clean during installation, remove all mortar splatters immediately using soft damp rag.
      b. Do not allow excess mortar to harden on faces.

END OF SECTION

SECTION 04510
MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Masonry cleaning.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Use experienced workmen familiar with product and its application.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Manufacturer's application instructions.
      b. Manufacturer's dilution recommendations.
      c. Manufacturer's recommendations on neutralizing rinse.

B. Certifications:
   1. Certification that Contractor is experienced in this type of masonry cleaning.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cleaning solution: Detergent type.
      a. Pro So Co.
      b. Diedrich Technologies, Inc.
   2. Cleaning solution for manganese or vanadium stained masonry:
      a. Pro So Co.
      b. Diedrich Technologies, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Detergent-Type Cleaning Solution: Pro So Co. "Sure Clean #600" detergent masonry cleaner.

B. Manganese or Vanadium-Stained Masonry: Pro So Co. "Vanatrol."

C. Water: Potable.

D. Neutralizing rinse as required by manufacturer.

2.3 MIXES

A. Dilute cleaning solution with potable water at rate which will provide for the weakest solution allowable for cleaning wall.

B. If project conditions require solution of greater than 5 percent acid, obtain permission from Engineer in writing prior to applying solution to wall surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Allow 7 days after completion of masonry work before start of cleaning.

B. Remove excess mortar using wooden paddles and scrapers.

C. Protect adjacent surfaces not to be cleaned.

3.2 APPLICATION

A. Protect adjacent surfaces subject to potential damage by cleaning solution.

B. Apply masonry cleaner to exposed-to-view masonry surfaces.
   1. Do not use wire brushes.
   2. Use only tools free of rust.
   3. Apply solution using fibered wall-washing brush.

C. Thoroughly rinse and pre-soak walls.

D. Flush all loose mortar and dirt from surface.

E. Wet to prevent "run-off" streaking.

F. Scrape off mortar and reapply cleaning solution.

G. After scrubbing, clean thoroughly with pressurized water.

H. Apply neutralizing rinse as recommended by manufacturer.

END OF SECTION

SECTION 05120
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Structural steel, including the fabrication and erection of framing and bracing members, including connections.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 03151 - Anchorage to Concrete
   4. Section 05211 - Steel Joists.
   5. Section 05313 - Metal Deck.
   6. Section 05505 - Metal Fabrications.
   7. Section 05522 - Aluminum Railings.
   8. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC):
      a. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
      b. 303, Code of Standard Practice for Steel Buildings and Bridges dated March, 2000.
      c. Quality Certification Program for Fabricators.
      d. Erector Certification Program.
      e. Manual of Steel Construction.
      f. Technical Bulletin #3, Shape Material, dated March, 1997.
   2. American Society of Civil Engineers (ASCE).
   3. American Society of Mechanical Engineers (ASME):
      a. B18.22.1, Plain Washers.
   4. ASTM International (ASTM):
      a. A2, Standard Specification for Carbon Steel Girder Rails of Plain, Grooved, and Guard Types.
      b. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      c. A36, Standard Specification for Carbon Structural Steel.
      d. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      e. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
      f. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      g. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      h. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      i. A449, Standard Specification for Quenched and Tempered Steel Bolts and Studs.
      j. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
      k. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.

l. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
m. A563, Standard Specification for Carbon and Alloy Steel Nuts.
n. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
o. A847, Standard Specification for Cold-Formed Welded and Seamless High Strength, Low Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance.
p. A992, Standard Specification for Steel for Structural Shapes.
q. F436, Standard Specification for Hardened Steel Washers.
r. F593, Standard Specification for Stainless Steel Bolts, Hex Caps Screws and Studs.
s. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
t. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

5. American Welding Society (AWS):
   a. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   c. A5.17, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   d. A5.18, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
   e. A5.20, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   f. A5.23, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
   g. A5.28, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
   h. A5.29, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
   i. D1.1, Structural Welding Code - Steel (referred herein as AWS Code).
   j. Steel stud connectors and their installation to comply with requirements of AWS Code.
6. Research Council on Structural Connections (RCSC):
   a. Specification for Structural Joints using ASTM A325 or A490 Bolts, referred to herein as Specification for Structural Joints.
7. Building code:
   a. International Code Council (ICC):
      1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
1. Steel fabricator:
   a. Minimum of (10) ten years experience in fabrication of structural steel and shall be certified under AISC Quality Certification Program Category MB.
   b. Use a professional engineer on fabrication staff.
2. Steel erector:
   a. Minimum of (10) ten years of experience in erection of structural steel.
   b. With an active and enforced quality assurance program in place, as described in the Building Code.
3. Qualify welding procedures and welding operators in accordance with AWS.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Fabrication and/or layout drawings:
   a. Prepare Shop Drawings under National Institute of Steel Detailing Quality Procedures Program certification.

b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
   1) All Shop Drawings must be checked for completeness and conformance to the Contract Documents and signed "approved" by Contractor before submittal.
   2) Show all cuts, copes, and holes.
   3) Indicate all shop and field bolts.
   4) Indicate all shop and field welds using AWS symbols.
   5) Where designated as Design by Contractor, be reviewed and sealed by a professional engineer retained by Contractor to verify conformance with design criteria stipulated in the Contract Documents.
c. Prepare complete erection drawings showing the location and marks of all pieces.
   1) Copies of up-to-date erection drawings shall accompany the Shop Drawings.
      a) Use match marks on the erection drawings to indicate the sheet number on which each particular member is detailed.
d. Correct any incorrect or unacceptable material or fabrication due to incorrect detailing, shop work, or erection, without additional charge.

3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Detailed supplemental specification relating to load indicator washers or high-strength bolts - alternate design for approval of Engineer (submitted at Contractor's option if desired by Contractor for use).
   d. Source and certification of quality for high-strength bolts, nuts and washers.
4. Certifications:
   a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
   b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
   c. Welder qualification data and prequalified procedures.
5. Test reports:
   a. Certified copies of mill tests.
   b. Manufacturer's load test and temperature sensitivity data for expansion anchor bolts and adhesive anchor bolts.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle and store steel members above ground on skids or other supports.
   1. Keep free of dirt and other foreign material and protect against corrosion.

1.5 DEFINITION

A. Code: AISC 303, Code of Standard Practice for Steel Buildings and Bridges.

B. Owner: May mean the Owner's Designated Representative for Construction as defined by the Building Code.

C. Galvanizing: Hot-dipped galvanizing per ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. High-strength bolts:
      a. Bethlehem Steel Corporation.

b. Lewis Bolt & Nut Company.
c. Nucor Fasteners.
d. St. Louis Screw and Bolt Company.

2. Load indicator washers for high-strength bolts:
   a. Bethlehem Steel Corporation.
   b. Mid-South Bolt and Screw Co., Inc.
   c. J and M Turner, Inc.
3. Alternate design high-strength bolts:
   a. T. C. Bolt Corporation.
   b. Construction Fastener Systems Division of Bristol Machine Company.
   c. LeJuene Bolt Co.
4. Headed studs and deformed bar anchors:
   a. Nelson Stud Welding Division, TRW, Inc.
   b. Stud Welding Products, Inc.
5. Expansion anchor bolts: See Section 03151.
6. Adhesive anchors bolts: See Section 03151.
7. Anchor bolt sleeves:
   a. Sinco/Wilson.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):
1. All W-shapes and WT-shapes: ASTM A992, Grade 50.
   a. Provide ASTM A992, Grade 50.
   b. ASTM A572, Grade 50 with special requirements per AISC Technical Bulletin #3, Shape Material, dated March, 1997 may be used in lieu of ASTM A992, Grade 50.
2. All other plates and rolled shapes: ASTM A36.

B. Plate and Bar: ASTM A36.

C. Pipe: ASTM A53, Grade B (Type E or S) (Fy=35).

D. Hollow Structural Sections (HSS):
1. Round: ASTM A500, Grade B (Fy=42) .
2. Square or rectangular: ASTM A500, Grade B (Fy=46).

E. High-Strength Bolts, Nuts and Washers, ASTM A325 with ASTM A563 nuts galvanized:
1. High-strength bolts:
   a. Provide two (2) ASTM F436 washers for all bolts.
   b. Provide beveled washers at connections of sloped/tapered sections.
2. High-strength bolts with load indicating devices, ASTM F959, Type 325.
   a. Provide at Contractor's option and subject to approval of Engineer.
3. Alternate high-strength design:
   a. Provide at Contractor's option and subject to approval of Engineer.

F. Bolts and Nuts, Unfinished: ASTM A307, Grade C.

G. Washers, Plain (Unfinished Bolts): ASME B18.22.1, Type B.

H. Welding Electrodes (AWS):
1. Shielded metal arc: AWS A5.1 or AWS A5.5, E70XX or E801X-X.
2. Submerged arc: AWS A5.17 or AWS A5.23, F7XX-EXXX or F8XX-EXXX-XX.
3. Gas metal arc: AWS A5.18, E70S-X or E70U-1 or AWS A5.28, ER805-XX, E80C-XXX.
4. Flux cored arc: AWS A5.20, E7XT-X (except 2, 3, 10, GS), AWS A5.29, E7XT-X or E8XTX-X, E8XTX-XM.

I. Anchor Rods and Bolts:
1. See Section 03151.

J. Headed Studs and Deformed Bar Anchors:
   1. Studs: ASTM A108, complying with AWS Code Section 7, Type B; minimum yield strength 50,000 psi, minimum tensile strength 60,000 psi.
      a. Uniform diameter.
      b. Heads: Concentric and normal to shaft.
      c. Weld end: Chamfered and solid flux.
   2. Deformed anchor bars:
      a. ASTM A496, complying with AWS Code Section 7 Type C.
      b. Minimum yield strength: 70,000 psi.
      c. Minimum tensile strength: 80,000 psi.
      d. Straight, unless indicated otherwise.
      e. Solid flux.
   3. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.

K. Non-shrink Grout: See Section 03308.

L. Crane Rails:
   1. Controlled-cooled, open-hearth carbon steel ASCE rails per ASTM A2, Class A, #1 rails, unless noted otherwise, of size and weight indicated.
   2. Furnish rails with milled tight end joints suitable for crane service, with standard drilling, removable end stops and all related accessories required, including:
      a. Joint bars: Match rail section and properties, drilled to match rail drilling.
      b. Joint bar bolts and nuts: High strength.
      c. Hardened washer: ASTM F436 for bar bolts.
      d. Except as indicated otherwise, two-bolt type fixed or floating rail clamps to suit the conditions, of forged or pressed steel, complete with ASTM A325 bolts, reversible fillers, and self-locking nut or nut and lock washer.

M. Expansion Anchor Bolts and Adhesive Anchor Bolts for Fastening to Concrete:
   1. See Section 03151.

2.3 FABRICATION

A. Comply with requirements of applicable Building Codes and AISC Specification with modifications and additional requirements specified herein.
   1. Identify high-strength steel material in fabricated members in accordance with ASTM A6.

B. Minimize the amount of field welding.
   1. Shop assemble components into largest size possible commensurate with transportation and handling limitations.
   2. Shop connections: Bolted with high-strength bolts or welded.

C. Connection Details:
   1. Connections not fully detailed on Drawings shall be designed by a Professional Engineer registered in the State of California, retained by Contractor, based on requirements of Contract Documents.

D. Provide as a minimum, two (2) 3/4 IN DIA, high-strength bolts for all bolted connections.

E. Provide bearing type connections for all bolted connections, unless specified otherwise or required to be slip-critical by the RCSC Specification for Structural Joints.

F. One-sided or other types of eccentric connections not indicated will not be permitted without prior approval.

G. Field Connections: Provide bolts for all field connections except where shown otherwise on the Drawings.
   1. Use high-strength bolts unless shown or specified otherwise.
   2. Use of high-strength bolts: Conform to RCSC Specification for Structural Joints.
   3. Stainless steel bolts must be used for attaching stair treads to stringers.

4. If structural steel details (field welds versus shop welds, etc.) shown on design Drawings are not compatible with selected erection procedures, submit proposed modifications for review.
5. Connections to structural steel provided by others: Provide all connectors and coordinate location of bolt holes to match connection holes in steel provided by others.

H. Accurately mill column end bearing surfaces to true plane.

I. Fabricate and erect beams with non-specified camber in accordance with AISC Specification Chapter L1.

J. Cut, drill, or punch holes at right angles to surface of metal.
   1. Do not make or enlarge holes by burning.
   2. Make holes clean cut, without torn or ragged edges.
   3. Remove outside burrs resulting from drilling or reaming operations with tool making 1/16 IN bevel.
   4. Provide holes in members to permit connection of work of other trades or contractors.

K. Make allowance for draw in all cross bracing to provide small amount of initial tension in members.

L. Make splices only where indicated or where approved.

M. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

N. Flame cut bevels for welds, provided such cutting is done automatically.
   1. Leave free of burrs and slag by grinding or planing the cut edges.

O. Grind smooth all rough welds and sharp steel edges shall be ground to approximately 1/8 IN radius.

P. Tolerances (unless noted otherwise on Drawings):
   1. ASTM A6: When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating, and mechanical straightening, subject to the limitations of the AISC Specification.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32 IN.
         2) Framed members 30 FT or less: 1/16 IN. Over 30 FT: 1/8 IN.
      b. Member straightness:
         1) Compression members: 1/1000 of axial length between points laterally supported.
         2) Non-compression members: ASTM A6 tolerance for wide flange shapes.
      c. Specified member camber (except compression members):
         1) 50 FT or less: +1/2 IN.
         2) Over 50 FT: +1/2 IN (plus 1/8 IN per 10 FT over 50 FT).
         3) Members received from mill with 75 percent of specified camber require no further cambering.
         4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
         5) Camber shall be measured in fabrication shop in unstressed condition.
      d. At bolted splices, depth deviation shall be taken up by filler plates.
         1) At welded joints, adjust weld profile to conform to variation in depth.
         2) Slope weld surface per AWS requirements.
      e. Finished members shall be free from twists, bends and open joints.
         1) Sharp kinks, bends and deviation from the above tolerances are cause for rejection of material.

2.4 WELDING

A. Comply with AWS Code, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
   1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.

B. Test and qualify welders, welding operators and tackers in compliance with AWS Code for position and type of welding to which they will be assigned.
   1. Conduct tests in presence of approved testing agency.
   2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.

C. Before Starting Welding:
   1. Carefully plumb and align members in compliance with specified requirements.
   2. Fully tighten bolts.
   3. Comply with Section 5 of AWS Code for assembly and surface preparation.
   4. Preheat base metal to temperature stated in AWS Code.
      a. When no preheat temperature is given in AWS Code and base metal is below 50 DegF, preheat base metal to at least 70 DegF.
      b. Maintain temperature during welding.
      c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 IN, whichever is greater, to specified preheat temperature.
      d. Maintain this temperature during welding.
   5. Each welder shall use identifying mark at welds.

D. Make flange welds before making web welds.

E. Where groove welds have back-up plates, make first three (3) passes with 1/8 IN round electrodes.
   1. Use backup plates in accordance with AWS Code, extending minimum of 1 IN either side of joint.

F. Flame cut edges of stiffener plates at shop or field butt weld.
   1. Do not shear.

G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.

H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS Code.

I. Do not perform welding when ambient temperature is lower than 0 DegF or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

J. Headed Studs and Deformed Bar Anchors:
   1. Automatically end welded in accordance with the AWS Code and manufacturer's recommendations.
   2. Fillet welding of headed studs and deformed bar anchors is not allowed unless approved by Engineer.

K. Test in-place studs in accordance with requirements of AWS Code to ensure satisfactory welding of studs to members.
   1. Replace studs failing this test.

L. When headed stud-type shear connectors are to be applied, clean top surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding.
   1. Do not shop paint or galvanize metal surfaces to receive field applied studs.

2.5 SHOP COATING

A. Refer to Section 09905 and coordinate shop primer, surface preparation and coating with field applied primers and coatings where specified.

B. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.

C. Do not coat following surfaces:
   1. Machined surfaces, surfaces adjacent to field welds, and surfaces fully embedded in concrete.
   2. All other members for which no coating is specified.
   3. Contact surfaces at bolted slip-critical connections, unless surface condition conforms to the RCSC Specification for Structural Joints, Part 3b.

D. Clean thoroughly all surfaces not coated before shipping.
   1. Remove loose mill scale, rust, dirt, oil and grease.
   2. Protect machined surfaces.

2.6 SOURCE QUALITY CONTROL

A. OWNER pays for inspection and testing:

B. Responsibilities of Testing Agency:
   1. Inspect shop and field welding in accordance with Section 6 of AWS Code including the following non-destructive testing:
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
      c. Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints, Section 9.
      a. Verify proper pretension for slip-critical bolted connection.
      b. Verify direct tension indicator gaps.
   3. Inspect structural steel which has been erected.
   4. Inspect stud welding in accordance with AWS Code Section 7.8.
   5. Prepare and submit inspection and test reports to Engineer.
      a. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor is solely responsible for safety.
   1. Construction means and methods and sequencing of work is the prerogative of the Contractor.
      a. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, bracing or rigid connections are installed.
   2. Partially complete structural members shall not be loaded without an investigation by the Contractor.
   3. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment is the responsibility of the Contractor.

1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
3. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
    a. If not obvious from experience or from the Drawings, the Contractor shall confer with the Engineer to identify those structural steel element that must be complete before the temporary bracing system is removed.
4. Remove and dispose of all temporary work and facilities off-site.

C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
    1. Report defects in work-in-place which may influence satisfactory completion of the work.
    2. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement:
    1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
    2. Contractor responsible for the accurate fit of the work.

E. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
    1. Notify Engineer of any errors or deviations found by such checking.

3.2 ERECTION

A. Framing member location tolerances after erection shall not exceed the frame tolerances listed in Article 3.3.

B. Erect plumb and level; introduce temporary bracing required to support erection loads.

C. Use light drifting necessary to draw holes together.
    1. Drifting to match unfair holes is not allowed.

D. Welding:
    1. Conform to AWS D1.1 and requirements of this Specification.
    2. When joining two (2) sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

E. Shore existing members when unbolting of common connections is required.
    1. Use new bolts for re-bolting connections.

F. Clean stored material of all foreign matter accumulated during erection period.

G. Clean bearing and contact surfaces before assembly.

H. Set beam and column base and bearing plates accurately, as indicated, on non-shrink grout.
    1. Set and anchor each base plate to proper line and elevation.
    2. Use metal wedges, shims or setting nuts as required and tighten anchor bolts.
        a. Use same metal as base plate.
        b. Cut off protrusions of wedges and shims flush with edge of base plate.
    3. Fill sleeves around anchor bolts with non-shrink grout.
    4. Pack grout solidly between bottom of plate and bearing surface.
    5. Refer to Section 03308 for non-shrink grout requirements.

I. Anchor Bolt Installation:
    1. See Section 03151.

J. Install high strength bolts with hardened washers.
   1. Install and tighten in accordance with the RCSC Specification for Structural Joints, Section 8.
   2. Coordinate installation with inspection.
      a. Do not start installation until coordination with Testing Agency is complete.
   3. Bearing-type connections: High-strength bolts shall be tightened to snug-tight condition.
   4. Slip-critical connections: Perform calibration testing for all methods of installation of high-strength bolts in accordance with the RCSC Specification for Structural Joints, Section 8(b).
      a. Turn-of-nut tightening: Torque wrenches shall be used only by laboratory personnel.
      b. Calibrated wrench tightening: Calibrate on a daily basis.
      c. Direct tension indicator tightening: If previously approved by Engineer.
      d. Installation of alternate design bolts: If previously approved by Engineer.
   5. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.

K. Do not use gas cutting to correct fabrication errors.
   1. In case members do not fit or holes do not match, ream out the holes and insert the next larger size bolt.
      a. If the connections require new holes, then drill new holes.
      b. Make no such corrections without prior approval of the Engineer.
   2. Burning of holes: Not permitted.

L. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.

M. Tighten and leave in place erection bolts used in welded construction.

N. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.

O. After bolts are tightened, upset threads of A307 unfinished bolts and anchor bolts to prevent nuts from backing off.

P. After erection, grind smooth all sharp surface irregularities resulting from field cutting or welding; power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

Q. Expansion anchor bolts and adhesive anchor bolts:
   1. See Section 03151.

3.3 FIELD QUALITY CONTROL

A. Testing Agency responsibilities are described in Article 2.6.

B. Erected Frame Tolerance (Unless noted otherwise on the Drawings):
   1. Overall finished dimensions shall not exceed cumulative effect of rolling, fabrication and erection tolerance.
   2. Erection tolerances are defined relative to member working points and working lines as follows:
      a. Actual centerline of top flange or surface at each end for horizontal members.
      b. Actual center of member at each end for all other members.
      c. Other points may be used, providing they are based on these definitions.
      d. Working line is straight line connecting member working points.
   3. Tolerances on position and alignment are as specified in the Code, unless otherwise modified. "Adjustable items" such as lintels, wall supports, curb angles, window mullions and similar members shall be provided with adjustable connections to supporting structural frame.
   4. Steel erector shall certify the location of erected structural steel is acceptable for plumbness, level and aligned within tolerances specified.
      a. Such certification can be provided upon completion of any part of work and shall be done prior to start of work by other trades that may be supported, attached or applied to structural steel work.

3.4 CLEANING AND REPAIR OF SHOP PRIMER PAINT

A. After erection, clean all steel of mud or other foreign materials, and repair any damage.
   1. Touch-up coatings to comply with Section 09905.

END OF SECTION

SECTION 05131
STRUCTURAL ALUMINUM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Structural aluminum including the fabrication and erection of framing and bracing members, including connection design as required.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 05505 - Metal Fabrications.
   4. Section 05522 - Aluminum Railings.
   5. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ADM 1, The Aluminum Design Manual.
      b. DAF 45, Designation System for Aluminum Finishes.
   2. American Institute of Steel Construction (AISC):
      a. 325, Manual of Steel Construction.
   3. ASTM International (ASTM):
      a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      b. B210, Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
      c. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      d. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
      e. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
      f. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
      g. F467, Standard Specification for Nonferrous Nuts for General Use.
      h. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
      i. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
      j. F594, Standard Specification for Stainless Steel Nuts
   4. American Welding Society (AWS):
      a. D1.2, Structural Welding Code - Aluminum.
   5. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
   1. For welding aluminum:
      a. Qualify welding procedures and welding operators in accordance with AWS D1.2.
      b. Welding operators to have been qualified during the 12-month period prior to commencement of welding.

2. Connections and members not detailed on the Drawings shall be designed by a registered professional Structural Engineer in the state where the Project is located.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings:
      a. Erection plans and details of each piece including connection details:
         1) Show all cuts, copes and holes.
         2) Indicate all shop and field welds using AWS symbols.
         3) Indicate all shop and field bolts.
         4) Reviewed and sealed by Professional Engineer retained by Contractor to verify conformance with design criteria stipulated in the Contract Documents.
      b. Complete shop drawings for all of the work showing clearly all pieces, details, connections, materials and shop-applied coatings.
      c. Prepare complete erection drawings showing the location and marks of all pieces.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   4. Certifications.
      a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
      b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
   5. Test reports.
      a. Certified copies of mill tests.
      b. Manufacturer's load test and temperature sensitivity data for expansion anchor bolt and adhesive anchor bolts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Expansion anchor bolts: See Specification Section 03151.
   2. Adhesive anchor bolts: See Specification Section 03151.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Alloy 6061-T6, 32,000 psi tensile yield strength minimum.
   1. ASTM B209 for sheets and plates.
   2. ASTM B210 for tubes.
   3. ASTM B221 and ASTM B308 for shapes: Beams, channels, and angles.
   4. ASTM B247 for forgings.

B. Alloy 6063-T5 or T6, 15,000 psi tensile yield strength minimum.
   1. ASTM B221 and ASTM B429 for bars, rods, wires, and pipes.

C. Nonferrous Bolts and Nuts: ASTM F467 and ASTM F468 of alloy 2024-T4 (60,000 psi tensile strength minimum).

D. Stainless Steel Bolts and Nuts : ASTM F593 and ASTM F594, Type 316 with a minimum yield strength of 30,000 psi and a minimum tensile strength of 75,000 psi.

E. Washers: Same material and alloy as found in bolts and nuts with which the washers are to be used.

F. Electrodes for Welding Aluminum: AWS D1.2 filler alloy 5356.

G. Expansion and Adhesive Anchor Bolts for Fastening to Concrete:
   1. Where approved by Engineer.
   2. Stainless steel, Type 316.
   3. See Specification Section 03151.

2.3 DESIGN

A. All design shall consider effect of welds on material properties.
   1. Minimize or eliminate the use of field welding.
   2. Observe locations of any specified shop splice welds.

B. Where final design of connections for any portion of structure is not indicated, perform final design of such connections in accordance with the Building Code.

C. Final designs of connections shall conform to AA ADM 1 and to details and requirements stated in the Contract Documents.
   1. Design loads for connections to be designed by the Contractor shall be as shown on the Drawings.
   2. Where design loads are not specified, connections shall be detailed to develop the full capacity of the member.

2.4 FABRICATION

A. Fabrication of bolted and welded connections of aluminum work shall be in accordance with AA ADM 1.

B. Contractor to be solely responsible for correctness of all shop and field fabrication and fit. Verify field conditions and dimensions prior to fabrication.

C. Fabricate aluminum work and assemble in shop to greatest extent possible.
   1. Make splices only where indicated or approved by Engineer.

D. Provide connections as indicated.
   1. Where not indicated, design and provide connections in accordance with requirements of this Specification Section.
   2. One-sided or other types of eccentric connections are not acceptable unless indicated on Contract Drawings or approved on Shop Drawings.

E. Drill or punch holes at right angles to surface of metal.
   1. Do not make or enlarge holes by burning.
   2. Provide holes clean and free of torn or ragged edges.
   3. Use tools which will make a 1/16 IN bevel to remove outside burrs resulting from drilling or punching operations.
   4. Punch or drill for field connections and for attachment of work by other trades.

F. Cope at 45 degrees corners of stiffener plates at junction of member flanges with webs.

G. Welding:
   1. Weld connections to members in shop and bolt connections in field.
   2. Perform welding using electrodes of filler alloy 5356.
   3. Perform welding in accordance with AWS D1.2.
   4. Use only welding procedures and welding operators qualified in accordance with requirements of Paragraph 1.2B. Qualifications.

H. All full penetration welds shall be non-destructively tested by liquid penetrant or ultrasonic methods per AWS standards.

I. Form to shapes indicated with straight lines, true angles and smooth curves.

1. Grind smooth all rough welds and sharp edges.
2. Round all corners to approximately 1/8 IN radius.

J. Finish: Mill finish as fabricated.
1. Architectural Class 1 coating per AA DAF 45:
a. Clear anodized AA-M12C22A413.

PART 3 - EXECUTION

3.1 ERECTION

A. Contractor is solely responsible for safety.
1. Construction means and methods and sequencing of work is prerogative of the Contractor.
2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until decks and diagonal bracing or rigid moment-type connections are installed.
3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
4. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished and installed by the Contractor.

B. Bolting:
1. Protect bolt threads from damage.
2. Rest bolt heads and nuts squarely against surfaces.
3. Where bolt heads or nuts rest on beveled surfaces having slope greater that 1 in 20 with plane normal to bolt axis, use beveled washers to provide full bearing to head and nut.
4. Correct poor matching of holes by drilling to next larger size and use larger diameter bolt
5. Unless otherwise specified, connect aluminum members to:
a. Aluminum members using 3/4 IN DIA nonferrous bolts of alloy 2024-T4 or stainless steel bolts (ASTM F593 and ASTM F594).
b. Carbon and low alloy steel using 3/4 IN DIA stainless steel bolts (ASTM F593 and ASTM F594).
c. Concrete or masonry using stainless steel expansion anchor bolts or adhesive anchor bolts unless shown otherwise.
1) Provide dissimilar materials protection.

C. Welding: Field welding of aluminum is not allowed unless indicated on Drawings.

D. Correct fabrication errors and damaged members in shop.
1. Do not use cutting torch in shop or in field to cut any members, to correct fabrication errors, or to cut openings.

E. Provide templates for anchors, bolts, and other items to be installed in other work.

F. Field Assembly:
1. Tolerances shall comply with AISC 325.
a. Before members are assembled, thoroughly clean all bearing surfaces and surfaces that will be in permanent contact.
b. After assembly, carefully align all members of each frame or assembly and accurately adjust until final, correct and true location is achieved.
1) As work progresses, securely fasten in place.
2. Provide full length members without splices.
3. Securely tighten and leave in place all erection bolts used in welded construction, unless removal is required.

G. Set beam and column baseplates accurately, as indicated on non-shrink grout, in accordance with Division 3.
1. If not indicated, provide minimum of 1 IN grout thickness under base plates.

2. Set and anchor each base plate to proper line and elevation.
   a. Use aluminum wedges, shims, or setting nuts for leveling and plumbing columns and beams.
      1) Tighten anchor bolts.
   b. Fill space between bearing surface and bottom of base plate with nonshrink grout.
      1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
   c. Do not remove wedges or shims and where they protrude, cut off flush with edge of base plate.

H. Temporary Protection:
   1. Suitably protect aluminum surfaces against lime mortar stains, discoloration, surface abrasion and other construction abuses.
   2. Remove protection during Predemonstration Period.

I. Contact with Dissimilar Materials: Where aluminum surfaces will be embedded in concrete, built into masonry, or in contact with steel, concrete, grout, masonry, or other dissimilar materials, coat the aluminum surfaces as described in Specification Section 09905.

END OF SECTION

SECTION 05211
STEEL JOISTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manufactured open-web steel joists, joist girders and joist accessories.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 05120 - Structural Steel.
   4. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC):
      a. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      d. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
   3. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
   4. Corps of Engineers (COE):
      a. CRD-C621, Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Nonshrink).
   5. Steel Joist Institute (SJI):
      a. Recommended Code of Standard Practice for Steel Joists and Joist Girders.
      b. Standard Specification for Open Web Steel Joists, K-Series (ANSI SJI-K-1.1).
      c. Standard Specification for Longspan Steel Joists LH-Series and Deep Longspan Steel Joists DLH-Series (ANSI SJI-LH-DLH-1.1).
      d. Standard Specification for Joist Girders (ANSI SJI-JG-1.1).
      e. Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders:
         1) Standard Load Table Open Web Steel Joists, K-Series.
         2) Standard Load Table Longspan Steel Joists, LH-Series.
         3) Standard Load Table Deep Longspan Steel Joists, DLH-Series.

B. Qualifications:
   1. Manufacturer: Member of SJI.
      a. Structural design calculations and details of manufactured joists shall be prepared by a qualified professional engineer retained by the manufacturer.
   2. Qualification of welding work:
      a. Qualify welding processes, operations, and operators in accordance with requirements of AWS D1.1.

b. Welding operators to have been qualified during the 12-month period prior to commencement of welding.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Fabrication and/or layout drawings:
   a. Detailed Shop Drawings showing size and layout of each joist unit, bridging, connections, and accessories. Include mark, number, type, location, and spacing of joists and bridging.
   b. Show joining splice and connection to other work details.
   c. Provide templates or location drawings for installation of anchor bolts.
   d. Provide details of bridging, method of attachment to joists, and joist end anchorage and other details required for joist installation. Indicate beveled end plates for joist roof pitch where required.
   e. Show shop-applied coatings.
   f. Shop Drawings shall not be reproductions of the Contract Drawings.
3. Product technical data including:
   a. Joist manufacturer's load tables, Standard Specifications and installation instructions for each type of joist and its accessories. Include product data describing materials, shop coating, bridging, and accessories.
4. Certifications:
   a. Manufacturer's certification that steel joists and accessories comply with specified requirements.
   b. Manufacturer member of SJI.
   c. Joist material, shop welding and testing, manufacturing and shop inspection and testing are in accordance with SJI requirements.
   d. Capability of joists per Paragraph 2.3A and D.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle steel joists as recommended by SJI.
1. Exercise care to avoid damage to joists.

B. Store joists clear of earth on platforms, skids or other supports.
1. Protect joists after delivery to prevent rust and deterioration.

C. Provide anchor bolts and other items to be embedded in concrete or masonry, with templates as required, in time for incorporation into the work.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Nucor Corporation Vulcraft Divisions.
2. CANAM Steel Corporation.
3. Socar Incorporated.

2.2 MATERIALS

A. Steel: Comply with SJI and AISC Specifications for joist series indicated.

B. High-Strength Bolts, Nuts and Washers: ASTM A325 or ASTM A490 as required, heavy hexagon structural bolts with nuts and hardened washers.

C. Bolts and Nuts, Unfinished: ASTM A307, Grade A, regular hexagon type, low carbon steel, with carbon steel washers.

2.3 STEEL JOISTS

A. Design of steel joists to be supplied to have been checked by the SJI and found to conform to the standard specifications and load tables.

B. Fabricate Joists and Accessories in accordance with SJI Specifications and as follows:
   1. Make shop connections and splices using either arc or resistance welding.
      a. Do not shop bolt connections.
   2. Design and fabricate for maximum deflection of 1/360 of clear span under design live load.
   3. Shop holes, field holes, and enlargement of holes will not be permitted unless approved by Engineer.
   4. Fabricate bearing ends to provide following minimum bearing unless a longer bearing length is indicated on the Contract Documents.

	K SERIES	LH AND DLH SERIES	JOIST GIRDERS
On masonry or concrete:	4 IN min	6 IN min	6 IN min

   5. With steel angle tops and bottom short members

C. Special or Concentrated Loads:
   1. Where special or concentrated loads are indicated, reinforce joist and develop details as necessary for support of such loads.
   2. Submit written certification that the joist(s) for special loads indicated on Drawings have been designed, fabricated, and are capable of supporting the indicated design loadings for the span(s) shown on the Drawings.
      a. Written certification to be signed and sealed by a registered professional Structural Engineer.
      b. Submit certification along with the Shop Drawings for the joist(s).

D. Provide extended bottom chords where indicated.
   1. Comply with SJI and AISC requirements and load tables.

E. Provide extended top chords where indicated.
   1. Comply with SJI and AISC requirements and load tables.

F. Provide ceiling extensions in areas having ceilings attached directly to joist bottom chord.
   1. Provide either an extended bottom chord or a separate unit of sufficient strength to support ceiling construction.
   2. Extend ends to within 1/2 IN of wall surface.

G. Prepare and paint steel joists and accessories in compliance with Section 09905.

H. Comply with SJI Specifications:
   1. Joist designations indicated on the Drawing are minimum requirements; increase as required to comply with design requirements specified.
   2. Wherever possible increased joists shall have the same depth as joist indicated on Drawings.
   3. Where necessary to increase joist depths to meet design requirements, coordinate all project changes required due to the increased depth.
   4. Make all required joist revisions at no additional cost to Owner.

2.4 SOURCE QUALITY CONTROL

A. Engineer reserves right to inspect joists or manufacturer's shop during joist fabrication.

B. Identify each joist type, size and manufacturer.
   1. Provide tagging or other suitable (permanent) means.

2. Maintain identification continuously.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which steel joists are to be installed for conditions detrimental to proper and timely completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Do not start placement of steel joists until supporting work is in place and secured.

D. Joists will be subject to rejection if:
   1. Joists do not comply with requirements of SJI and AISC Specifications and requirements herein.
   2. Joists are improperly manufactured, welded, painted or installed.
   3. Joists are damaged so that strength is impaired.
   4. Joists are not installed as indicated on Drawings.
   5. Chords are not installed straight within a tolerance of plus or minus 0.0028 times the length of the joist or the distance between points of lateral support.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
   1. Where not specifically indicated otherwise, place and secure steel joists in accordance with SJI and AISC Specifications and as herein specified.

B. Splice joists delivered to the site in more than one piece.

C. Do not overload joists.
   1. Note: Joists may not be stable or able to carry design loads until bridging and deck is fully installed.
   2. Contractor is solely responsible for safety, construction methods and sequencing of the Work.
   3. Do not install joists damaged so that strength is impaired.

D. Place joists on supporting work, adjust and align in accurate location and spacing before permanently fastening.
   1. Provide end bearing and anchorages to secure all joists to supporting members or walls in accordance with SJI Specifications, unless otherwise indicated.
   2. When joists do not bear flush on supporting member or wall, take corrective measures to ensure full bearing.
      a. Provide steel shims as required for uniform flush bearing.

E. Field weld joists to supporting steel framework in accordance with SJI, AISC and AWS Specifications for type of joists used.
   1. Coordinate welding sequence and procedure with placing of joists.

F. Bearing on Masonry or Concrete Bearing Surfaces:
   1. Secure joists resting on masonry or concrete bearing surfaces by bedding in mortar and anchoring to masonry or concrete construction as specified in SJI Specifications for type of steel joist used.
      a. Masonry or concrete required to support joists to have reach required 28-day compressive strength prior to placing joists thereon.
      b. Area under joist bearing shall be solidly filled with grout.
   2. Furnish anchor bolts or steel bearing plates to be built into concrete and masonry construction.
      a. Furnish templates as may be necessary for accurate location of anchors. Steel bearing plates to conform to ASTM A36.

3. Bedding mortar:
   a. Sand cement grout:
      1) Approximately 3 parts sand, 1 part Portland cement, 6 plus/minus 1 percent entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
      2) Minimum 28-day compressive strength: 3000 psi.
   b. Non-shrink grout complying with COE CRD-C621.

G. Provide type, size, spacing, and attachment of bridging in accordance with SJI and AISC Specifications, where not specifically indicated otherwise, except as modified herein.
   1. Provide diagonal type bridging as indicated.
   2. Do not use sag rods as substitute for bridging.

H. Install bridging completely, immediately after erection, and before any loads are applied.
   1. Anchor ends of bridging lines at top and bottom chords of each joist and where terminating at walls or beams.
   2. Provide bridging connections at top and bottom chords capable of safely resisting a force specified by SJI Specifications for open web, long span, deep long span joists, and joist girders respectively.
   3. Where five rows of bridging are required in spans over 40 FT, laterally brace each joist before erecting next joist or applying loads.
   4. Do not release hoisting cables before installing center row of diagonal bridging and anchoring bridging line to prevent lateral movement.
   5. During construction period, Contractor is responsible for any loads placed on joists.
      a. Contractor's attention is directed the fact that joists may be unstable and cannot carry their design load until steel deck and bridging are completely installed.

I. Remove or repair damaged joists or other work, to satisfaction of Engineer at no additional expense to Owner.

J. After installation, touch up paint or field paint as specified in Section 09905.

END OF SECTION

SECTION 05313
METAL DECK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manufactured metal roof deck.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. S100, Specification for the Design of Cold-Formed Steel Structural Members.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      c. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      d. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
      e. A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
      f. D746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
      g. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
   3. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
      b. D1.3, Structural Welding Code - Sheet Steel.
   4. Steel Deck Institute (SDI):
      a. 31, Design Manual for Composite Decks, Form Decks and Roof Decks.
   5. Underwriters Laboratories, Inc. (UL):
      a. Fire Resistance Directory.

B. Qualifications:
   1. Manufacturer:
      a. Member of SDI.
      b. Structural design of manufactured deck shall be prepared by a qualified professional engineer retained by the manufacturer.
   2. Welding work:
      a. Qualify welding processes, operations, and operators in accordance with requirements of AWS D1.1 and AWS D1.3.
      b. Welding operators to have been qualified during the 12-month period prior to commencement of welding, and be experienced in welding light gage metal.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings:
      a. Detailed Shop Drawings showing the following:
         1) Complete framing and erection layouts.
         2) Location, length, type, cross section, thickness, and markings of metal deck units.
            a) Size and location of openings.
            b) Accessories and reinforcing.
         3) Sequence and procedure to be followed for erecting, fastening, and securing the deck units.
         4) Shop applied coatings.
         5) Location of required shoring for form decks.
         6) Details and gages of accessories and miscellaneous items showing sump pans, cant strips, ridge and valley plates, closure strips and insulation supports.
         7) Welding procedures for installation including size, number, type and location of all welds required to install deck units.
         8) Recommended welding rod size, type, burn off rate and welder setting for deck thickness to be joined.
            a) Define welds by use of standard AWS welding symbols.
         9) Correct fitting of members and accessories.
         10) Size and location of all openings in deck and all conditions requiring closure panels and supplementary framing.
         11) Shop Drawings shall not be reproductions of the Contract Drawings.
   3. Product technical data including:
      a. Metal deck manufacturer's specifications and installation instructions.
      b. Manufacturer's specifications and installation instructions for:
         1) Welds and welding procedure.
         2) Galvanizing repair paint.
         3) Screws.
         4) Joint sealing compound.
      c. Manufacturer's load tables for deck to be furnished on this project, including:
         1) Allowable gravity load for metal roof deck.
         2) Allowable diaphragm shear values for metal roof deck.
         3) Allowable superimposed load for metal deck.
         4) Allowable unshored span lengths for form deck.
   4. Manufacturers certification that metal deck complies with specified requirements:
      a. Manufacturer member of SDI.
      b. Deck material, manufacturing, and shop testing and inspection are in accordance with SDI requirements.
      c. Welders.
   5. Test reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle metal deck as recommended by SDI.
   1. Exercise care to avoid damage to deck.

B. Protect materials from rusting, denting or crushing.
   1. Store metal deck on project site off the ground with one end elevated to provide drainage and protected from the elements with a waterproof covering, ventilated to avoid condensation.
   2. Prevent rust, deterioration and accumulation of foreign material.

1.5 PROJECT CONDITIONS

A. Do not overload supporting members.
   1. Until the entire assembly is complete, the structural elements may not be stable or capable of supporting code or stated design loads.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. 1-1/2 IN deep metal roof deck:
      a. Vulcraft.
      b. United Steel Deck, Inc.
      c. Consolidated Systems, Inc., Metal Dek Group.
      d. New Millennium Building Systems.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 METAL ROOF DECK

A. Design of the metal deck to be supplied to have been checked by the SDI and found to conform to the standard specifications and load tables.
   1. The allowable superimposed live uniform loading per square foot for metal roof deck supplied for the spans indicated shall equal or exceed the allowable superimposed live uniform load per square foot for the same spans as indicated in the SDI latest tables.
   2. Maximum deflection: Less than 1/240 of span under live load.

B. Use deck configurations complying with SDI 31and as indicated.
   1. Galvanized deck: ASTM A653 with ASTM A924 G90 zinc coating.

C. Metal Roof Deck, 1-1/2 IN Deep:
   1. Wide rib type, sheet steel, 18 GA, minimum, with minimum uncoated thickness of 0.0474 IN, galvanized.
   2. Wide rib deck: ribs spaced approximately 6 IN OC; width of rib opening at top surface maximum 2-1/2 IN; width of bottom rib surface minimum 1-3/4 IN.

2.3 FABRICATION

A. Standard Deck Profiles:

DEPTH	TYPE	RIB SPACING	TOP SURFACE MAXIMUM RIB OPENING	MINIMUM BOTTOM OF RIB WIDTH
1 1/2 IN	Roof Deck ('N')	6 IN	2-1/2 IN	1-3/4 IN

B. Minimum Deck Thickness:
   1. Where gage of metal is indicated, provide the following:
      a. Minimum uncoated decimal thickness:

GAGE	DESIGN THICKNESS
18	0.0474 IN

      b. The delivered thickness of the uncoated steel shall not be less than 95 percent of the design thickness.

2. The steel used shall have a minimum yield stress of 33 ksi.

C. Fabrication:
1. Fabricate deck units in lengths to span three or more support spacings with flush, telescoped or nested 2 IN end laps.
   a. End laps shall occur on supporting members.
   b. Provide deck units having interlocking male and female type side laps or joints to provide positive vertical and lateral alignment of adjacent deck units.

2.4 ACCESSORIES

A. Metal Closure Strips:
1. Form to configuration required to provide tight-fitting closures at open ends and sides of deck.
2. Minimum thickness before galvanizing: 0.0358 IN (20 GA).

B. Ridge and Valley Plates:
1. Minimum width: 4-1/2 IN.
2. Bend to provide tight-fitting closure with deck units.
3. Provide plates in 10 FT length where possible.
4. Minimum thickness before galvanizing: 0.0747 IN (14 GA).

C. Roof Sump Pans:
1. Fabricate from a single piece of galvanized sheet steel with level bottoms and sloping sides to direct water flow to drain.
2. Provide sump pans of adequate size to receive roof drains with bearing flanges minimum 3 IN wide.
3. Recess pans not less than 1-1/2 IN below roof deck surface, unless otherwise indicated or required by deck configuration.
4. Minimum thickness before galvanizing: 0.0747 IN (14 GA).

D. Cant Strips:
1. Bend cant strips to form 45 degree slope not less than 5 IN wide, with top and bottom flanges not less than 3 IN wide.
2. Minimum thickness before galvanizing: 0.0358 IN (20 GA).

E. Insulation supports.

F. Venting: Slotted openings in bottom flutes in accordance with manufacturer's standards.

G. Metal Closures and Pour Stops: Form to configuration required to provide mortar-tight closures at open sides and ends of deck.

H. Primer Paint Required for Metal Deck: Deck manufacturer's baked on, rust-inhibitive paint applied to chemically cleaned and phosphate chemically treated metal surfaces.

I. Galvanized coating for metal deck accessories shall conform to ASTM A924 G90 zinc coating.

J. Galvanized Repair Paint: Comply with Specification Section 09905 and ASTM A780 for repair of damaged galvanized surfaces.

K. Screws:
1. Self-drilling, self-tapping, #12 size minimum hex washer head sheet metal screws.
2. Carbon steel by Hilti.
   a. Organic zinc chromate coated, Hilti Kwik-cote.

L. Miscellaneous Steel Shapes: Comply with ASTM A36.

M. Sheet Metal Accessories: Same material and finish as deck members.

N. Flexible Closure Strips for Deck:
1. Vulcanized, closed cell expanded chloroprene elastomer, complying with ASTM D1056, Grade SCE 41.

2. Brittleness temperature: -40 DegF, ASTM D746.
3. Flammability resistance: "Self-extinguishing."
4. Install with adhesive in accordance with manufacturer's instructions.
   a. Ensure complete closure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which metal deck is to be installed for conditions detrimental to proper and timely completion of work.

B. Do not proceed with work until unsatisfactory conditions have been corrected.

C. Do not start placement of metal deck until supporting work is in place and secured.

D. Deck will be subject to rejection if:
   1. Metal deck units do not comply with requirements of SDI specifications and requirements herein.
   2. Metal deck is improperly manufactured, painted or installed.
   3. Metal deck is damaged so that strength is impaired.
   4. Metal deck is not installed as indicated on Drawings.

3.2 INSTALLATION

A. Install roof deck units and accessories as indicated, in accordance with SDI 31, manufacturer's recommendations, final approved Shop Drawings and as specified herein.
   1. Furnish manufacturer's standard accessories as needed to complete the deck installation.

B. Locate deck bundles to prevent overloading of structure.

C. Do not overload metal deck or supporting members:
   1. Contractor is solely responsible for safety, construction means, methods and sequencing of the Work.
   2. Until the entire assembly is complete, the structural elements may not be stable or capable of supporting code or stated design loads.
   3. Use care to assure deck construction loads are less than the recommendation of the SDI 31, except where temporary shoring is installed.

D. Place each deck unit on supporting structural frame, adjust to final position, accurately align with ends bearing on supporting members.
   1. Lap roof deck units at ends no less than 2 IN.
   2. Interlock units at sides without stretching, contracting, or deforming.
   3. Place deck units flat and square and secure to framing without warp or excessive deflection.
   4. Place units in accurate and close alignment for entire length of run and with close registration of flutes of one unit with those of abutting unit.

E. Plug weld sizes specified are effective fusion diameter of welds.
   1. Weld metal shall penetrate all layers of deck material and have good fusion to supporting members, which shall be 1/4 IN thick minimum.
   2. Do not burn through deck.

F. Prevent overtorquing of screw fasteners by using a tool with a depth limiting nosepiece and a clutch.

G. Fastening of 1-1/2 IN Deep Metal Roof Deck:
   1. Unless a more stringent requirements are specifically called out on drawings, secure deck units to supporting frame and side laps as follows:
      a. Fasten edge ribs of panels at all supports.
      b. At all interior supports and at ends of deck use:

1) For 24 IN wide deck: Three (3) 5/8 IN round plug welds per deck unit.
2) For 30 and 36 IN wide deck: Four (4) 5/8 IN round plug welds per deck unit.

c. At perimeter supports, use:
1) 5/8 IN round plug welds at 12 IN OC.

d. At side laps, use 5/8 IN round puddle weld or 3/8 x 1-1/2 IN arc seam weld at 18 IN OC.

H. Remove and replace deck which is structurally weak or unsound or which has burn holes due to improper welding or damage which Engineer declares defective.

I. Cut and fit deck units and accessories around other work projecting through or adjacent to decking.
1. Make cutting and fitting neat, square and trim.
a. Cut deck by mechanical means, not by burning.
2. Neatly and accurately install reinforcing at all openings except:
a. Circular openings less than 6 IN DIA.
b. Rectangular openings having no side dimension greater than 6 IN.
3. Reinforce openings that have not been framed between 6 and 12 IN with 20 GA flat steel sheet 12 IN greater in each dimension than opening.
a. Place sheet around opening and fusion weld to top surface of deck at each corner and midway along each side.

J. Install insulation supports for support of roof insulation.
1. Provide where top surface of roof deck does not occur adjacent to edge and openings as required to completely support roof insulation.
2. Weld into position.

K. Install metal closure strips at all open uncovered ends and edges of roof deck, and in voids between deck and other construction.
1. Weld into position to provide a complete decking installation.
2. Provide flexible closure strips instead of metal closures, at Contractor's option and when approved by Engineer wherever their use will ensure complete closure.
a. Install with elastomeric type adhesive in accordance with written directions and recommendations of manufacturers of closure strips and adhesives.

L. Ridge and Valley Plates:
1. Weld ridge and valley plates to top surface of roof deck.
2. Lap end joints not less than 3 IN with laps in direction of water flow.

M. Roof Sump Pans:
1. Place over openings in roof deck.
2. Weld to top deck surface.
a. Space welds maximum 12 IN OC with at least one weld at each corner and each side midway between each corner.
3. Cut opening in bottom of roof sump to accommodate drain size indicated.

N. Cant Strips:
1. Weld cant strips to top surface of roof deck at 12 IN OC.
2. Lap end joints not less than 3 IN.

O. Install metal closures to close all openings and gaps between form deck and other construction, at objects projecting through deck, at locations where deck changes direction, and at open ends of deck units where deck units terminate.
1. Weld into position to provide a complete installation.

P. Clean and Touch Up:
1. Remove all surplus materials and debris from surface of deck after installation.
2. Repair damaged galvanized surfaces in accordance with Specification Section 09905.

3.3 FIELD QUALITY CONTROL

A. Remove and replace defective or damaged deck units.

B. Testing:
   1. The following test shall be made in the presence of the Engineer or Testing Agency employed on the project on the first deck panel to be installed.
   2. Place one (1) end of panel over a perimeter support and attach it only to that support with two (2) welds as specified 6 IN apart.
   3. The opposite end of the panel shall be moved in plane parallel to the span of the panel until shear distress is noted in the weld.
   4. The welds shall be of sufficient quality to cause local distortions in the panel around the welds and show good perimeter contact between the welds and the panel.
   5. When the results of this test are satisfactory and approved by the Engineer or Testing Agency, the remainder of the deck may be installed using the same weld rod size and type, amperage setting, and procedures used in the tested deck.
   6. The remainder of the welds shall be visually inspected.
      a. When in the opinion of the Engineer or Testing Agency any weld is of poor quality, an additional weld shall be provided adjacent to the rejected weld.
      b. It shall be a sufficient distance away from the rejected weld so that the new weld will be done on sound, unburned deck.

END OF SECTION

SECTION 05505
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
   2. Design of all temporary bracing not indicated on Drawings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Division 3 - Concrete.
   4. Section 05120 - Structural Steel.
   5. Section 05131 – Structural Aluminum.
   6. Section 05522 - Aluminum Railings.
   7. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ADM-1, Aluminum Design Manual.
      b. 45, Designation System for Aluminum Finishes.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. Standard Specification for Highway Bridges.
   3. American Institute of Steel Construction (AISC):
      a. Manual of Steel Construction - Allowable Stress Design (ASD).
      b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
   4. American National Standards Institute (ANSI):
      a. A14.3, Ladders - Fixed - Safety Requirements.
   5. ASTM International (ASTM):
      a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      b. A36, Standard Specification for Carbon Structural Steel.
      c. A47, Standard Specification for Ferritic Malleable Iron Castings.
      d. A48, Standard Specification for Gray Iron Castings.
      e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      f. A108, Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
      g. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      h. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      i. A197, Standard Specification for Cupola Malleable Iron.
      j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      k. A276, Standard Specification for Stainless Steel Bars and Shapes.
      l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
o. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
p. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
q. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
r. A536, Standard Specification for Ductile Iron Castings.
s. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
t. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
u. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
v. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
w. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786, Standard Specification for Hot-Rolled Carbon, Low-.Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A992, Standard Specification for Steel for Structural Shapes.
z. B26, Standard Specification for Aluminum-Alloy Sand Castings.
aa. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
bb. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
cc. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
dd. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ee. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
ff. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
gg. F467, Standard Specification for Nonferrous Nuts for General Use.
hh. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
ii. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
jj. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

6. American Welding Society (AWS):
   a. A5.1, Standard Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code Steel.
   c. D1.2, Structural Welding Code Aluminum.
7. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.
   b. MBG 531, Metal Bar Grating Manual.
8. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
9. Building code:
   a. International Code Council (ICC):
      1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS.
   2. Fabricator shall have minimum of 10 years experience in fabrication of metal items specified.
   3. Engineer for contractor-designed systems and components: Professional engineer licensed in the State of California.

1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Hardware: As defined in ASTM A153.

C. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings and details:
      a. Submit drawings for all fabrications and assemblies.
         1) Include erection drawings, plans, sections, details and connection details.
      b. Identify materials of construction, shop coatings and third party accessories.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Provide manufacturer's standard allowable load tables for the following:
         1) Grating and checkered plate.
         2) Expansion anchor bolts.
         3) Adhesive anchor bolts.
         4) Castings, trench covers and accessories.
   4. Contractor designed systems and components, including but not limited to, stairs, landings, ladders, gratings and checkered plates:
      a. Certification that manufactured units meet all design loads specified.
      b. Shop Drawings
         1) Sealed by a Professional Engineer registered in the State of California.
      c. Structural design calculations:
         1) Indicate all required design loads.
         2) Sealed by a Professional Engineer registered in the State of California.
            a) Calculations to be for information only.
            b) Engineer’s review not required.

B. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Certification of welders and welding processes.
      a. Indicate compliance with AWS.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Abrasive stair nosings (embedded in concrete stairs):
      a. American Safety Tread.
      b. Balco.
   2. Headed studs and deformed bar anchors:
      a. Nelson Stud Welding Div., TRW Inc.
      b. Stud Welding Products, Inc.
   3. Expansion anchor bolts:
      a. See Section 03151.
   4. Adhesive anchor bolts:
      a. See Section 03151.
   5. Castings, trench covers and accessories:
      a. Neenah Foundry Co.
      b. Deeter Foundry Co.
      c. Barry Craft Construction Casting Co.
      d. McKinley Iron Works.
   6. Aluminum ladders:
      a. Any manufacturer capable of meeting the requirements of this Specification Section.
   7. Galvanizing repair paint:
      a. ZRC Products.
   8. Ladder safety extension post:
      a. Bilco.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Steel:
   1. Structural:
      a. W-shapes and WT-shapes: ASTM A992, Grade 50.
      b. All other plates and rolled sections: ASTM A36.
   2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
   3. Structural tubing:
      a. ASTM A500, Grade B (46 ksi minimum yield).
   4. Bolts, nuts and washers, high strength:
      a. ASTM A325.
      b. Provide two (2) washers with all bolts.
   5. Bolts and nuts:
      a. ASTM A307, Grade A.
   6. Welding electrodes: AWS D1.1, E70 Series.
   7. Steel forgings: ASTM A668.

B. Iron:
   1. Ductile iron: ASTM A536.
   2. Gray cast iron: ASTM A48 (minimum 30,000 psi tensile strength).
   3. Malleable iron: ASTM A47, ASTM A197.

C. Stainless Steel:
   1. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.
      a. Bars, shapes: ASTM A276, Type 316.
      b. Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 316.
      c. Strip, plate and flat bars: ASTM A666, Type 316, Grade A.
      d. Bolts and nuts: ASTM F593, Type 316.

2. Minimum yield strength of 25,000 psi and minimum tensile strength of 70,000 psi.
    a. Strip, plate and flat bar for welded connections, ASTM A666, Type 316L.
3. Welding electrodes: In accordance with AWS for metal alloy being welded.

D. Aluminum:
1. Alloy 6061-T6, 32,000 psi tensile yield strength minimum.
    a. ASTM B221 and ASTM B308 for shapes including beams, channels, angles, tees and zees.
2. Alloy 6063-T5 or T6, 15,000 psi tensile yield strength minimum.
    a. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.
3. ASTM B26 for castings.
4. ASTM F468, alloy 2024 T4 for bolts.
5. ASTM F467, alloy 2024 T4 for nuts.
6. Electrodes for welding aluminum: AWS D1.2, filler alloy 4043 or 5356.

E. Washers: Same material and alloy as found in accompanying bolts and nuts.

F. Embedded Anchor Bolts:
1. See Section 03151.

G. Expansion Anchor Bolts and Adhesive Anchor Bolts:
1. See Section 03151.

H. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

I. Deformed Bar Anchors: ASTM A496 with a minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

J. Iron and Steel Hardware: Galvanized in accordance with ASTM A153 when required to be galvanized.

K. Galvanizing Repair Paint:
1. High zinc dust content paint for regalvanizing welds and abrasions.
2. Dried film shall contain not less than 93 percent zinc dust by weight.
3. Similar to ZRC by ZRC Products.
4. VOC: 0 LBS per GAL.

L. Dissimilar Materials Protection: See Specification Section 09905.

2.3 MANUFACTURED UNITS

A. Ladders:
1. Material:
    a. Aluminum.
2. Rails:
    a. Maximum 3 x 2 IN heavy-duty rectangular tubing or channel, with minimum thickness of 0.125 IN or 1-1/2 IN nominal diameter schedule 80 pipe.
    b. Spacing: Nominal 18 IN from centerline of rails except at top.
        1) Minimum clear distance between rails to be 16 IN.
    c. Brackets for wall supported units: Provide 3/8 x 2-1/2 IN x length required angle brackets welded to side rails with punched holes for 3/4 IN bolts.
        1) Maximum spacing: 4 FT OC.
    d. For floor supported units provide 3/8 x 2-1/2 x 4 IN rectangular bracket or 3/8 x 6 x 6 IN square plate welded to rails with punched holes for 3/4 IN bolts.
        1) Provide wall brackets on floor supported units if vertical run is over 4 FT.
3. Rungs:
    a. Minimum 1 IN DIA or 1 IN square extruded, with integral serrated non-slip finish on all sides.
    b. Shop or field-applied grit tape and cap type non-slip finish is not acceptable.
4. Minimum distance from centerline of rung to wall or any obstruction: 7 IN.

5. Rung spacing:
    a. Uniform, 12 IN.
    b. Top rung shall be level with landing or platform.
    c. Spacing of bottom rung from grade or platform may vary but shall not exceed 14 IN.
6. As a minimum, design ladder in accordance with OSHA Standards, ANSI A14.3, and applicable Building Codes.
    a. Ladders shall be designed to support a minimum concentrated live load of 200 LBS.
    b. Maximum allowable stresses per AISC Specification and AA Specification.
    c. Maximum lateral deflection: Side rail span/240 when lateral load of 100 LBS is applied at any location.
7. Construction:
    a. Fully welded type.
    b. All welds to be full penetration welds, where applicable.
    c. All ladders of a particular material shall have consistent construction and material shapes and sizes unless detailed otherwise on the Drawings.
    d. Provide cap at top and bottom of side rails.
    e. Rungs shall not extend beyond the outside face of the side rail.
    f. The side rails of through ladder extension shall extend 42 IN above the top rung or landing and shall flare out on each side to provide a clearance of 24 IN centerline to centerline of rails.
8. Finish:
    a. Aluminum: Anodized
        1) Color: AA-M10C22A41 clear.
9. Ladder safety extension post:
    a. Telescoping tubular aluminum section that automatically locks into place when fully extended.
    b. Non-ferrous corrosion-resistant spring and hardware.
    c. Factory assembled with all hardware necessary for mounting ladder.
    d. Bilco “Ladder Up” safety post or equal.

B. Bollards:
1. 8 IN DIA extra strength steel pipe, ASTM A53.
    a. Galvanized.
2. Minimum 48 IN projection above ground.
3. Minimum 48 IN embedment in concrete.
4. Provide and install 24 bollards, above and beyond those shown on the Drawings to be placed as directed by the Construction Manager throughout construction to protect existing and new facilities.

C. Abrasive Stair Nosings:
1. Two (2) component consisting of an embedded subchannel, installed with the concrete pour, and an abrasive tread plate to be installed later.
2. 6063-T5 extruded aluminum, mill finished and heat treated.
3. Complete with concrete anchors and tread plate securing screws.
4. Units: 4 IN less in length than stair width unless noted otherwise and unless required different to avoid guardrails base plates (see below).
5. Tread plate: Extruded aluminum with solid epoxy abrasive filler.
6. Similar to Balco "DXH-330."
7. Color: To be selected by Engineer

D. Metal Stairs:
1. Fabricated as indicated.
2. Treads: Aluminum grating as specified.
    a. Provide integral corrugated non-slip nosing.
3. Risers:
    a. Grating treads: Solid plate attached to trailing edge of tread
4. Landings:

a. Aluminum grating as specified.
b. Provide integral corrugated non-slip nosing at edge acting as stair tread/nosing.

5. Fabricate and design stair, platforms and landings, and all connections to support a 100 PSF uniform live load or a concentrated load of 1000 LBS, whichever requires the stronger component.
6. Design, fabricate, and install in compliance with NAAMM AMP 510 and applicable codes.
7. Handrails and guardrails: Refer to Specification Section 05522.
8. Materials:
   a. Grating at landings and guardrails – Aluminum.
   b. Stair and stair treads – Aluminum.

E. Steel Checkered Plate:
1. Conform to ASTM A786.
   a. Diamond pattern: No. 3 (large) or No. 4 (medium).
   b. Use one (1) pattern throughout Project.
   c. Material: 36 ksi minimum yield strength.
2. Design live load:
   a. 100 psf, uniform load.
   b. 300 LBS concentrated lod on 4 IN square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 50 psf.
3. Reinforce as necessary with steel angles.
4. Plate sections:
   a. Maximum 3 FT wide.
   b. Minimum 1/4 IN thick.
   c. Maximum 100 LBS per section if required to be removable.
5. Provide joints at center of all openings unless shown otherwise.
   a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
6. Unless shown otherwise, frame for opening with steel checkered plate cover:
   a. Steel support angles:
      1) 3 by 2 by 1/4 IN minimum size with long leg vertical.
      2) 5/8 IN DIA adhesive anchor bolts spaced at maximum of 24 IN OC along each side with not less than two (2) anchor bolts per side.
   b. Steel concrete insert seats:
      1) 2 by 2 by 1/4 IN minimum size.
      2) Auto-welded studs or strap anchors, ASTM A108 at 18 IN OC with not less than two (2) studs or anchors per side.
   c. Drill and tap frame to receive 3/8 IN DIA fasteners at not more than 24 IN OC with not less than two (2) fasteners per side.
      1) Fasteners: Flat countersunk cap screws, ASTM F835.
         a) Galvanized, ASTM A153/A153M.
7. Provide galvanized checkered plate and edge supports.

F. Aluminum Checkered Plate:
1. Conform to ASTM B632.
   a. Diamond pattern: Use one (1) pattern throughout Project.
   b. Material: Type 6061-T6.
2. Design Live Load:
   a. 100 PSF, uniform load.
   b. 300 LBS, concentrated load on 4 IN square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under superimposed live load of 50 PSF.
3. Reinforce as necessary with aluminum angles.

a. See Drawings for additional reinforcing angle requirements if reinforcing is required to achieve required design loading.

4. Plate sections:
   a. Maximum 3 FT wide.
   b. Minimum 1/4 IN thick.
   c. Maximum 100 LBS per section if required to be removable.
5. Provide joints at center of all openings unless shown otherwise.
   a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
6. Provide watertight continuous neoprene gaskets at supports configured to provide a watertight installation and where indicated on Drawings.
   a. Embedded support frames to be shop fabricated and pre-fitted to assure water tightness in shop and delivered to site as a unit.
7. Unless shown otherwise, frame for openings with aluminum checkered plate cover:
   a. Aluminum support angles:
      1) 3 IN by 2 IN by 1/4 IN minimum size with long leg vertical.
      2) 5/8 IN DIA adhesive anchor bolts spaced at maximum of 24 IN OC along each side with not less than two (2) anchor bolts per side.
   b. Aluminum concrete insert seats:
      1) 2 IN by 2 IN by 1/4 IN minimum size.
      2) Auto-welded studs or strap anchors at 18 IN OC with not less than two (2) studs or strap anchors per side.
   c. Drill and tap frame to receive 3/8 IN DIA fasteners at not more than 24 IN OC with not less than two (2) fasteners per side.
      1) Fasteners: Stainless steel flat countersunk cap screws: ASTM F879.

G. Steel Grating:
1. NAAMM MBG 531.
2. Bearing bars:
   a. Rectangular 1-1/2 x 1/4 IN unless shown otherwise on Drawings.
   b. Maximum 1-3/16 IN OC spacing.
3. Design Live Load:
   a. 100 PSF, uniform load.
   b. 300 LBS, concentrated load on 4 IN square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 50 PSF.
4. Cross bars:
   a. Welded, swagged or pressure locked to bearing bars.
   b. Maximum 4 IN OC spacing.
5. Top edges of bars: Serrated or grooved.
6. Removable grating sections: Not wider than 3 FT and not more than 100 LBS.
7. Finish:
   a. Galvanized.
   b. Clips and bolts: Galvanized.
   c. Seat angles: Galvanized steel.
8. Ends and perimeter edges: Banded.
9. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate. (None intended)
10. Provide joints at openings between individual grating sections.

H. Aluminum Grating:
1. NAAMM MBG 531.
2. Minimum depth: 1 1/2 IN.
3. Minimum rectangular bearing bar size:
   a. 3/16 IN thick.
   b. Maximum 1-3/16 IN OC spacing.

4. Minimum I-Bar flange width: 1/4 IN.
5. Design Live Load:
   a. 100 PSF, uniform load.
   b. 300 LBS, concentrated load on 4 IN square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 50 PSF.
6. Cross bars:
   a. Welded, swaged or pressure locked to bearing bars.
   b. Maximum 4 IN OC spacing.
7. Top edges of bars: Serrated or grooved.
8. Removable grating sections: Not wider than 3 FT and not more than 100 LBS.
9. Standard mill finish.
10. Ends and perimeter edges: Banded.
11. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
12. Provide joints at openings between individual grating sections.
13. Clips and bolts: Stainless steel.
14. Seat angles: Aluminum.
15. Where indicated in Contract Drawings aluminum plank grating with skid-resistant surface shall be used.

I. Heavy-Duty Castings, Trench Covers, and Accessories:
   1. Prefabricated, cast aluminum ASTM B26.
   2. Design load: AASHTO HS-20 wheel loading for indicated span.
   3. Machine horizontal mating surfaces.

J. Access Cover:
   1. Tank type manhole frame and solid lid: ASTM A48 or ASTM A536, cast iron.
   2. Unless shown otherwise, design of cover shall be such that top of frame extends several inches above slab to prevent surface water from entering tank.
   3. Equip lid with four (4) stainless steel screws to secure lid to frame.

K. Hose Rack:
   1. Fabricate in accordance with details indicated on the Drawings.
      a. Grind smooth all welds after fabrication.
   2. For galvanized steel units, galvanize after fabrication in accordance with ASTM A123/A123M.
   3. Provide U-bolt mounting to fit size of member being mounted to.
   4. Provide stainless steel fasteners, anchor bolts and U-bolts.
   5. For aluminum units provide dissimilar materials protection on all surfaces where unit comes into contact with concrete, masonry or dissimilar metals.
   6. Material: As indicated on the Drawings.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
   1. Grind smooth all rough welds and sharp edges.
      a. Round all corners to approximately 1/32 - 1/16 IN nominal radius.

C. Provide drilled or punched holes with smooth edges.
   1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Permanent Shop Connections:
   1. Welds to be continuous fillet type unless indicated otherwise.
   2. Full penetration butt weld at bends in stair stringers and ladder side rails.

3. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1.
4. Weld aluminum in accordance with AWS D1.2.
5. All headed studs to be welded using automatically timed stud welding equipment.
6. Grind smooth welds that will be exposed.

E. Conceal fastenings where practicable.

F. Fabricate work in shop in as large assemblies as is practicable.

G. Tolerances:
1. Rolling:
a. ASTM A6.
b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specifications.
2. Fabrication tolerance:
a. Member length:
1) Both ends finished for contact bearing: 1/32 IN.
2) Framed members:
a) 30 FT or less: 1/16 IN.
b) Over 30 FT: 1/8 IN.
b. Member straightness:
1) Compression members: 1/1000 of axial length between points laterally supported.
2) Non-compression members: ASTM A6 tolerance for wide flange shapes.
c. Specified member camber (except compression members):
1) 50 FT or less: Minus 0/plus 1/2 IN.
2) Over 50 FT: Minus 0/plus 1/2 IN (plus 1/8 IN per 10 FT over 50 FT).
3) Members received from mill with 75 percent of specified camber require no further cambering.
4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
5) Camber shall be measured in fabrication shop in unstressed condition.
d. At bolted splices, depth deviation shall be taken up by filler plates.
1) At welded joints, adjust weld profile to conform to variation in depth.
2) Slope weld surface per AWS requirements.
e. Finished members shall be free from twists, bends and open joints.
1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

H. Fabricate checkered plate, ladders, grating, stairs, stair landing gratings, stair treads and accessories using aluminum unless shown otherwise on Drawings.
1. Finish:
a. Aluminum: Mill finished unless scheduled or otherwise specified or, if approved by Engineer, finished in manufacturer's standard.
b. Coat or otherwise separate surfaces in contact with dissimilar materials.
1) See Specification Section 09905.
2. See Specification Section 09905 for preparation and painting of ferrous metals and other surfaces.

I. Maximum tolerance for difference in depth between checkered plate or grating depth and seat or support angle depth: 1/8 IN.

J. Distance between edge of grating or checkered plate and face of embedded seat angle or face of wall or other structural member shall be 1/4 IN.
1. Tolerance per NAAMM MBG 531.

2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:
   1. Refer to Specification Section 09905 for surface preparation requirements.

B. Shop Applied Paint Coating Application:
   1. Refer to Specification Section 09905 for painting requirements.

C. Meet structural requirements of Specification Section 05120 for inspection and testing items of structural nature.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
   1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
   1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.
   1. Shim and grout as necessary.

B. Bolt Field Connections: Where practicable, conceal fastenings.

C. Grind welds smooth where field welding is required.

D. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.
   1. Replace entire section.

E. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

F. Unless noted or specified otherwise:
   1. Connect steel members to steel members with 3/4 IN DIA ASTM A325 high strength bolts.
   2. Connect aluminum to aluminum with 3/4 IN DIA aluminum bolts.
   3. Connect aluminum to structural steel using 3/4 IN DIA stainless steel bolts.
      a. Provide dissimilar metals protection.
   4. Connect aluminum and steel members to concrete and masonry using stainless steel expansion anchor bolts or adhesive anchor bolts unless shown otherwise.
      a. Provide dissimilar materials protection.
   5. Provide washers for all bolted connections.
   6. Where exposed, bolts shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top nut.
      a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

G. Install and tighten ASTM A325 high-strength bolts in accordance with the AISC Manual of Steel Construction - Allowable Stress Design (ASD).
   1. Provide hardened washers for all ASTM A325 bolts.
      a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

H. After bolts are tightened, upset threads of ASTM A307 unfinished bolts or anchor bolts to prevent nuts from backing off.

I. Secure metal to wood with lag screws of adequate size with appropriate washers.

J. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
   1. Provide full penetration welded splices where continuity is required.

K. Provide each fabricated item complete with attachment devices as indicated or required to install.

L. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

M. Set beam and column base plates accurately on non-shrink grout as indicated on Drawings.
   1. See Division 3 Specification Sections for non-shrink grout.
   2. Set and anchor each base plate to proper line and elevation.
      a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
         1) Wedges, shims and setting nuts to be of same metal as base plate they support.
         2) Tighten nuts on anchor bolts.
      b. Fill space between bearing surface and bottom of base plate with non-shrink grout.
         1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
      c. Do not remove wedges or shims.
         1) Where they protrude, cut off flush with edge of base plate.
      d. Fill sleeves around anchor bolts solid with non-shrink grout.

N. Tie anchor bolts in position to embedded reinforcing steel or embedded standees using templates and wire.
   1. Tack welding prohibited.
      a. Coat bolt threads and nuts with heavy coat of clean grease.
   2. Anchor bolt location tolerance:
      a. 1/16 IN.
      b. Provide sturdy templates for all anchor bolts.

O. Install bollards in concrete as detailed.
   1. Fill pipe with concrete and round off at top.

P. Provide abrasive stair nosings in each tread and landing of all concrete stairs and at each concrete stair landing having metal stair structure attaching to the concrete landing.
   1. Center stair nosings in stair width.
   2. Coordinate nosings with railing vertical posts.
      a. Maintain 2 IN clear between end of nosing and edge of railing base plate.

Q. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.
   1. Keep screw holes clean and ready to receive screws.

R. Attach grating to end and intermediate supports with grating saddle clips and bolts.
   1. Maximum spacing: 2 FT OC with minimum of two (2) per side.
   2. Attach individual units of aluminum grating together with clips at 2 FT OC maximum with a minimum of two (2) clips per side.

S. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09905.

T. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

U. Anchor ladder to concrete or masonry structure with minimum 3/4 IN stainless steel adhesive anchor bolts with minimum 6 IN embedment.

1. When anchoring into masonry, fill masonry cores with grout at anchor locations and each masonry core within 8 IN of anchor.

V. Install manhole steps in cast-in-place concrete where indicated on the Drawings.
   1. Provide in compliance with ASTM C478, OSHA, and Or-OSHA requirements for fixed ladders.
   2. Tie steps to reinforcing or formwork.
      a. Provide equal spacing from surface to first rung and equal spacing on remaining rungs.
         1) Maximum spacing: 12 IN.
      b. Minimum clear distance from face of wall to center of step: 7 IN.
      c. Minimum embedment: 6 IN.
   3. Provide dissimilar materials protection.
      a. See Specification Section 09905.
   4. At the Contractor's option, manhole steps may be installed in drilled holes and grouted in place.
      a. Grout: See Specification Section 03308.

W. Install ladder safety extension post in accordance with manufacturer's instructions.
   1. Mount device opposite the climbing side.
   2. Provide ladder safety extension device for all ladders where indicated on Drawings.

X. Anchor ladder to metal stud walls using minimum 1/2 IN stainless steel bolts, nuts and washers.
   1. Verify that stud wall has been provided with adequate backing to accept ladder anchors.

3.3 CLEANING

A. After erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings specified in Specification Section 09905.

END OF SECTION

SECTION 05522
ALUMINUM RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aluminum handrail, stair rail and guardrail.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 05505 - Metal Fabrications.
   4. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   2. ASTM International (ASTM):
      a. B108, Standard Specification for Aluminum-Alloy Permanent Mold Castings.
      b. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      c. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      d. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
      e. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
      f. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
   3. American Welding Society (AWS):
      a. C5.5, Recommended Practices for Gas Tungsten Arc Welding.
      b. D1.2, Structural Welding Code - Aluminum.
   4. National Association of Architectural Metal Manufacturers (NAAMM):
      a. AMP 521, Pipe Railing Systems Manual.
   5. U.S. Department of Justice, Architectural and Transportation Barriers Compliance Board (Access Board):
      a. Americans with Disabilities Act (ADA):
         1) Accessibility Guidelines for Buildings and Facilities (ADAAG).
   6. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
   7. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS and ASME Section IX.

1.3 DEFINITIONS

A. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

B. Handrail: A railing provided for grasping with the hand for support.

C. Railing: A generic term referring to guardrail, handrail and/or stair rails.

D. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings:
      a. Drawings showing profile, location, sections and fabrication details including all welding information of each railing.
      b. Type and details of anchorage.
      c. Location and type of expansion joints.
      d. Materials of construction, shop coatings and all third-party accessories.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation details.
   4. Certification that railings have been designed and fabricated to meet the loading requirements specified.
   5. Calculations for all proposed deviations from the Specification.
      a. Calculations shall be performed, sealed, signed and dated by a registered professional engineer licensed in the State of California.
      b. Calculations shall be specific to this Project and shall include all assumptions, references and design interpretations used to achieve the results obtained by the Engineer.
      c. Reduction in load criteria is not acceptable as reason for deviation from sizes indicated in the Specification.

B. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Certification of welders and welding procedures indicating compliance with AWS requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle railings to preclude damage.

B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect against corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Welded railing systems:

a. Any manufacturer meeting this Specification Section.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Alloy 6061-T6, 32,000 psi tensile yield strength minimum.
1. ASTM B209 for sheets and plates.
2. ASTM B221 and ASTM B308 for shapes - beams, channels, angles, tees, and zees.
3. ASTM B247 for forgings.

B. Alloy 6063-T5 or T6, 15,000 psi tensile yield strength minimum.
1. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.

C. Cast Fittings: Aluminum, ASTM B108.

D. Shims: Aluminum of same alloy as component being shimmed.

E. Fasteners: See Specification Section 05505.

F. Expansion and Adhesive Anchors: See Specification Section 03151.

G. Electrodes for Welding:
1. Aluminum: AWS D1.2.
2. Filler alloy 5356 or 4043.

2.3 FABRICATION

A. General:
1. Verify field conditions and dimensions prior to fabrication.
2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
   a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
   a. Ease exposed edges to a radius of approximately 1/32 IN.
   b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
   c. Drill or punch holes with smooth edges.
4. Form exposed connections with flush, smooth, hairline joints, using stainless steel or aluminum splice locks to splice sections together or by welding.
   a. Ease the edges of top rail splices and expansion joints and remove all burrs left from cutting.
5. Provide for anchorage of type indicated on Drawings or as required by field conditions.
   a. Drill or punch holes with smooth edges.
6. Design railings and anchorage system in accordance with NAAMM AMP 521 to resist loading as required by Building Code.
   a. Maximum allowable stresses per AA ADM 1.
7. Design railings in accordance with accessibility requirements per the Building Code and ADAAG.
8. Custom fabricate railings to dimensions and profiles indicated.
   a. Fabricate handrail mounted to wall or to guardrail vertical posts using minimum 1-1/4 IN nominal diameter Schedule 40 pipe.
   b. Fabricate all guardrail top rails using minimum 2 IN nominal diameter Schedule 40 pipe.
   c. Fabricate all guardrail vertical posts using minimum 2 IN nominal diameter Schedule 40 pipe.
      1) Guardrail vertical posts that are to be side-bracket mounted to a vertical concrete surface or metal structure shall use Alloy 6063-T6.

d. All intermediate rails shall be fabricated using minimum 1-1/2 IN nominal diameter Schedule 40 pipe.
   1) Where details are not indicated, set horizontal rails to requirements of the Building Code, ADAAG or OSHA Standards, whichever requires the more restrictive design.
e. Space vertical posts as required by loading requirements but not more than 4 FT on center.
f. Space handrail brackets as required by loading requirements but not more than 4 FT on center.
g. Base plate for vertical guardrail posts mounted to top of concrete surface:
   1) 3/8 x 6 x 6 IN square plate.
   2) Predrilled to accept four (4) anchors.
   3) Provide a 2 IN DIA x 8 IN long solid aluminum rod welded to the base plate.
   4) Fit the vertical post over the solid rod and weld the post to the base plate.
h. Base plate for vertical guardrail post mounted to flange of metal structure:
   1) 3/8 x 3 x 8 IN plate.
   2) Predrilled to accept two (2) fasteners.
   3) Provide a 2 IN DIA x 8 IN long solid aluminum rod welded to the base plate.
   4) Fit the vertical post over the solid rod and weld the post to the base plate.
i. Mounting bracket for vertical guardrail post mounted to vertical concrete surface or web of metal structural member:
   1) Pair of 3/8 IN angles or bent plates.
   2) Predrilled to accept two (2) fasteners each.
   3) Weld angles or bent plates to vertical posts.
j. Removable railing section base assembly:
   1) Base plate for vertical posts mounted to concrete surface:
      a) 3/8 x 6 x 6 IN square plate.
      b) Predrilled to accept four (4) anchors.
   2) Base plate for vertical posts mounted to flange of metal structure:
      a) 3/8 x 3 x 8 IN plate.
      b) Predrilled to accept two (2) anchors.
   3) Provide 2 IN DIA x 10 IN long solid aluminum rod welded to the base plate.
   4) Provide 2 IN long pipe section to match vertical post.
      a) Fit pipe over solid aluminum rod and weld to base plate.
      b) Do not weld pipe section to solid aluminum rod.
   5) Guardrail vertical post shall fit over solid rod and rest on pipe section.
      a) Provide two (2) drilled and tapped holes in vertical guardrail post to accept set screws.
      b) Set screws: 1/4 IN stainless steel.
   6) Completed assembly shall be designed to withstand the loading capacity specified.
k. Provide 3/8 IN x 4 IN flat bar toeboards or 1/4 IN minimum thickness x 4 IN high extruded toeboard with stiffener ribs on back side at all elevated walkways, platforms and stair landings, and where indicated on the Drawings or required by OSHA Standards.

9. Fit exposed ends of guardrails and handrails with solid terminations.
   a. Return ends of handrail to wall, but do not attach to wall.
   b. Where guardrail terminates at a wall, provide a vertical post located 4 IN off the wall to center of post.
10. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.

B. Finish: Mill.

C. Railing Fabrication:
   1. All railings are to be welded systems.
   2. Use wire welding for all joints.
   3. All welding to be continuous in accordance with AWS C5.5 and AWS D1.2.

a. All welded railing joints shall have full penetration welds unless noted otherwise.

4. All exposed welds to be ground smooth and flush to match and blend with adjoining surfaces.
   a. NAAMM AMP 521, Type 2.
5. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
6. Finishing joints with filler is not acceptable.
7. Provide flush weld fittings using locking weld connectors or coped drive-on connectors.

D. Install weeps to drain water from hollow sections of railing at exterior and high humidity conditions.
   1. Drill 1/4 IN weep hole in railings closed at bottom:
      a. 1 IN above walkway surface at bottom of posts set in concrete.
      b. 1 IN above solid aluminum rod at posts having base plate.
      c. At low point of intermediate rails.
      d. Do not drill weep holes:
         1) In bottom of base plate.

E. Expansion Joints:
   1. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.
      a. Top rail splices and expansion joints shall be located within 8 IN of post or other support.
      b. Where railings span building or tank expansion joints; provide a railing expansion joint in the span crossing the building or tank expansion joint.
   2. Provide expansion joints in any continuous run exceeding 20 FT in length.
      a. Space expansion joints at not more than 40 FT on center.
   3. Provide minimum 0.10 IN of expansion joint for each 20 FT length of top rail for each 25 DegF differential between installation temperature and maximum design temperature.
      a. Maximum expansion joint width at time of installation shall not exceed 3/8 IN.
         1) Provide additional expansion joints as required to limit expansion joint width.
   4. Provide slip-joint with internal sleeve.
      a. Extend slip joint min 2 IN beyond joint at maximum design width.
      b. Fasten internal sleeve securely to one side
         1) Provide allen-head set screw located in bottom of rail.
         2) Rivets or exposed screw heads are not acceptable.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to installation, inspect and verify condition of substrate.

B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
   1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

A. Install handrails and guardrails to meet loading requirements of the Building Code.

B. Install products in accordance with manufacturer's instructions.

C. Set work accurately in location, alignment and elevation; plumb, level and true.
   1. Measure from established lines and items which are to be built into concrete, masonry or similar construction.

D. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.
   1. Provide shims as required.

E. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.
   1. Lubricate expansion joint splice bar for smooth movement of railing sections.

F. Provide removable railing sections where indicated on Drawings.

G. Attach handrails to walls or guardrail with brackets designed for condition:
   1. Provide brackets which provide a minimum 1-1/2 IN clearance between handrail and nearest obstruction.
      a. Handrails shall not project more than 4-1/2 IN into required stairway width.
   2. Anchor handrail brackets to concrete or masonry walls with 1/2 IN stainless steel adhesive anchors with stainless steel hex head bolts.

H. Anchor railings to concrete with minimum 1/2 IN stainless steel adhesive anchors with stainless steel bolts, nuts and washers unless noted otherwise in the Contract Documents.
   1. Where exposed, bolts shall extend minimum 1/2 IN and maximum 3/4 IN above the top nut.
      a. If bolts are cut off to required height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nut.
      b. Bevel the top of the bolt after cutting to provide a smooth surface.

I. Anchor railings to metal structure with minimum 3/4 IN stainless steel bolts, nuts and washers.

J. Install toeboards to fit tight to the walking surface.
   1. Notch toeboards at base plates or other obstructions.
   2. Bottom of toeboard shall not exceed 1/4 IN above walking surface.

K. Coat aluminum in contact with dissimilar metal or concrete in accordance with Specification Section 09905.

L. Provide railings as required for stair construction identified in Specification Section 05505.

END OF SECTION

SECTION 06100
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rough carpentry.
   2. Air barrier membrane.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 05505 - Metal Fabrications.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. APA - The Engineered Wood Association (APA):
      a. PRP-108, Performance Standards and Qualification Policy for Structural Use Panels.
      b. U450E, Storage and Handling of APA Trademarked Panels.
      c. Y510T, Plywood Design Specification.
   2. ASTM International (ASTM):
      a. D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
      b. D4442, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
      c. D4444, Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters.
      d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   3. American Wood Protection Association (AWPA):
      a. Book of Standards.
      b. Use Category System.
   4. Environmental Protection Agency (EPA).
   5. National Institute of Standards and Technology (NIST):
      a. PS-1, Construction and Industrial Plywood.
      b. PS-2, Performance Standard for Wood-Based Structural-Use Panels.
      c. PS-20, American Softwood Lumber Standard.
   6. Underwriters Laboratories, Inc. (UL):
      a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
   7. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Wood Treatment Plant: AWPA M3.
   2. Treated Wood Inspection: AWPA M2.

C. Miscellaneous:
   1. Factory marking:
      a. Lumber:
         1) Identify type, grade, moisture content, inspection service, producing mill, and other qualities specified.

2) Marking may be omitted, as allowed by Building Code, if certificate of inspection is provided for each shipment.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Fabrication drawings of all fabricated items.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions for all products specified.
4. Certifications:
   a. Chemicals used in treatment process are registered with and approved by EPA.
   b. Moisture content of material prior to treatment: 25 percent maximum.
   c. Material has been kiln-dried after treatment (KDAT) to the moisture content specified.
5. Documentation of treatment of preservative and fire retardant treated material in accordance with standards referenced.

1.4 DELIVERY AND STORAGE

A. Delivery, storage and handling of untreated wood products:
1. Lumber: As recommended by the grading agency indicated on the grade stamp.
2. Plywood: APA U450E.

B. Delivery, storage, handling and disposal of treated wood products: AWPA M4.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. General:
1. Lumber (for framing, blocking, nailers, furring, grounds and similar members):
   a. NIST PS-20.
   b. Species:
      1) Treated material: As indicated in the appropriate AWPA Standard.
      2) Untreated material:
         a) For nominal sizes up to and including 2 x 4: Douglas Fir or Spruce/Pine/Fir.
         b) For nominal sizes up to 2 IN thick and wider than 4 IN: Douglas Fir.
   c. Grade:
      1) For nominal sizes up to and including 2 x 4: Standard and better.
      2) For nominal sizes up to 2 IN thick and wider than 4 IN: #2 and better.
2. Structural plywood:
   a. NIST PS-1, NIST PS-2.
   b. APA PRP-108, APA Y510T.
   c. Structural I Rated Sheathing:
      1) Exposure: EXT.
      2) Span rating: 12/0.
         a) All plywood furnished for a single span rating to be the same thickness.
      3) Thickness: 3/8 IN.
3. Moisture content:

a. Kiln-dry, ASTM D4442 and ASTM D4444.
b. Lumber, 19 percent maximum.
c. Wood structural panels plywood, 15 percent maximum.

B. Preservative Treated Material:
1. Moisture content:
a. Prior to treatment: 25 percent.
b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
1) Lumber: 19 percent maximum.
2) Plywood: 18 percent maximum.
2. Preservative:
a. Waterborne, AWPA P5.
b. As indicated in the appropriate AWPA commodity standards.
3. Pressure-treat material in accordance with AWPA C1 and the following:
a. Lumber: C2, C15.
b. Plywood: C9 .
4. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

C. Fire-Retardant Treated Material (FRTM):
1. Acceptable manufacturer:
a. Hoover Treated Wood Products, Inc.:
1) Interior: "Pyro-Guard".
2) Exterior: "Exterior Fire-X".
2. Maximum moisture content:
a. Prior to treatment: 25 percent.
b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
1) Lumber: 19 percent (KDAT).
2) Plywood: 15 percent (KD-15).
3. Fire-retardant preservative:
a. Provide protection against decay:
1) EPA registered for use as a wood preservative.
b. Shall not bleed-through or adversely affect bond of any finish.
4. Pressure-treat material in accordance with AWPA C1 and the following:
a. Lumber: C20.
b. Plywood: C27.
5. UL Classified:
a. FR-S, UL 723.
b. Exterior: No increase in classification when subjected to the Standard Rain Test, ASTM D2898.
c. Provide UL mark on each piece of FRTM.
6. Maximum flame spread rating: 25, ASTM E84.
7. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

D. Fasteners and Anchors:
1. Proper type, size, material, and finish for application.
2. Nuts, bolts and washers: See Specification Section 05505.
3. Expansion anchors: See Specification Section 05505.
4. Adhesive anchors: See Specification Section 05505.

E. Air Barrier Membrane:
1. Acceptable manufacturer:
a. DuPont "TYVEK Commercial Wrap."
2. Flash spun bonded olefin.
3. Non-woven, non-perforated, vapor open and breathable.
4. Water vapor transmission: ASTM E96 Method B, minimum 28 perms.

5. Type 1 air barrier per ASTM E1677.
6. Tape for sealing seams: As recommended by air barrier manufacturer.
7. Fasteners: For steel stud construction, provide 1-5/8 IN corrosion resistant screws with 2 IN DIA plastic cap as recommended by air barrier manufacturer.
8. Sealants: Polyurethane or butyl rubber as recommended by manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify measurements, dimensions, and shop drawing details before proceeding.

B. Coordinate location of studs, nailers, blocking, grounds and similar supports for attached work.

C. Eliminate sharp projections which would puncture roofing, flashing or underlayment material.

3.2 ERECTION AND INSTALLATION

A. General:
   1. Provide treated material in accordance with appropriate AWPA standard for intended end use.
   2. Provide preservative treated material for all wood used:
      a. Outside building.
      b. Below grade.
   3. Provide fire-retardant treated material for all wood used:
      a. Inside building.
      b. Within exterior building walls including parapets.
      c. In roof construction.
      d. For roofing nailers.

B. Attach work securely by anchoring and fastening as indicated or required to support applied loading.
   1. Provide washers under bolt heads and nuts.
   2. Fasten plywood in accordance with APA recommendations.
   3. Use galvanized nails and fasteners unless indicated otherwise.
      a. When anchoring treated wood material use appropriately treated fasteners for corrosion protection against the chemicals used in the wood treatment process.
   4. Use common wire nails or screws for general work.
   5. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
   6. Install fasteners without splitting of wood; predrill as required.
   7. Do not drive threaded friction type fasteners.
   8. Tighten bolts and lag screws at installation and retighten as required.

C. Set work to required levels and lines, plumb, true.
   1. Shim as required.
   2. Cut and fit accurately.

D. Provide wood grounds, nailers, or blocking where required for attachment of other work and surface applied items.
   1. Form to shapes indicated or required.
      a. Field treat cuts and holes in preservative and fire-retardant treated material in accordance with AWPA M4 and manufacturer's published recommendations.
         1) FRTM lumber:
            a) Do not rip or mill.
            b) Cross-cutting and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.

c) Resurfacing, planing or fabrication of special shapes or profiles shall be done prior to treatment.

2) FRTM plywood:

a) Cross-cutting, ripping and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.

3) Light sanding as permitted by UL to remove raised grain or prepare for finishing is allowable.

2. Grounds:

a. Dressed, key beveled lumber minimum 1-1/2 IN wide of thickness required to bring face of ground even with finish material.

b. Remove temporary grounds when no longer required.

3. Install roofing nailers as indicated:

a. Install per roofing manufacturer's recommendations.

b. Match height of nailers to insulation.

c. Anchor nailers to resist force of 75 PLF unless required otherwise by roofing manufacturer.

1) Metal decking attachment:

a) Attach base nailer to metal roof deck using self-tapping stainless steel sheet metal screws (STSMS) with plate washers or with minimum 3/8 IN Type 304 stainless steel hex head bolts with nuts and washers.

b) Countersink heads of bolts flush with top of nailer.

c) Provide size and spacing of STSMS as required to meet loading criteria specified.

d) Provide spacing of minimum 3/8 IN hex head bolts as required to meet loading criteria specified.

2) Concrete decking attachment:

a) Attach base nailer to concrete roof deck using minimum 3/8 IN stainless steel adhesive anchors with minimum 3 IN embedment.

b) Countersink heads of bolts flush with top of nailer.

c) Provide spacing of minimum 3/8 IN stainless steel adhesive anchors as required to meet loading criteria specified.

d. Provide 1/2 IN vent spaces between lengths of nailers.

e. Install nailers over vapor retarder where indicated.

E. Install wood furring plumb and level with closure strips at all edges and openings.

F. When wood has been exposed to moisture allow to completely dry out prior to covering with additional wood or another material.

G. Correct or replace wood which shows bowing, warping or twisting to provide a straight, plumb and level substrate for applications of other materials.

H. Air Barrier Membrane Installation:

1. Install air barrier over exterior face of exterior wall sheathing in accordance with manufacturer's recommendations.

2. Install prior to installing windows and doors.

3. Install air barrier in a horizontal manner starting at bottom of wall.

a. Work up the wall face shingle fashion with subsequent layers of barrier material.

1) Overlap each layer minimum of 6 IN at seams unless recommended otherwise by manufacturer.

2) Overlap exterior corners minimum 12 IN.

4. Extend barrier completely over all door, window, louver and any other opening in the exterior wall.

5. Maintain barrier plumb and level.

6. Attach barrier to sheathing using fasteners spaced 16 IN OC maximum vertically and 16 IN OC maximum horizontally.

   a. Attach barrier to studs through sheathing using fasteners recommended by barrier manufacturer.
7. Tape all laps and seams using seam tape recommended by air barrier membrane manufacturer.
   a. Seal all tears and cuts in membrane as recommended by manufacturer.
8. Install all sheet metal flashing over top of air barrier membrane and seal the flashing edges with seam tape.
9. Prepare all openings in accordance with air barrier membrane manufacturer's recommendations.
10. Secure all loose edges of membrane with seam tape and fasteners, if required.

END OF SECTION

SECTION 06610
FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fiberglass reinforced plastic:
      a. Baffle Walls.
      b. Solid plate.
      c. Railings.
      d. Grating.
      e. Stairs.
      f. Ladders.
      g. Hydraulic Baffles.
      h. Weirs and Baffles.
      i. Slide Gates and frames.
      j. Structural members.
      k. Supporting structure design.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
   2. ASTM International (ASTM):
      a. A320, Specification for Alloy steel bolting Materials for Low-Temperature Service.
      b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
      c. D570, Standard Test Method for Watr Absorption of Plastics.
      d. D638, Standard Test Method for Tensile Properties of Plastics.
      e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
      f. D790, standard Test Methods for Flexural Properties of Unreinforced and reinforced Plastics and Electrical Insulating Materials.
      g. D2000, Classification System for Rubber Products in Automotive Applications.
      h. D2563N, recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   3. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
   4. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on the International Building Code, associated standards, and all amendments, referred to herein as Building Code.

1.3 DEFINITIONS

A. Skid-resistant:
   1. Manufacturer's standard applied abrasive grit coating.
   2. Abrasive coated tape is not acceptable.

B. FRP: Fiberglass Reinforced Plastic.

C. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

D. Handrail: A railing provided for grasping with the hand for support.

E. Railing: A generic term referring to guardrail, handrail and/or stair rails.

F. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.4 SYSTEM DESCRIPTION

A. All fiberglass reinforced plastic support systems shall be designed by a registered professional structural engineer licensed in the State of California.

1.5 SUBMITTALS

A. Shop Drawings:
   1. Sealed by a Professional Engineer registered in the State of California.
   2. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   3. Fabrication and/or layout drawings.
      a. Plan showing profile, location, section and details of each item including anchorage or support system(s).
      b. Locations and type of expansion joints.
      c. Materials of construction including shop applied coatings.
      d. Listing of all accessory items being provided indicating material, finish, etc.
   4. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations on reinforcing field cut openings.
   5. Manufacturer's full line of colors available for each component.

B. Samples:
   1. Connections and flush fit connections, not less than 6 IN long.
   2. Railing section 6 IN long.
   3. Grating section minimum 8 x 8 IN.

C. Miscellaneous Submittals:
   1. Certification that Professional Engineer preparing the structural design has a minimum of five (5) years of experience in the design of the type of fabrications specified for this Project with specific items listed and certified.
   2. Complete structural design calculations of all supporting structure and fastening conditions. Sealed by a Professional Engineer registered in the State of California.
      a. Indicate all required design loads.
      b. Structural design calculations to be for information only.
      c. Engineer will not review or take any action on structural design calculations.
   3. Certification that all components and systems have been designed and fabricated to meet the loading requirements specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle each item to preclude damage.

B. Store all items on skids above ground.
   1. Keep free of dirt and other foreign matter which will damage items or finish and protect from corrosion and UV exposure.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Baffle Walls:
      a. Enduro Composite Systems.
      b. Or Approved Equal.
   2. Railings:
      a. AICKIN
      b. International Grating Inc.
      c. Fibergrate Composite Structures, Inc.
      d. Seasafe, Inc.
      e. IKG Industries.
      f. Strongwell.
      g. Enduro Composite Systems.
   3. Grating and solid plate:
      a. International Grating Inc.
      b. IKG Industries.
      c. Fibergrate Composite Structures International.
      d. Enduro Composite Systems.
      e. Strongwell.
      f. Seasafe, Inc.
   4. Stairs:
      a. IKG Industries.
      b. Fibergrate Composite Structures International.
      c. Seasafe, Inc.
      d. Strongwell.
      e. Enduro Composite Systems.
   5. Ladders:
      a. Fibergrate Composite Structures International.
      b. IKG Industries.
      c. Seasafe, Inc.
      d. Strongwell.
      e. Enduro Composite Systems.
   6. Baffles and weirs:
      a. Strongwell, composolite Fiberglass Building Panel.
      b. Plasti-Fab, Inc.
      c. Or approved equal.
   7. Slide gates and frames:
      a. Plasti-Fab, Inc.
      b. Warminster fiberglass Company.
   8. Structural shapes:
      a. Strongwell.
      b. Fibergrate Composite Structures International.
      c. Enduro Composite Systems.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Baffle Wall Panels, Columns, and Angles:
   1. Polyester resin with fiberglass reinforcing.
   2. U.L. Certified to ANSI/NSF Standard 61.
   3. Color: Gray.
   4. Baffle wall FRP structural materials shall exhibit the following minimum properties:

a. Tensile Strength: 40,000 psi (ASTM D 638)
b. Flexural Strength: 45,000 psi (ASTM D 790)
c. Flexural Modulus: 1,690,000 psi (ASTM D 790)
d. Izod Impact: 25 (ASTM D256)
e. Water Absorption: 0.25% Maximum (ASTM D 570)

5. Baffle wall panels shall exhibit the following minimum properties:
   a. Stiffness (EI): 5,591,000 lb-in^2/ft.
   b. Moment Capacity: 19,700 lb-in/ft.
6. Treated with UV inhibitor.

B. Other Fiberglass Reinforced Plastic Products:
1. Polyester or vinyl ester resin with fiberglass reinforcing.
   a. Resin shall be selected by manufacturer to meet requirements of chemical resistance specified.
2. Fire retardant.
3. Color: To be selected by Engineer when more than one color is available for any one component.
4. Treated with UV inhibitor.

C. Fasteners, Clips, Saddles, and Miscellaneous Components:
1. In the chemical storage and feed area:
   a. Use fiberglass exclusively.
2. In other areas:
   a. Fiberglass where possible.
   b. Stainless steel may be used if fiberglass component is not available.
      1) Stainless steel to be Type 316 or 316L.
3. Treated with UV inhibitor.

D. General:
1. Treated with UV inhibitor.
2. Self-contained gates with operators or handles in accordance with the configuration noted in the gate schedule or shown on the Contract Drawings.
3. Maximum leakage rate: Not to exceed 0.1 gpm per foot of seat perimeter with water at top of gate slide and operating in seating position.
4. All gates shall be of fiberglass reinforced polyester (FRP) with a UV stabilizer.
5. Gates shall be flat and level. Warpage throughout the entire gate shall not produce a crown of more than l/16 IN in any direction. Visual inspection for defects shall be made without the aid of magnification. Defects shall be classified as to type and level as shown in Table I of ANSI/ASTM D2563.
6. Allowable surface tolerances shall not exceed the following:

DEFECT	ALLOWABLE TOLERANCE
Cracks, Crazing, Chips, Pits, Blisters, Dry Spots, Fish Eyes, Burned Areas or Entrapped Air	None
Scratches	None more than 0.002 IN depth
Exposed glass, Exposure of cut edges	None
Wrinkle and solid blisters	Max. deviation: 10 percent of thickness, but not to exceed 1/8 IN
Surface porosity (pinholes or pores in the laminate surface)	None
Foreign Matter	None

E. Stop Plates and Gates:
   1. Fiberglass Reinforced Polyester (FRP).
   2. Structural characteristics for an 3/8 IN glass mat laminate shall meet the following minimum physical properties:
      a. Tensile strength: 14,700 PSI.
      b. Flexural modulus: 800,000 PSI.
      c. Flexural strength: 23,300 PSI.
      d. Impact strength: 9.0 FT-LBS/IN.
      e. Water absorption: 0.3 percent (in 24 HRS).
   3. Treated with UV inhibitor.

F. Guides:
   1. Pultruded Fiberglass Reinforced Polyester (FRP).
   2. Structural characteristics for an 5/16 IN glass mat laminate in the longitudinal direction shall meet the following minimum physical properties:
      a. Tensile strength: 30,000 PSI.
      b. Flexural strength: 30,000 PSI.
      c. Flexural modulus: 1.3×10^6 PSI.
      d. Impact strength: 20.0 FT-LBS/IN.
      e. Water absorption: <0.7 percent (in 24 HRS).
   3. Treated with UV inhibitor.

G. Hollow Bulb J-Seals and Flush Bottom Seal:
   1. Molded of extruded virgin neoprene per ASTM D-2000.
   2. The following physical characteristics apply:
      a. Specific gravity: 1.25.
      b. Hardness: 55-65 Shore A Durometer.
      c. Tensile strength: 1,500 PSI minimum.
      d. Elongation: 300 percent.
      e. Low temperature brittleness: -40 DegF.
      f. Maximum compression: 25 percent.
   3. Treated with UV inhibitor.

H. Manual Operators:
   1. Lift nuts and thrust nuts. Manganese bronze, ASTM B-584, Alloy 865.
   2. 2:1 gearbox housing. Cast iron, ASTM A-126 Class B.
   3. Handwheel. Cast iron, ASTM A-126 Class B.
   4. Anchor bolts. T-316 stainless steel.

I. Motorized Operators:
   1. See Section 15100.

J. Adhesive: Recommended by manufacturer.

K. Skid-resistant Surfacing: Manufacturer-applied abrasive grit coating.

L. Anchors: See Specification 03151.

2.3 FABRICATION

A. General:
   1. Flame spread index ("FSI") = 25 or less, per ASTM E84.
   2. Verify field conditions and dimensions prior to fabrication.
   3. Chemical resistance.
      a. System shall be capable of withstanding splash and spillage of the following chemicals.
         1) 12.5 percen sodium hypochlorite.
         2) 25 percent sodium bisulfite.
         3) 43 percent ferric chloride.

4) 50 percent sodium hydroxide.

4. Preassemble items in shop to greatest extent possible.
5. All components shall be treated with UV inhibitor.
6. Drill or punch holes with smooth edges.

B. Baffle Walls:
1. Verify field conditions and dimensions prior to fabrication.
2. Preassemble items in shop to greatest extent possible.
3. All components to be treated with UV inhibitor.
4. Baffle wall materials shall include UV stabilized polyester resin and surfacing veil at top and bottom sides.
5. Factory cut edges and drilled hole shall be sealed with ANSI/NSF approved material.
6. Baffle wall panels shall be a minimum 1/8 IN nominal thickness and shall have 40% minimum glass fiber reinforcing content, with top, horizontal ribs sloped downward not less than 10 degrees to minimize sediment build-up.
7. Baffle wall columns, where required, shall have a minimum 50 percent glass fiber reinforcing content.
8. Baffle wall angles, where required, shall be a minimum of 1/4 IN thick and shall have a 90 degree angle between legs.

C. Railings:
1. Custom fabricate handrail and guardrail to profiles and dimensions indicated on Drawings.
2. Where not indicated on Drawings, set intermediate horizontal rails to requirements of Building Code.
3. Minimum 2 IN SQ x 0.156 IN tube.
4. Kickplate:
   a. 4 x 1/2 IN (corrugated) x 0.125 IN thick.
   b. Provide at all elevated platforms and where required by OSHA/Or-OSHA Standards.
5. Provide handrail supports at 4 FT maximum spacing for wall brackets and 4 FT maximum spacing for posts.
   a. Provide vertical supports at 4 FT maximum spacing on all inclined rail sections.
   b. Provide brackets which provide a 1-1/2 IN projection from finish wall surface or guardrail to wall or guardrail side of rail.
   c. Handrails shall not project more than 4-1/2 IN into required stairway width.
6. Fit exposed ends of guardrails and handrails with solid terminations.
   a. Return ends of handrail to wall but do not attach end to wall.
   b. Where guardrail terminates at a wall or other obstruction, provide a vertical support post located 4 IN off wall or obstruction to center of post.
7. Design railings to resist loading as required by the Building Code.
8. Form exposed connections with flush, smooth, hairline joints.
   a. Top rail splices and expansion joints shall be located within 8 IN of support.
9. Fabricate items free of blemishes, seam marks, roller marks, rolled trade names and roughness.
10. Provide removable railing where indicated.
11. Provide weeps to drain moisture from hollow railing sections at exterior and in high humidity areas.
    a. 1/4 IN weep hole in railing 1 IN above walkway surface at bottom of posts set in concrete or otherwise closed at bottom, and at other low points where moisture can collect.
12. All railings and fittings to be from one manufacturer.

D. Grating and Solid Plate Material:
1. Design live load:
   a. 100 PSF uniform live load.
   b. 300 LBS concentrated load.
   c. Maximum deflection of l/300 of span under a superimposed live load.
   d. Design for the most severe loading condition noted above.

2. Minimum grating depth: 1-1/2 IN.
3. Bar span: Maximum of 1-1/2 IN center to center.
4. Walking surface: Manufacturer's standard applied abrasive grit coating.
5. Bearing bars and cross-bars to be fabricated at the same time creating a one-piece type construction.
6. Solid plate: Minimum 1/8 IN thick molded FRP sheet with skid-resistant abrasive grit surface.

E. Embedded Grating Supports:
1. Fiberglass.
2. Size to suit depth of grating.
3. Provide leg or strap for embedding and anchoring into concrete.
4. Strongwell Duradek Fiberglass Curb Angle.

F. Stairs:
1. Fabricated to profiles indicated.
2. Treads: Grating with integral 1 IN skid-resistant nosing.
   a. Provide center reinforcing for treads over 36 IN wide.
3. Risers:
   a. Solid plate material to match treads.
   b. Provide center vertical reinforcing for risers over 36 IN wide.
4. Landings:
   a. Grating with manufacturer's standard applied skid-resistant abrasive grit coating.
      1) Provide skid-resistant nosing on leading edge of stairs.
   b. Provide intermediate support as required to meet loading requirements.
5. Design and fabricate stair, platforms and landings, and all connections to support a 100 PSF uniform live load plus a 300 LB concentrated load.
6. Provide railing per this Specification Section.

G. Ladders:
1. Design in accordance with ANSI A14.3, OSHA Standards and Building Code requirements unless noted otherwise below.
2. Ladders shall be designed to support a minimum 300 LB concentrated vertical load with 150 LB concentrated horizontal load without failure or permanent set.
   a. Maximum lateral deflection: Side rail span/300.
3. Rungs:
   a. 1 IN square or diameter solid bar with skid-resistant surface on all sides.
   b. Uniform maximum spacing of 12 IN.
   c. Top rung level with top of platform.
   d. Rungs shall not extend beyond the outside face of the ladder side rail.
4. Rails:
   a. 2 IN SQ tube, minimum 0.156 IN thick.
   b. Provide minimum 1/2 x 2-1/2 IN x length required standoff brackets on each side rail with punched holes for 3/4 IN anchors.
      1) Maximum vertical spacing: 5 FT OC.
   c. The side rails of through ladder extensions shall extend 42 IN above the top rung or landing and shall flare out on each side to provide a clearance of 24 IN between the rails.
   d. Provide 1/2 x 6 x 6 IN floor flange anchored to siderails with punched holes for four 1/2 IN anchors.
5. Minimum distance from centerline of rungs to wall or obstruction shall be 7 IN.
   a. Ladder fall protection systems: See Section 05505.
   b. Ladder safety extension post: See Section 05505.

H. Baffles and Weirs:
1. Dimensions shall be in accordance with the Drawings.

I. Slide Gates:
   1. General:
      a. Fabricate in accordance with the configuration shown on the Contract Drawings.
      b. Gate assemblies will be designed so that the maximum fiber stress does not exceed 2.5 times the working stress.
      c. Gates shall be suitably reinforced to withstand the maximum head with a deflection at the maximum operating head of less than 1/360 of the gate width, or 1/4 IN whichever is less.
      d. Gates with unseated heads shall be designed for a minimum deflection of 1/16 IN.
      e. Gates shall be flat and level.
      f. Warpage throughout the entire gate shall not produce a crown of more than 1/16 IN in any direction.
   2. Gates:
      a. Maximum deflection: 1/360 of the span of the gate under maximum head.
      b. Stop gates shall utilize sandwich core structural reinforcing to attain the necessary stiffness to meet deflection requirements, and shall be manufactured of reinforced thermoset plastic containing ultraviolet absorbers.
      c. The surface shall be resin rich to a depth of 0.010 IN to 0.020 IN and reinforced with C-glass or polymeric fiber surfacing material.
      d. The surface shall be free of exposed reinforcing fibers. The composition of these layers shall be approximately 95 percent (by weight) resin. The remaining laminate shall be made up of copolymer composite and reinforcing fibers in a form, orientation and position to meet the mechanical requirements.
      e. Structural reinforcing shall be utilized to attain the necessary stiffness to meet deflection requirements, and shall be well encapsulated with a laminate not less than 1/8 IN thick on each side to insure against any permeation by water.
      f. Gates having reinforcing members bolted or bonded to flat sheet stock will not be acceptable.
      g. Gates shall be sandwich construction with built-up urethane foam or balsa wood core on only one side of gate.
      h. Each gate shall be provided with handwheel or 316 stainless steel handles, as indicated in the Schedule and shown on the Contract Drawings.
      i. Gate shall be labeled in accordance with Section 10400.
   3. Frames:
      a. Guides shall be fiberglass reinforced polyester manufactured by the pultrusion process and shall incorporate a polymeric fiber surfacing material for high corrosion and weather resistance.
      b. The guide frames shall be embedded in concrete channel or surface mounted, as indicated in the Schedule and shown on the Drawings.
      c. All guides shall be factory assembled one piece with bonded corners and reinforced with butt straps. The corner shall be capable of withstanding a torque of 300 foot pounds pull applied parallel to gate in either direction.
   4. Seals:
      a. The gate shall be equipped with elastomeric seals to reduce leakage.
      b. At the maximum operating head the leakage rate shall be equal to or less than that allowed by AWWA standard C-501.
      c. Gates shall not exceed 0.10 gpm/ft of wetted perimeter.
   5. Stem:
      a. Of suitable length and ample strength for the intended service.
      b. Stem diameter capable of withstanding twice the rated output of the operator at 40 LB pull, and supported such that L/r ratio for unsupported part of the stem shall not exceed 200.

J. Structural Members:
   1. Provide structural members having the same resin composition as the item being supported.

2. Factory fabricate with all required connection holes and holes for work of other trades.

2.4 GATE OPERATORS AND LIFTS

A. General: Provide lifts in accordance with AWWA C501 or as modified in these Specifications. Provide all lifts with clear butyrate plastic stem cover with Mylar open-close indicator.

B. Manual Operators:
1. A side mounted handwheel shall be supplied 36 IN above operating floor, as shown on Drawings.
2. Maximum effort of 40 LBS on crank or handwheel shall operate gate after unseating gate from wedges bored upon seating head specified.
3. Handwheel or crank shall not rotate more than 18 IN diameter during operation.

2.5 ALL GATES, VALVES, OPERATORS AND LIFTS

A. Comply with requirements of Section 11005 and Section 15100.

B. Provide gates, including lift, designed with a minimum factor of safety of five. Provide rising stems on all gates.

2.6 DESIGN CRITERIA

A. Baffle Walls:
1. Provide one FRP personnel door and one opening with dimensions and locations as show on Drawings. Provide reinforcement for the door and the opening. The door hardware shall be Type 316 or 316L stainless steel.
2. Baffle wall panels shall have perforated design with 2 1/2 IN diameter holes. All perforated holes shall be factory cut and sealed.
3. Baffle Wall Design Loads:
   a. The baffle wall system shall be designed for a normal operating load of at least 3 IN of differential water height between the two sides of the wall at the high water level.
   b. The baffle wall panels shall be designed to break away from the supports under a load of no more than 12 IN of differential water height between the two sides of the wall. The manufacturer shall determine the method by which the panels break away from the supports.

B. Hydraulic Baffles:
1. Grit Basin Hydraulic Baffle:
   a. Maximum deflection: 0.25 IN with 3-IN difference in water surface elevation.
   b. Maximum of 3 column supports mid-span with epoxy anchors to concrete slab below.
   c. Support structure to minimize locations for solids accumulation.
2. Other flow split hydraulic baffles:
   a. Maximum deflection: 0.25 IN with 3-IN difference in water surface elevation.
   b. Support structure to minimize locations for solids accumulation.

C. Compressor Canopy:
1. Utilize epoxy anchors for connection to Grit Basins and two columns maximum on free standing side of canopy.
2. Slope roof at 2 percent minimum away from Grit Basins.
3. Minimum clearance below canopy: 8 FT – 0 IN.
4. See Drawings for dimensions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install baffle wall products in accordance with manufacturer’s instructions.

B. Install all other FRP products in accordance with manufacturer's instructions.

C. Set work accurately in location, alignment and elevation, plumb, level, and true.
   1. Measure from established lines and levels.
   2. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
   3. Tolerances:
      a. Maximum variation from plumb in vertical line: 1/8 IN in 3 FT.
      b. Maximum variation from level of horizontal line: 1/4 IN in 20 FT.
      c. Maximum variation from level for weirs: 1/16 IN in 20 FT.
      d. Maximum variation from plan location: 1/4 IN in 20 FT.

D. Railings:
   1. Adjust railings prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length.
      a. Plumb posts in each direction.
   2. Provide posts with floor flange, attached to post and with predrilled holes for bolting to stringer, floor or beam.
   3. Anchor handrails to walls or guardrails with brackets designed for condition.
      a. For concrete and solid masonry anchorage, use stainless steel adhesive anchors with stainless steel bolts with hex nuts.
      b. Anchor size and embedment to be designed by component fabricator.
         1) Provide minimum of 1/2 IN anchor bolts.

E. Coat all exposed surfaces of stainless steel fasteners with minimum 15 mil gel coating to match component being anchored.

F. Fasten railings to beams and stair stringers with stainless steel bolts, nuts and washers.
   1. Provide two washers for each bolt.

G. Attach grating to each end and intermediate support clip or saddle with bolts, nuts and washers.
   1. Maximum spacing: 2 FT OC with minimum of two per side.
   2. Attach clips or saddles to bearing bars only.
   3. Reinforce all field cut openings in accordance with manufacturer's recommendations.

H. Attach stair treads at ends to stair stringer with hold-down clips, bolts, nuts, and washers.
   1. Minimum two clips per end.

I. File cut ends of all fiberglass to a 1/32 IN radius.

J. Seal cut ends of all items with catalyzed resin as recommended by manufacturer.
   1. Provide same resin used in fabrication of item as a minimum.

K. Provide all modular framing components as required to suit condition.
   1. Install in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

A. Installation Check and Startup: Employ and pay for services of the equipment manufacturer’s field service representative(s) fully commissioned and authorized by manufacturers to do the following:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments, calibrations and installation checks and full commissioning.
   3. Perform basic operational checks.
   4. Provide Owner with a written statement that manufacturer’s equipment has been installed properly, lubricated, and calibrated and is ready for operation by the Owner.

B. Field Leakage Test:
   1. Test gate under design seating head and adjust to maximum leakage of 0.1 gpm per foot of seating perimeter.

3.3 SCHEDULE

A. The following is a schedule of the FRP slide gates required:

TAG NUMBER	TYPE	SIZE W x H	SEAT HD-FT	UNSEAT HD-FT	TYPE LIFT
13SLG101	Self Contained Slide Gate	48 IN x 48 IN	10	10	Elec/Hdwhl
12SLG102	Self Contained Slide Gate	48 IN x 48 IN	10	10	Elec/Hdwhl
13SLG201	Self Contained Slide Gate	48 IN x 48 IN	10	10	Elec/Hdwhl
13SLG202	Self Contained Slide Gate	48 IN x 48 IN	10	10	Elec/Hdwhl
13SLG203	Self Contained Downward Opening Slide Gate	54 IN x 24 IN	10	10	Elec/Hdwhl
13SLG204	Self Contained Slide Gate	12 IN x 12 IN	10	10	Manual Hdwhl
71SLG001	Pedestal Type Slide Gate	36 IN x 36 IN	15	15	Elec/Hdwhl
71SLG002	Pedestal Type Slide Gate	36 IN x 36 IN	15	15	Elec/Hdwhl

END OF SECTION

SECTION 07101
PVC SHEET LINER FOR CONCRETE PIPE AND STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the supply, installation, and repair of a PVC sheet liner in the following structure:
   1. Headworks influent pump station and grit removal structures (area 12 and 13).

B. The liner must be continuous and free of pinholes both across the joints and in the liner itself.

C. All work for and in connection with the installation and repair of the lining of the concrete, and the field sealing and welding joints, will be done in strict conformity with all applicable specifications, instructions, and recommendations of the lining manufacturer.

D. See notes on structural sheets for PVC liner location requirements.

1.2 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Liner schedule.
   3. Material certifications.
   4. Test results.
   5. Material samples.
   6. The manufacturer of the lining will submit an affidavit attesting to the successful use of its material as a lining for wastewater facilities for a minimum period of 5 years in sewage conditions recognized as corrosive or otherwise detrimental to concrete.
   7. Proposed details for installation of liner at seams, terminations, corners, openings, pipe penetrations, etc., and the type of factory and field welds and attachments.
   8. PVC lined pipe details shall be included.

B. Fabrication and/or installation of the lining shall not commence until the shop drawings and materials submittals have been reviewed and accepted by Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Liner.
   1. Ameron T-Lock as manufactured by Ameron Protective Linings Division, Brea, California.
   2. Or approved equal.

2.2 MATERIAL

A. Liner.
   1. Material used in the liner and in all joint, corner, and welding strips to be a combination of poly (vinyl chloride) resin, pigments, and plasticizers, specially compounded to remain flexible.
   2. Poly (vinyl chloride) resin shall constitute not less than 99 percent, by weight, of the resin used in the formulation.
   3. Copolymer resins will not be permitted.
   4. Physical properties:

a. Plastic liner plate sheets, joint, corner, and welding strips to have the following physical properties when tested at 77 Deg F ± 5 Deg F.

PROPERTY	ASTM TEST METHOD	INITIAL	AFTER CHEMICAL EXPOSURE TEST (a)
Tensile Strength	D-412-Die B	220 psi min	2100 psi min
Elongation at break	D-412-Die B Instantaneous	200% min	200% min
Shore durometer - Type D	1 Second D2240	50-06	± 5% with respect to initial test results
Shore durometer - Type D	10 seconds D2240	35l-50	± 5% with respect to initial test results
Weight change	(b)		1.5% with respect to initial test results
(a) Chemical Exposure Test Requirement listed below. (b) Specimens shall be 1 IN x 3 IN sample sheet thickness, taken from sheet and strip at any time prior to final acceptance of the Work.			

1) Liner plate locking extensions embedded in concrete to withstand a pull test of at least 100 pounds per linear IN, applied perpendicularly to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test is to be conducted at a temperature of 70 to 80 Deg F inclusive.
2) All plastic liner plate sheets, include locking extensions, all joint, corner, and welding strips shall be free of cracks, cleavages, or other defects adversely affecting the protective characteristics of the material. The Engineer may authorize the repair of such defects by approved methods.
3) The lining to have good impact resistance, be flexible, and have an elongation sufficient to bridge up to 1/4 IN settling cracks, which may occur in the structure or pipe or in the joint after installation, without damage to the lining.
4) The lining to be repairable at any time during the life of the pipe or structure.

5. Chemical Resistance:
   a. After conditioning to constant weight at 110 Deg F, tensile specimens and weight change specimens to be exposed to the following solutions for a period of 112 days at 77 Deg F ± 5 Deg F.
      1) At 28-day intervals, tensile specimens and weight change specimens to be removed from each of the chemical solutions and tested. If any specimen fails to meet the 112-day requirements before completion of the 112-day exposure, the material will be subject to rejection.

Chemical Solution	Concentration
Sulfuric Acid	20%*
Sodium Hydroxide	5%
Ammonium Hydroxide	5%*
Nitric Acid	1%*
Ferric Chloride	1%
Soap	0.1%
Detergent (linear alkyl benzyl sulfonate or LAS)	0.1%
Bacteriological	BOD not less than 700 ppm

* Volumetric percentages of concentrated C.P. grade reagents.

6. Details and dimensions of basic size sheets (4 FT widths):
   a. Liner sheets will integral locking extensions to be a minimum of 0.065 IN thickness.
   b. Locking extensions (T-shaped) of the same material as that of the linear to be integrally extruded with the sheet.
   c. Locking extensions to be approximately 2.5 IN apart and shall be at least 0.375 IN high.

d. Sheets to have a nominal width of 48 IN and a length of not more than 24 FT, except that longer lengths may be supplied on special order.
   1) Lengths specified shall include a tolerance at a ratio of ± 1/4 IN for each 100 IN.
e. Sheets not used for shop fabrication into larger sheets to be shop tested for pinholes using an electrical spark tester set at 20,000 volts minimum.

7. Sheets and Accessories:
   a. Linings to be supplied as fabricated by shop welding the basic size sheets together.
      1) Shop welds to be made by lapping sheets of a minimum of 1/2 IN and applying heat and pressure to the lap to produce a continuous welded joint. Welding strips shall be approximately 1 IN wide with a minimum width of 7/8 IN. The edges of weld strips shall be beveled in the manufacturing process. Thickness of weld strip shall be nominal 1/8 IN
      2) Tensile strength measured across shop-welded joints measured in accordance with ASTM D412 to be at least 2,000 psi.
   b. Sheets that are strapped on forms to have a transverse strap channels cut in the locking extensions so that the strapping can be placed into perpendicular to the locking extensions.
      1) Channels to be not less than 3/4 IN wide and not more than 1 IN wide and to be cut so that a maximum 3/16 IN of the base of the locking extensions remains in the base of the strap channel.
      2) Strap channels to be provided at intervals of not less than 15 IN nor more than 20 IN center-to-center.
      3) Strap channels will not be cut through the final two locking extensions on each edge of the sheet.
8. Corrosion Resistance:
   a. Joint and welding straps shall have the same corrosion resistance as the sheet lining material. (The joint and welding strips shall be applied by thermal welding methods in the field.)
9. Holiday Testing.

B. Installation Products:
   1. Adhesive Products: Adhesive products and application procedures used in the installation of plain liner sheets shall be as recommended by the manufacturer of the liner. Adhesive products intended for use inside existing and cast-in-place structures shall be non-flammable. Use of adhesive products shall be approved by the Engineer.
   2. Caulking Products: Caulking material s hall be in accordance with the following requirements:
      a. Caulking between PVC liner and unlined surfaces, including but not limited to bare concrete, other than PVC lined pipes, etc., shall be performed with a 1-component moisture-cured, non-sag permanently flexible elastomeric polyurethane sealant.
      b. Caulk shall be resistant to attack from dilute acids and alkaline substances, jet fuel, water and domestic wastewater.
      c. Caulk shall cure to a permanently flexible consistency and accommodate joints between materials with dissimilar coefficients of expansion.
      d. Caulk shall have the following material characteristics:

PROPERTY	VALUE	TEST METHOD
100% Modulus*	80 psi	ASTM D-412
Hardness (Shore A)*	40 + 5	ASTM D-2240
Elongation at Break*	700%	ASTM D-412
Tensile Stress*	140 psi	ASTM D-412
Movement Capability	±25%	TT-S-00230C
(*Cured and Tested at 21 days)		

      e. Caulk color shall be "aluminum gray" unless approved otherwise by the Engineer.

f. Caulk shall be SIKAFLEX-1a as manufactured by the Construction Products Division of SIKA Corporation, or equal. The primer shall be SIKAFLEZ 449/203.

3. Mechanical Fasteners: Mechanical fasteners shall be power driven pins which are placed through Type 316 stainless steel washers. Washer diameter shall be as recommended by the liner manufacturer except that the minimum diameter shall be 0.75 IN. A 1/8-IN thick neoprene gasket shall be provided between the washer and the liner.
4. Cleaners: Cleaners used in the installation of the liner shall be as recommended by the manufacturer of the liner. Cleaners shall be nonflammable and shall be water soluble or water dispersible and shall not be detrimental to t he plastic liner.

C. Product Delivery, Storage, and Handling.
1. In accordance with manufacturer's recommendations.

PART 3 - INSTALLATION

3.1 GENERAL

A. Installation of the lining, including preheating of sheets in cold weather and the welding of all joints, to be done in accordance with the recommendations of the manufacturer.

B. Coverage of the lining to be not less than the minimum shown on the plans.

C. The lining to be held snugly in place against inner forms by means of steel banding straps or by other means recommended by the manufacturer.
1. Banding straps must be located in the precut strap channels to prevent crushing or tilting of the locking extension.

D. If banding straps are used, a steel channel, angle, or bar may be inserted along the edge locking extension of each liner sheet for cast-in-place structures.
1. Banding straps must be located in the precut strap channels to prevent crushing or tilting of the locking extensions.

E. Concrete poured against lining to be vibrated, spaded, or compacted in a careful manner to protect the lining and produce a dense, homogenous concrete, securely anchoring the locking extensions into the concrete.

F. In removing forms, care should be taken to protect the lining from damage.
1. Sharp instruments not to be used to pry forms from lined surfaces.
2. When forms are removed, any nails that remain in the lining to be pulled, without tearing the lining, and the resulting holes clearly marked.
3. Form tie holes to be marked before ties are broken off and all areas of serious abrasion or damage shall be marked.

G. All nail and tie holes and all cut, torn, and seriously abraded areas in the lining to be patched.
1. Patches made entirely with welding strip to be fused to the liner over the entire patch area.
2. Larger patches may consist of smooth liner sheet applied over the damaged area with adhesive.
3. All edges must be covered with welding strip fused to the patch and the sound lining adjoining the damaged area.

H. Hot joint compounds, such as coal tar, not to be poured or applied to the lining.

I. Contractor to take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the work.

3.2 APPLICATION TO CAST-IN-PLACE CONCRETE STRUCTURES - SPECIAL REQUIREMENTS

A. Linear sheets to be closely fitted and properly secured to the inner forms.

1. Sheets to be cut to fit curved and warped surfaces using a minimum number of separate pieces.
2. If liner joins are to be Type C-3 joints, the adjacent sheets to be butted with not more than 1/4 IN opening between the sheets.
3. A 2-IN-wide water-resistant tape or welding strip to be welded on the back of butt joints to prevent wet concrete from flowing around edges.

B. Unless otherwise shown on the plans, the lining will be returned at least 3 IN at the surfaces of contact between the concrete structure and items not of concrete (including manhole frames, gate guides, clay pipe, or brick manholes, and clay or cast iron pipes).
1. The same procedure will be followed at joints where the type of protective lining is changed or the new work is built to join existing unlined concrete.
2. At each return, the return liner will be sealed to the item in contact with the plastic-lined concrete using Amer-Plate 19Y (or equal) adhesive system.
3. If the liner cannot be sealed with this adhesive because of the joint at the return being too wide or rough or because of safety regulations, the joint space will be densely caulked with lead wool or other approved caulking with lead wool or other approved caulking
4. material to a depth of 2 IN and finish with a minimum of 1 IN of an approved corrosion resistant material.

3.3 JOINTS IN LINING FOR CAST-IN-PLACE CONCRETE STRUCTURES

A. Lining at joints will be free of all mortar and other foreign material and will be clean and dry before joints are made.

B. Field joints in the lining will be of the following described types, used as prescribed:
1. Type C-1: The joint will be made with a separate 4-IN joint strip and two welding strips.
   a. The 4-IN joint strip will be centered over the joint, heat-sealed to the liner then welded along each edge to adjacent sheets with 1-IN-wide welding strip.
   b. The width of the space between adjacent sheets will not exceed 2 IN.
   c. The 4-IN joint strip will lap over each sheet a minimum of 0.5 IN. It may be used at any transverse or longitudinal joint.
2. Type C-2: The joint will be made by lapping sheets not less than 0.5 IN.
   a. One 1 IN welding strip is required.
   b. The upstream sheet will overlap the one downstream.
   c. The lap will be heat-sealed into place prior to welding.
3. Type C-3: The joint will be made by applying 2 IN wide waterproof tape or 1 IN wide welding strip on the back of the butt joint or by some other method approved by the engineer to prevent wet concrete from getting under the sheet.
   a. After the forms have been stripped, a 1 IN welding strip will be applied over the face of the sheet.

C. All welding is to be in strict conformance with the specifications of the lining manufacturer.

3.4 TESTING AND REPAIRING DAMAGED SURFACES

A. After the pipe is installed in the trench, all surfaces covered with lining, including welds, will be tested with an approved electrical holiday detector [Tinker & Rasor Model No. AP-W (or equal) with power pack] with the instrument set at 20,000 volts minimum. Contractor shall pay for testing.
1. All welds shall be physically tested by a nondestructive probing method.
   a. All patches over holes, or repairs to the liner wherever damage has occurred.

B. Each transverse welding strip which extends to a lower edge of the liner will be tested by the purchasing agency.
1. The welding strips will extend 2 IN below the liner to provide a tab.
2. A 10-pound pull will be applied to each tab.
3. The force will be applied normal to the face of the structure by means of a spring balance.

4. Liner adjoining the welding strip will be held against the concrete during application of the force.
5. The 10-pound pull will be maintained if a weld failure develops, until no further separation occurs.
6. Defective welds will be retested after repairs have been made.
7. Tabs shall be trimmed away neatly by the installer of the liner after the welding strip has passed inspection.
8. Inspection will be made within 2 days after joint has been completed in order to prevent tearing the projecting weld strip and consequent damage to the liner from equipment and materials used in or taken through the work.

3.5 LINING MANUFACTURER REPRESENTATIVE

A. A representative of the lining manufacturer shall visit the jobsite on four separate occasions as follows:
   1. When the first pipe is delivered, taking this opportunity to train the welders.
   2. Twice to witness installation of PVC on forms.
   3. When the welding is complete.
      a. Charges for these visits should be obtained by the Contractor from the lining manufacturer and these charges should be included in the Contractor's bid.

B. Training Requirements:
   1. Prior to installation of lining on-site, a representative of the lining manufacturer shall provide training to the Contractor (including PVC welders, and concrete form carpenters), and CMD staff. The training shall cover the following applications:
      a. Field joints and lining.
      b. Pipe laterals (non PVC-lined pipe) installed through lined concrete pipe.
      c. Cast-in-place concrete structures.
      d. Field quality control.
   2. Charges for this training will be at the Contractor's expense.

3.6 WELDER QUALIFICATION TESTING

A. Each PVC liner welder shall pass a qualification welding test before doing any welding. Requalification may be required at any time deemed necessary by the Engineer and shall consist of the following:
   1. Two pieces of liner, at least 15 IN long and 9 IN wide shall be lapped 1-1/2 IN and held in a vertical position.
   2. A welding strip shall be positioned over the edge of the lap and welded to both pieces of liner. Each end of the welding strip shall extend at least 2 IN beyond the liner to provide tabs.

END OF SECTION

SECTION 07120
FLUID APPLIED WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fluid applied waterproofing.
   2. Protection course.
   3. Specific concrete finishing requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C836, Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
      b. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   2. International Concrete Repair Institute (ICRI):
      a. 310.2, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
   3. The Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 6/NACE No. 3, Commercial Blast Cleaning.
      b. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Applicator(s) licensed or approved in writing by manufacturer.
   2. Applicator(s) shall have minimum of seven (7) years experience in application of cold liquid-applied elastomeric waterproofing membranes with minimum of two (2) years installation of products specified or accepted for use on this Project.
      a. Provide list of projects completed in last two (2) years using products proposed for use.
         1) Include name of structure, area waterproofed (SF) and name of contact with phone number.

C. Miscellaneous:
   1. Manufacturer's authorized representative shall review substrate preparation and provide written approval of substrate prior to installation of product.

1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Details showing flashing of penetrations, terminations, expansion joints, protection course attachment and other special conditions.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

4. Certification of Applicator qualifications.
5. Applicator's experience record.
6. Listing of projects completed in last two (2) years.

B. Informational Submittals:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Manufacturer's written approval of substrate.
3. Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Waterproofing system:
a. Tremco Sealants and Waterproofing.
b. Carlisle Coatings and Waterproofing.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Primer: Manufacturer's recommended primer appropriate to substrate.

B. Waterproofing System:
1. One (1) or two (2) component, moisture curing polyurethane elastomer meeting requirements of ASTM C836.
2. Flowing type for surfaces up to 5 percent slope.
3. Non-flow type for surfaces exceeding 5 percent.
4. Carlisle "Liquiseal CCW-525" or Tremco "TREMproof 201/60."

C. Adhesive: Manufacturer's standard.

D. Flashing Reinforcement: Woven uncoated fiberglass mesh.

E. Sealant: Manufacturer's recommended sealant.

F. Protection Course:
1. Material capable of protecting cured membrane from damage caused by rocks and other debris in the backfill material.
2. Acceptable to waterproofing manufacturer.

G. Backer Rod: Closed cell polyurethane foam rod.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cure concrete and masonry in accordance with manufacturer's recommendations.
1. Verify moisture content does not exceed manufacturer's maximum allowable.
2. Ensure that curing agents used are compatible with coating system.

B. Remove surface contamination by high pressure water cleaning per ASTM D4258.

C. Verify that concrete has been troweled and broomed, free of fins, ridges or voids.
1. Verify that all tie holes and honeycomb areas, holes and voids have been patched in accordance with specifications and coating manufacturer's recommendations.

D. Prepare substrate per manufacturer's published instructions and this Specification Section.

1. Concrete surfaces:
    a. Abrasive blast in accordance with SSPC SP 13/NACE No. 6 to provide a profiled surface.
        1) Profile: ICRI 310.2, CSP 3 minimum.
2. Metal surfaces:
    a. Abrasive blast in accordance with SSPC SP 6/NACE No. 3.
        1) Minimum one (1) mil surface profile.
    b. Prime coat all metal surfaces.
3. Flash all penetrations and other areas in accordance with manufacturer's instructions.
4. Clean and seal cracks and joints in accordance with manufacturer's instructions.

E. Protect adjacent surfaces.

3.2 APPLICATION AND INSTALLATION

A. Apply waterproofing system in accordance with manufacturer's printed instructions and this Specification Section.
    1. Provide minimum 60 mil dry film thickness.
    2. Apply waterproofing to the exterior side of vertical concrete wall surfaces (surfaces against earth) where finished interior building space occurs on the opposite side of the wall and where indicated on the Drawings.
        a. Terminate top of waterproofing in accordance with manufacturer's instructions approximately 4 IN below finished grade unless shown otherwise on Drawings.

B. Extend coating over all previously flashed areas.

C. Allow vertical applications to cure minimum of 12 HRS at 75 DegF or as recommended by manufacturer, prior to backfilling.

END OF SECTION

SECTION 07176
LIQUID WATER REPELLENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Liquid water repellent.

1.2 QUALITY ASSURANCE

A. Material must not inhibit the adhesion of future paint coatings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Letter from manufacturer stating that product is suitable for intended use and is compatible with and will not cause discoloration of masonry units.
   3. Field conducted water spray test results.
   4. Warranty.

1.4 WARRANTY

A. Provide manufacturer's standard five (5) year performance warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Liquid water repellent:
      a. L&M Construction Chemicals, Inc.
      b. Chemprobe Technologies, Inc.
      c. Hydrozo, Inc.
      d. Degussa.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Liquid Water Repellent Type 1:
   1. Clear, penetrating micro-emulsion water repellent formulated for sealing concrete masonry.
      a. Water based, VOC compliant, odorless.
         1) VOC: Less than 195 g/L.
      b. Non-yellowing, non-staining.
      c. Provides both surface barrier and penetrating chemical action-forming barrier.

2. Surface barrier shall protect against water intrusion, mildew, dirt and airborne contaminants.
3. L&M Construction Chemicals, Inc. "HYDROBLOCK."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect adjacent surfaces not intended to be covered.

B. Clean surfaces to be covered in accordance with manufacturer's recommendations.

C. Make all mortar repairs at least 48 HRS prior to application.

D. Allow masonry surfaces to cure minimum of 10 days prior to application.

3.2 INSTALLATION AND APPLICATION

A. Install products in accordance with manufacturer's instructions.
   1. At a minimum apply material in accordance with manufacturer's recommended application rates using procedures and equipment recommended by manufacturer.
      a. Apply two (2) coats of material.

B. Apply liquid water repellent "Type 1" to exterior concrete masonry block surfaces.

3.3 FIELD QUALITY CONTROL

A. Manufacturer or manufacturer's designated representative shall conduct a water spray test.
   1. Water from the spray shall impact the wall at a 45-degree angle to the vertical and shall cover an area of not less than 9 SF.
   2. Water flow shall be minimum 5 gpm at 60 psi pressure.
   3. If, within 5 HRS, moisture appears on the inside face of the wall within the test area, the wall shall be recoated.

B. Retest as required.

C. Recoat as required until wall area remains dry within limits of testing procedure.

D. Results of this test shall be used to determine material quantity in excess of manufacturer's minimum recommended amounts to be applied per square foot to the building surface.

E. Protect adjacent materials not required to be coated.

END OF SECTION

SECTION 07412
METAL ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Standing seam metal roofing.
   2. Soffit panels.
   3. Prefinished gutters and downspouts.
   4. Roof insulation, vapor retarder, sheathing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 621, Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
   2. ASTM International (ASTM):
      a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. C209, Standard Test Methods for Cellulosic Fiber Insulating Board.
      c. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
      d. E96, Standard Test Methods for Water Vapor Transmission of Materials.
      e. E1592, Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
      f. E1646, Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
      g. E1680, Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.
      h. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Architectural Sheet Metal Manual, Sixth Edition, 2003.
   4. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
      b. Fire Resistance Directory.
      c. 580, Standard for Tests for Uplift Resistance of Roof Assemblies.
   5. Building code:
      a. 2010 California Building Code and associated standards including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Manufacturer shall have minimum of 10 years experience in the production of structural standing seam metal roofing.
      a. All structural components of the roof system shall be designed and sealed by registered professional structural engineer licensed in the State of California.
   2. Installing contractor shall be licensed or approved in writing by manufacturer.
   3. Contractor and installer shall have minimum of seven (7) years experience in the installation of structural standing seam metal roof systems similar to system specified.
   4. Contractor and installer shall have successfully completed two (2) projects of similar size, scope and complexity within past two (2) years.

5. All roll forming performed on-site shall be supervised by personnel trained and employed by the roofing manufacturer.
    a. Roofing manufacturer shall have been engaged in field roll forming for a minimum of 15 years with experience in roll forming long panels similar to panels being used.

C. Mock-Ups:
1. Prior to start of permanent roof construction construct mock-ups of roofing.
    a. Mock-ups shall be of sufficient size to properly display all components required by the roofing and fascia, and soffit system.
    b. Mock-ups shall be a minimum 5 FT x 5 FT in size.
    c. Provide multiple mock-ups as required.
2. Mock-ups shall incorporate all components, specified and/or required but not specified, needed for a complete water and airtight roofing fascia, and soffit system.
    a. Components include, but are not limited to:
        1) Roofing panels, seaming, eave, rake and top of roof flashing and counterflashing as well as roof/vertical wall intersection flashing and counterflashing conditions, all reglet conditions, mansard fascia, gutter, downspout and soffit conditions.
        2) Vapor retarders, insulation, roof underlayment, sheathing, miscellaneous clips, angles, plates, brackets, closures, calking, roof penetration flashing, counter flashing.
3. Panels shall be same panels as specified or approved for Project.
    a. Exact color is not necessary; however, Contractor is to label each exposed component to identify final installed color of component.
4. Step construction to allow observation of all components.
5. Construct additional mock-ups or rework existing mock-ups until acceptable to Engineer.
6. Maintain mock-ups at project site until Engineer approves removal of mock-ups.
7. Approved mock-ups to constitute minimum acceptable standard of quality for actual construction.

D. Completed roof system to be inspected by roof manufacturer's authorized factory trained representative prior to issuance of roof warranty.

1.3 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Steep Slope: Having a pitch of 3:12 or greater.

C. Low Slope: Having a pitch less than 3:12 but greater than 1/4:12.

D. PVDF: Polyvinylidene fluoride.

1.4 SYSTEM DESCRIPTION

A. Prefinished steel gutters and downspouts, prefinished aluminum soffit panels, and field-insulated standing seam roof system consisting of exterior panel, field installed insulation, and vapor retarder over sheathing over metal roof deck.
1. Roof panel support and attachment system to be determined by standing seam roof manufacturer.

B. System also includes masonry reglets, metal flashing, counterflashing, snow retention system, and miscellaneous trim required for a complete water and airtight system.

1.5 SUBMITTALS

A. Shop Drawings:
1. See Section 01340 for requirements for the mechanics and administration of the submittal process.

2. Fabrication and/or layout drawings:
    a. Manufacturer prepared computer generated Drawings showing anchorage, flashing, jointing and all other accessories required and all special detailing required by the system.
        1) Minimum plan scale: 1 IN = 8 FT.
        2) Minimum detail scale: 1-1/2 IN = 1 FT.
    b. Provide complete erection plan for each building structure with all details and sections referenced, all penetrations shown, expansion joints shown, detailed and referenced, and all special conditions identified, referenced and detailed.
    c. Erection plan to identify limits of each different substrate material (decking).
    d. Provide distinction between factory and field assembled work.
3. Product technical data including:
    a. Manufacturer data sheets on each component, including masonry reglets used in the roof system.
    b. Acknowledgement that products submitted meet requirements of standards referenced.
        1) Certification by manufacturer that roofing assembly being supplied has been successfully tested under UL 580 procedures and has achieved a Class 90 rating.
4. Test results:
    a. UL 580, Class 90 test data.
    b. ASTM E1592 test results.
        1) Provide results of tests conducted in accordance with ASTM E1592 for panel size and gage and clip type and spacing similar to panels and clips being used.
    c. ASTM E1646 and ASTM E1680 test results.
    d. Concentrated load test data.
        1) Load test to be conducted on panel size, gage and with clip spacing as required.
5. Qualifications:
    a. Manufacturer: Provide structural engineer qualifications.
    b. Contractor:
        1) Certification of approval or license to install product from manufacturer.
        2) Certification of experience.
        3) Listing of projects completed in the past two (2) years.
        4) Completed projects information to include, square footage of roofing installed, dollar value of roofing installed, manufacturer and type of roofing installed and contact name and telephone number of building Owner.
    c. Installer: Provide qualifications of all personnel expected to be working on the Project.
6. Roofing manufacturer's letter of approval for insulation proposed for use.
7. Warranty: Sample language of manufacturer's warranty to be provided on this Project.
8. Structural Engineer's sealed and signed calculations certifying that system structural components meet the requirements for lateral, upward and downward loads specified.

B. Samples:
    1. General: Tag, identify and provide statement regarding use for all fasteners, anchor clips, closures and sealants.
    2. Roof panel:
        a. Two (2) samples, full width, 24 IN long.
        b. Provide color selected or specified when possible.
    3. Fasteners.
    4. Anchor clips.
    5. Closures, (both metal and non-metallic).
    6. Masonry reglet.
    7. Factory and field applied sealants.
    8. Color samples:
        a. For initial preliminary color selection, provide manufacturer's color chart showing all colors available.
        b. For final color selection, provide two (2) 2 IN x 3 IN colored metal samples, for each color selected during the initial color selection.

C. Operation and Maintenance Manuals:
   1. See Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

D. Miscellaneous Submittals:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Final warranty.

1.6 WARRANTY

A. Provide 10 year complete system warranty, including material and material substrate for air and weather tightness of entire roof assembly signed by manufacturer.
   1. Warranty limits shall meet the minimum load capacity requirements of ASTM E1592.

B. Provide manufacturer's 20 year warranty on panel finish against fading, chipping, cracking and peeling of the panel exterior finish and/or erosion of substrate metal.
   1. Repair of panel finish shall be done using material, color and application method to match surrounding panel finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Metal roofing and fascia products specified are manufactured by Centria.

B. Manufacturers listed and other manufacturers not listed, but capable of meeting these specifications, are expected to provide a system with similar profile, standing seam height, spacing, construction and factory applied finish.

C. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Metal roofing and fascia:
      a. Centria.
      b. Merchant and Evans - Zip Rib.
      c. Or equal.
   2. Soffit panels: Provided by metal roofing panel manufacturer.
   3. Vapor retarder:
      a. Griffolyn.
      b. Or equal.
   4. Insulation: Any manufacturer meeting these specifications and approved by metal roofing manufacturer.
   5. PVDF resin:
      a. PPG - DURANAR.
      b. Valspar - Fluropon.
      c. Arkema Inc. - KYNAR 500.
      d. Solvay Solexis - HYLAR 5000.
      e. Or equal.
   6. Sheathing:
      a. Gypsum board sheathing: ASTM C1177.
         1) Water and moisture-resistant treated gypsum core.
         2) Glass mat facing front and back.
      b. Mold resistant: ASTM D3273.
      c. Class ‘A’ fire rated per UL 790.
      d. Flame spread 15 and smoke developed 0 when tested in accordance with ASTM E84 or UL 723.
      e. Thickness: 5/8 IN.

f. Compatible with roofing vapor retarder, insulation and adhesives.
g. Georgia-Pacific “DensDeck Roof Board”.
h. Or equal.

D. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Roof Panels:
1. General:
a. Steel, ASTM A653, SQ, Grade 37.
1) Galvanized G90 coating.
2) Galvalume coated steel conforming to ASTM A792, Grade 50B.

B. Soffit Panels: Aluminum, ASTM B209.

C. Insulation:
1. Rigid polyisocyanurate.
a. Approved by roofing manufacturer.

D. Perimeter Trim, Panel Closures, Flashing and Counterflashing: Material and factory applied finish to match roof panels.

E. Fasteners: 300 series stainless steel, ASTM F593.

F. Intermediate Support System:
1. Galvanized steel: ASTM A653, SQ, Grade 50, G90 coating.

G. Sealant: Manufacturer's standard.

H. Sheathing: See Specification Section 06100.

I. Masonry Reglets: See Specification Section 04155.

2.3 ACCESSORIES

A. Gutters and Downspouts:
1. Steel, ASTM A653, SQ, Grade 37.
a. Aluminum-zinc coated steel, ASTM A792, SQ, Grade 50B.
b. Minimum thickness: 22 GA.
c. Galvanized G90 coating.
1) Meet requirements of AAMA 621.
2. Gutters:
a. "Style D" gutter per SMACNA Figure 1-2.
1) Seamless except for expansion joints.
b. All exposed surfaces to have finish and color to match roofing metal.
c. Gutter straps and eave closure flashing: Minimum 22 GA to match gutter material, finish and color.
3. Downspouts:
a. SMACNA Figure 1-32B.
1) Seam on concealed side of downspout.
2) Provide gutter to downspout connection per SMACNA Figure 1-33B, Detail 1.
b. Downspout straps: Minimum 22 GA with finish and material to match downspout.
c. Finish: To match roof panels.
d. Color: To match roof panels on Administration Building.

B. Roof Insulation:
1. Rigid polyisocyanurate foam board.
a. ASTM C1289, Class I, Type II.
b. Compressive strength: 20 psi minimum.
c. Density: 2 pcf minimum.
d. Thermal resistance (R-Value): 7.2/IN.

e. Water vapor transmission: ASTM E96, less than 1.0 perms.
f. Water absorption: ASTM C209, less than 1.0 percent.
g. Thickness noted on Drawings.
h. Acceptable to roof manufacturer.

C. Roof Penetration Flashing:
1. Round penetrations:
a. Premolded EPDM boot with metal collar.
b. Buildex "DEK-TITE.".

D. Flashing Curb:
1. Provided by metal roofing manufacturer.
2. One-piece completely seal welded prefabricated roof curb, including vertical flashing, and counter flashing, cricket on high side of penetration and flat pan fabricated to replace standing seam metal roof panel.
3. Size as required for penetration.
4. Bottom sloped to match roof.
a. Level on top.
5. Minimum 16 GA galvanized metal finished to match roof panel.

E. Foam and metal closures, calking, gaskets, fasteners, washers, clips, angles, and all miscellaneous trims shall be provided by roofing manufacturer, fabricated for the specific condition as required.

F. Soffit Panels:
1. Minimum 0.032 IN aluminum, ASTM B209.
2. Factory applied finish to match roof panels.
3. AAMA 2605.
4. Profile: Flat interlocking sheet with reinforcing ribs as required to prevent warping and oil canning.
5. Panel joints shall match standing seam spacing of roof panels when possible.
6. Provide soffit vent panels where indicated on Drawings.
a. If not indicated, provide vent panels at maximum 4 FT OC with minimum of three (3) vent panels per side of building.
b. Vent panels shall be compatible with and supported by soffit panel systems.
c. Vent panels shall have minimum 10 percent free area and shall have the maximum amount of panel face perforations allowed structurally.
1) Perforations to be in the form of holes, minimum 3/32 IN and maximum 1/8 IN DIA, equally spaced on staggered centers from row to row.
d. Vent panels shall be same size and profile as solid panels.
1) Factory applied finish to match solid panels.
7. Hat shaped steel channel sub-framing:
a. 1 IN deep x 20 GA galvanized steel, G90 coating.

2.4 FABRICATION

A. General:
1. Fabricate with square, true corners, mitered and welded.
2. Fabricate trim, flashings and closure pieces to match panel profile and finish.
3. Hem all edges.
4. Fabricate panels in full length with no end laps.
a. Any roll-forming of panels at the jobsite must be performed with industrial type rolling mill having at least 10 stands to gradually shape the sheet metal, maintaining flatness and strict tolerances.
5. Soffit panels shall be continuous length.
a. Miter panels at corners and provide trim piece as required.
b. Miscellaneous length pieces not acceptable.

B. Standing Seam Metal Roof Panels:
   1. Profile: Centria "SRS" System.
   2. Height of standing seam: 2 IN.
   3. Gage: Minimum 24.
   4. Width: 18 IN.
      a. Longitudinal stiffening elements to minimize oil canning.
   5. System shall be designed as a true structural standing seam shape.
   6. Finish:
      a. PVDF based with minimum 70 percent resin.
      b. Three-coat system having minimum 0.8 mil epoxy primer coat on both sides of panel with a 0.8 mil PVDF resin color coat and a 0.8 mil PVDF resin clear top coat on the exterior side of the panel.
      c. Meet or exceed requirements of AAMA 621.
      d. Smooth finish.
      e. Centria "DURAGARD PLUS."
      f. Color:
         1) To be selected from manufacturers full range of colors.
            a) Does not include Centria "SUNDANCE" Series colors.
   7. Concealed fasteners:
      a. Provide concealed fasteners in all locations.
      b. If exposed fasteners are required by the roof panel manufacturer, because of location, constructability issues or other critical design requirement, finish of fastener shall match roof panel finish.
         1) Exposed fasteners are to be approved by Engineer.
      c. The use of deflection limiter devices is not allowed.

C. Intermediate Support System:
   1. Roof panel anchor clips:
      a. Manufacturer's standard one-piece clip suitable for condition.
         1) Two-piece clips are acceptable if required by roofing manufacturer.
      b. Minimum 16 GA.
      c. ASTM A653, hot-dipped galvanized, with minimum 2.0 OZ zinc/SF coating.
   2. Roof panel manufacturer shall be responsible for designing and providing all necessary intermediate "Z" or "hat-shaped" or other miscellaneous support members as required to transfer roof panel loads into building roof framing members.
      a. Design in accordance with Building Code and loads specified.
   3. Bearing plates:
      a. Galvanized steel sized by roofing manufacturer for roof loading indicated.
      b. Minimum 16 GA.
      c. ASTM A653, hot-dipped galvanized, with minimum 2.0 OZ zinc/SF coating.

2.5 SOURCE QUALITY CONTROL

A. Structural Testing:
   1. The system shall be designed to safely resist the positive and negative loads as specified below:

AREA	POSITIVE (DOWNWARD)
Overhangs	
All other areas	

AREA	NEGATIVE (UPWARD)
Ridge, Eave, Gable	
Corner	
All other areas	

2. Structural-uniform uplift load capacity of the panel system shall be determined in accordance with ASTM E1592.
    a. The factor of safety on the test results shall be 1.65 for the panel, batten or clip ultimate loads with no increase for wind.
    b. The factor of safety for fasteners shall be 3.0 for one (1) single fastener per clip, 2.25 for two (2) fasteners per clip and 4.0 in masonry.
    c. Design uplift capacity for conditions of gage, span or loading other than those tested may be determined by interpolation of test results.
        1) Extrapolation of conditions outside the range of the tests is not acceptable.
    d. Deflection shall be L/180 for positive loading.

B. Water Penetration: No uncontrollable leakage at minimum 6.4 psf when tested in accordance with ASTM E1646.

C. Air Infiltration: Maximum 0.00 scfm/SF when tested at 4.0 psf differential pressure when tested in accordance with ASTM E1680.

D. The panel system shall have a UL 580, Class 90, FM 1-120 rating.

E. The panels shall withstand a 250 LB concentrated load applied to a 4 SQ IN area at the center of the panel at mid span between supports with no panel deformation, rib buckling, or panel sidelap separation which will adversely affect the weather tightness of the system.

F. Support roofing panels on top of roof insulation using bearing plates attached to the structural frame or connect to manufacturer-provided intermediate support system.
    1. Bearing plate and standing seam roof panel anchor clip attachment is to be determined by the roofing manufacturer and shall take precedent over this Specification.
        a. Provide attachment to roof structural frame or deck as required for loading criteria specified.
    2. Roof panel anchor clips shall be designed to allow thermal movement of the panels except where specific fixed points are indicated.
        a. Roof panel manufacturer shall be responsible for determining fixed point locations unless otherwise indicated.
        b. Wood blocking shown at roof edge is strictly for attachment of miscellaneous flashings and shall not be used for any structural value.
    3. Maximum spacing of roof clips shall be determined by manufacturer.

G. Roof panel manufacturer shall be responsible for designing and installing all necessary expansion joints in the roof and fascia system.

2.6 MAINTENANCE MATERIALS

A. Provide Owner with 4 OZ of touch-up paint to match each different color used in the system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide all closures, trim, angles, plates, calking, gaskets, fasteners, washers, etc., as required for a complete water and air tight installation.

B. Install all soffit panels in accordance with manufacturer's recommendations using concealed fasteners when possible.
    1. Exposed fasteners to be painted to match soffit finish.

C. Install products in accordance with manufacturer's instructions, SMACNA (where referenced) and details shown on Drawings.

D. Attachments shall allow for thermal expansion and contraction.

E. Seal all joints as required for watertight installation.

F. Install panels in one (1) continuous length from ridge to eave.

G. Touch-up paint all damaged surfaces.

H. Gutters:
   1. Install gutters using gutter straps in accordance with SMACNA Table 1-8 and Figure 1-12 and per roofing manufacturer's recommendations.
      a. Provide gutter brackets or hangers at 24 IN OC maximum.
      b. Provide expansion joints in gutters per SMACNA and at expansion joint locations shown on Drawings.
      c. Install gutters to provide positive drainage to downspout locations.
      d. Seal all joints in gutters to provide completely water tight system.

I. Downspouts:
   1. Install downspouts in locations shown on the Drawings.
   2. Provide downspout anchor straps per SMACNA Figure 1-35 as appropriate for downspout style.
   3. Provide gutter to downspout connection per SMACNA Figure 1-33B, Detail 1.
   4. Seal all joints in downspout for a complete watertight system.
   5. Anchor hanger straps to building wall with stainless steel screws and anchor sleeves appropriate for wall construction.
      a. Provide minimum of two (2) anchors per strap.
   6. Maximum spacing of hanger straps shall be 10 FT with minimum of two (2) hanger straps per vertical piece of downspout.
   7. Spacing and location of hanger straps shall be consistent from downspout to downspout.

J. Install sheathing to meet wind uplift rating requirements specified.

END OF SECTION

SECTION 07900
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sealant work.

B. Work included consists of but is not necessarily limited to:
   1. Sealing all joints which will permit penetration of dust, air or moisture, unless sealing work is specifically required under other Specification Sections.
      a. Work includes but is not limited to:
         1) Flashing, reglets and retainers.
         2) Masonry control joints, brick expansion joints and between masonry and other materials.
         3) Flooring joints.
         4) Isolation joints.
         5) Joints between paving or sidewalks and building.
         6) Concrete construction, control and expansion joints.
         7) Joints between precast roof units, between precast roof units and walls, and joints between precast wall panels.
         8) Penetrations of walls, floors and decks.
         9) Perimeters of door and window frames, louvers, grilles, etc.
         10) Thresholds.
         11) Plumbing fixtures.
         12) Perimeter and penetrations of sound insulated walls.
         13) Other joints where sealant, expanding foam sealant or compressible sealant is indicated.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 302.1R, Guide for Concrete Floor and Slab Construction.
   2. ASTM International (ASTM):
      a. C834, Standard Specification for Latex Sealants.
      b. C920, Standard Specification for Elastomeric Joint Sealants.
      c. C1521, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   3. NSF International (NSF):
      a. 61, Drinking Water System Components -- Health Effects.
   4. Underwriters Laboratories, Inc. (UL).

B. Qualifications: Sealant applicator shall have minimum five (5) years experience using products specified on projects with similar scope.

C. Mock-Ups:
   1. Before sealant work is started, a mock-up of each type of joint shall be sealed where directed by the Engineer.
      a. The approved mock-ups shall show the workmanship, bond, and color of sealant materials as specified or selected for the work and shall be the minimum standard of quality on the entire project.

b. Each sample shall cure for a minimum of seven (7) days at which time the sealant manufacturer's authorized factory representative shall perform adhesion tests on each sample joint.
   1) Perform adhesion tests per ASTM C1521.
   2) If mock-up is not acceptable or if adhesion test fails, provide additional mock-up and adhesion testing as required until acceptable to Engineer.

1.3 DEFINITIONS

A. Corrosive Areas Include: All areas.

B. Defect(ive): Failure of watertightness or airtightness.

C. Finish sealant: Sealant material per this specification applied over face of compressible sealant or expanding foam sealant specified, to provide a finished, colored sealant joint.

D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

E. "Interior wet areas": Entire area is considered wet.

F. "Seal," "sealing" and "sealant": Joint sealant work.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling and bond breaker.
   3. Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied.
   4. Certification of applicator qualification.

B. Test Results:
   1. Provide adhesion test results for each sealant sample including adhesion results compared to adhesion requirements.
   2. Manufacturer's authorized factory representative recommended remedial measures for all failing tests.

C. Samples:
   1. Cured sample of each color for Engineer's color selection.
   2. Color chart not acceptable.

D. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in manufacturer's original unopened containers with labels intact: Labels shall indicate contents and expiration date on material.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Compressible sealant:
      a. Polytite Manufacturing Corporation.
      b. Emseal.
      c. Norton.
      d. Sandell.
   2. Expanding foam sealant:
      a. Macklanburg Duncan.
      b. Convenience Products.
      c. FAI International, Inc.
   3. Polyether sealants:
      a. BASF Sonneborn.
      b. ChemLink, Inc.
   4. Polyurea joint filler:
      a. Dayton Superior Specialty Chemical Corporation.
      b. Euclid Chemical Co.
      c. L&M Construction Chemicals, Inc.
      d. BASF Sonneborn.
   5. Polyurethane sealants:
      a. Pecora.
      b. Sika Chemical Corp.
      c. BASF Sonneborn.
      d. Tremco.
   6. Silicone sealants:
      a. ChemLink.
      b. GE Construction Sealants.
      c. Dow Corning.
      d. Tremco.
   7. Backer rod, compressible filler, primer, joint cleaners, bond breaker: As recommended by sealant manufacturer.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Sealants - General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Sealant backer rod and/or compressible filler:
      a. Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
         1) Control joint depth.
         2) Break bond of sealant at bottom of joint.
         3) Provide proper shape of sealant bead.
         4) Serve as expansion joint filler.

B. Compressible Sealant:

1. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing coated on front face with nonreactive release agent that will act as bond breaker for applied sealant.
    a. Polytite Manufacturing Corp. "Polytite-B."
2. Fire rated where required.
3. Adhesive: As recommended by sealant manufacturer.

C. Expanding Foam Sealant:
1. One (1) or two (2) component fire rated moisture cured expanding urethane.
2. Shall not contain formaldehyde.
3. Density: Minimum 1.5 pcf.
4. Closed cell content: Minimum 70 percent.
5. R-value: Minimum 5.0/IN.
6. Flame spread: Less than 25.
7. Smoke developed: Less than 25.

D. Polyether Sealant:
1. Silyl-terminated polyether polymer.
2. ASTM C920, Type S, Grade NS, Class 50, Use NT, M, A, and O.
    a. BASF Sonneborn Sonolastic 150 with VLM Technology.
    b. ChemLink DuraLink.

E. Polyurea Joint Filler:
1. Two (2) component, semi-rigid material for filling formed or saw-cut control joints in interior concrete slabs.
    a. Dayton Superior Specialty Chemical Corp. "Joint Fill, Joint Seal, Joint Saver II" as required for condition and recommended by manufacturer.
    b. Euclid Chemical Co. "EUCO QWIK" joint.
    c. L&M Construction Chemicals, Inc. "Joint Tite 750".
    d. BASF Sonneborn "TF-100" control joint filler.
2. Comply with ACI 302.1R performance recommendations regarding control and construction joints.
3. Color: Gray.

F. Polyurethane Sealant:
1. One (1) or two (2) components.
2. Paintable.
3. Meet ASTM C920 Type S or Type M, Grade NS or P, Class 25, Use NT, T, M, A and O.
    a. Pecora Dynatrol-IXL, Dynatrol II, Urexpan NR-200, NR-201.
    b. Sika Chemical Corporation Sikaflex-1a, Sikaflex-2C NS/SL.
    c. BASF Sonneborn Sonolastic NP-1, NP-II, SL-1 SL-2.
    d. Tremco Dymonic or Dymeric, Vulkem 116,227,45,245.

G. Silicone Sealant:
1. One (1) component.
2. Meet ASTM C920, Type S, Grade NS, Class 25, Use NT, G, A, O.
    a. ChemLink: DuraSil.
    b. General Electric: Silpruf, Silglaze II.
    c. General Electric: Sanitary 1700 sealant for sealing around plumbing fixtures.
    d. Dow Corning: 786 for sealing around plumbing fixtures.
    e. Dow Corning: 790, 795.
    f. Tremco: Spectrem 1, Spectrem 3, Tremsil 600.
3. Mildew resistant for sealing around plumbing fixtures.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before use of any sealant, investigate its compatibility with joint surfaces, fillers and other materials in joint system.

B. Use only compatible materials.

C. Where required by manufacturer, prime joint surfaces.
   1. Limit application to surfaces to receive sealant.
   2. Mask off adjacent surfaces.

D. Provide joint depth for joints receiving polyurea joint filler in accordance with manufacturer's recommendations.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions and UL requirements.

B. Clean all joints.

C. Make all joints water and airtight.

D. Make depth of sealing compounds, except expanding foam and polyurea sealant, not more than one-half width of joint, but in no case less than 1/4 IN nor more than 1/2 IN unless recommended otherwise by the manufacturer.

E. Provide correctly sized backer rod, compressible filler or compressible sealant in all joints to depth recommended by manufacturer:
   1. Take care to not puncture backer rod and compressible filler.
   2. Provide joint backer rod as recommended by the manufacturer for polyurea joint filler.

F. Apply bond breaker where required.

G. Tool sealants using sufficient pressure to fill all voids.

H. Upon completion, leave sealant with smooth, even, neat finish.

I. Where piping, conduit, ductwork, etc., penetrate wall, seal each side of wall opening.

J. Install compressible sealant to position at indicated depth.
   1. Size so that width of material is twice joint width.
   2. Take care to avoid contamination of sides of joint.
   3. Protect side walls of joint (to depth of finish sealant).
   4. Install with adhesive faces in contact with joint sides.
   5. Install finish sealant where indicated.

K. Install expanding foam sealant to minimum 4 IN depth or thickness of wall being penetrated if less than 4 IN or as indicated on Drawings.
   1. Provide adequate fire rated backing material as required.
   2. Hold material back from exposed face of wall as necessary to allow for installation of backer rod and finish sealant.
      a. Allow expanding foam sealant to completely cure prior to installing backer rod and finish sealant.
   3. Trim off excess material flush with surface of the wall if not providing finished sealant.

3.3 FIELD QUALITY CONTROL

A. Adhesion Testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: One (1) test per every 1000 LF of joint sealed.
      b. Exterior precast concrete wall panels: One (1) test per every 2000 LF of joint sealed.

c. Chemical containment areas: One (1) test per every 1000 LF of joint sealed.
d. Building expansion joints: One (1) test per every 500 LF of joint sealed.
e. All other type of joints except butt glazing joints: One (1) test per every 3000 LF of joint sealed.
f. Manufacturer's authorized factory representative shall recommend, in writing, remedial measures for all failing tests.

3.4 SCHEDULE

A. Furnish sealant as indicated for the following areas:
1. Exterior areas:
   a. Above grade: Polyether.
   b. Below grade: Polyurethane.
2. Interior areas:
   a. Noncorrosive areas:
      1) Wet exposure: Polyether.
         a) Toilet rooms, locker rooms, janitor closets or similar areas: Mildew resistant silicone.
      2) Dry exposure: Polyether, unless noted otherwise.
   b. Corrosive areas:
      1) Wet exposure: Polysulfide.
      2) Dry exposure: Polyurethane.
   c. Sealant exposed to or having the potential of being exposed to concentrated chlorine gas or chlorine liquid: Polysulfide.
   d. Casework, countertops and solid surface materials: Silicone.
      1) Sinks, fixtures or other areas subject to potential splash, spillage or condensation: Mildew Resistant Silicone.
3. Immersion:
   a. Prolonged contact with or immersion in:
      1) Potable water:
         a) Polysulfide.
         b) NSF 61 approved.
      2) Nonpotable water, wastewater or sewage: Polysulfide.
4. Compressible sealant: Where indicated.
5. Exterior wall penetrations: Expanding urethane foam, with finish sealant.
   a. Finish sealant:
      1) Exterior side:
         a) Above grade: Polyether.
         b) Below grade: Polyurethane.
      2) Interior side:
         a) Noncorrosive area:
            (1) Wet exposure: Polyether.
            (2) Dry exposure: Polyether, unless noted otherwise.
         b) Corrosive area:
            (1) Wet exposure: Polysulfide.
            (2) Dry exposure: Polyurethane.
6. Interior concrete slab formed or saw-cut control joints: Polyurea joint filler.

END OF SECTION

SECTION 08110
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal doors and frames.
   2. Grouting of door frames.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 04110 - Cement and Lime Mortars.
   4. Section 08700 - Finish Hardware.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. FM Global (FM).
   3. National Association of Architectural Metal Manufacturers (NAAMM):
      a. Hollow Metal Manufacturers Association (HMMA).
   4. Steel Door Institute (SDI):
      a. 117, Manufacturing Tolerances for Standard Steel Doors and Frames.
      b. All SDI publications.
   5. Steel Door Institute/American National Standards Institute (SDI/ANSI):
      a. A250.6, Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
      b. A250.7, Nomenclature for Standard Steel Doors and Steel Frames.
      c. A250.8 (formerly SDI 100), Recommended Specifications for Standard Steel Doors and Frames.
      d. A250.10, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
      e. A250.11, Recommended Erection Instructions for Steel Frames.
   6. Building code:
      a. Title 24, Part 2 California Building Code.

B. Qualifications: Manufacturer must be current member of SDI, and NAAMM (HMMA).

C. Wipe coat galvanized steel is not acceptable as substitute for galvanizing finish specified.

1.3 DEFINITIONS

A. As identified in SDI/ANSI A250.7.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

3. Schedule of doors and frames using same reference numbers as used on Drawings.
4. SDI certification.

B. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store doors and frames in accordance with SDI/ANSI A250.11.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Metal doors and frames:
a. CECO Corporation.
b. Steelcraft Manufacturing Co.
c. Curries Company.

B. No like, equivalent or "or-equal" item or substitution is permitted.

C. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Steel Sheet: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

B. Frames: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

C. Supports and Reinforcing: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

D. Inserts, Bolts and Fasteners: Manufacturer's standard.

E. Primer: Manufacturer's standard coating meeting SDI/ANSI A250.10.

F. Galvannealed Coating Repair: See Specification Section 09905.

G. Grout: As specified in Specification Section 04110.

H. Thermal Insulation: Polyurethane, CFC free.

2.3 ACCESSORIES

A. Frame Anchors:
1. Jamb anchors:
a. Masonry wire anchors: Minimum 0.1875 IN wire, galvanized.
b. Existing wall anchor: Minimum 18 GA, galvanized.
c. Stud partition and base anchors: Minimum 18 GA, galvanized.

B. Louvers:
1. In accordance with SDI 111C.
2. Galvanized steel: ASTM A653, G60.
3. Frame: Minimum 18 GA.
4. Blades: Minimum 22 GA.
5. Blades welded to frame.
6. Blade profile: Inverted "Y" with minimum free area of 50 percent.
7. Similar to Anemostat "AFDL."

2.4 FABRICATION

A. General:
   1. SDI/ANSI A250.8.
   2. Fabricate rigid, neat in appearance and free from defects.
   3. Form to sizes and profiles indicated on Drawings.
      a. Beveled edge.
   4. Fit and assemble in shop wherever practical.
   5. Mark work that cannot be fully assembled in shop to assure proper assembly at site.
   6. Continuously wire weld all joints, dress exposed joints smooth and flush.
   7. Provide minimum 18 GA galvanized steel channel reinforcing on all sides of louver cut out.
   8. Fabricate doors and frames to tolerance requirements of SDI 117.
   9. Fit doors to SDI clearances.
   10. All doors shall be handed.
   11. Hinge cut-out depth and size on doors and frames shall match hinge specified in Specification Section 08700.
   12. Design and fabricate doors to requirements of the Building Code.

B. Hollow Metal Doors:
   1. General:
      a. 1-3/4 IN thick.
      b. Fabricate with flush top caps.
         1) Thickness and material to match door face.
         2) Exterior doors: Seal weld top cap to door face and grind smooth and flush.
         3) Interior doors:
            a) Attach top cap to door with concealed fasteners or by welding.
            b) Factory seal if attached with fasteners.
            c) No exposed fasteners will be accepted.
      c. Continuously wire weld all joints and dress, smooth and flush.
   2. Exterior:
      a. SDI/ANSI A250.8, Level 4, and physical performance level A, Model 3.
         1) Face sheet minimum thickness: 14 GA.
         2) Insulated: Minimum R10.
   3. Interior:
      a. SDI/ANSI A250.8, Level 3, and physical performance level A, Model 3.
         1) Face sheet minimum thickness: 16 GA.
      b. Sound insulated, minimum STC-35.

C. Hollow Metal Frames:
   1. Door frames:
      a. Provide 2 IN face at all heads, jambs and mullions for frames in stud walls.
      b. Provide 4 IN face at head where noted on Drawings or required by wall construction.
      c. 26 GA galvannealed steel boxes welded to frame at back of all hardware cutouts.
      d. Steel plate reinforcement welded to frame for hinge, strikes, closers and surface-mounted hardware reinforcing.
         1) All plate reinforcement shall meet size and thickness requirements of SDI/ANSI A250.8.
      e. Split type frames not acceptable.
         1) All horizontal and vertical mullions and transom bars shall be welded to adjacent members.
      f. Conceal all fasteners.
      g. Frames shall be set up, all face joints continuously wire welded and dressed smooth.
      h. Frame thickness: 16 GA.
      i. Provide removable spreaders at bottom of frame.

D. Prepare for finish hardware in accordance with hardware schedule, templates provided by hardware supplier, and SDI/ANSI A250.6.

1. Locate finish hardware in accordance with SDI/ANSI A250.8.
2. See Specification Section 08700 for hardware.
3. Prepare doors for swing direction indicated.
    a. Preparing doors for non-handed hinges is not acceptable.

E. After fabrication, clean off mill scale and foreign materials and prime with rust inhibiting primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install doors and frames in accordance with SDI/ANSI A250.11, the Building Code and manufacturer's instructions.

B. Plumb, align, and brace frames securely until permanently anchored.
1. After completion of walls, remove temporary braces and spreaders.
2. Anchor frames with minimum of three (3) anchors per jamb.
    a. Number and location of anchors shall be in accordance with SDI and frame manufacturer's recommendations.

C. At new masonry or metal stud construction, place frames in conjunction with construction of walls or partitions.
1. Masonry construction: Anchor frames using masonry wire anchors.
2. Metal stud construction:
    a. Anchor frames using steel stud anchors.
    b. Attach wall anchors with self-tapping screws.

D. At concrete, precast concrete or existing masonry construction, place frames in rough opening using existing opening anchors.

E. Use plastic plugs to keep silencer holes clear during construction.

F. Immediately after erection, sand smooth rusted or damaged areas.
1. Touch-up with rust-inhibiting primer.
2. Finish paint door and frame in accordance with Specification Section 09905.

G. Install three (3) silencers on strike jamb of single door frame and two (2) on head of double door frame.
1. See Specification Section 08700.

H. Protect doors and frames during construction.

END OF SECTION

SECTION 08305
ACCESS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Floor access doors.
   2. H-20 loading doors.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. ASTM International (ASTM):
      a. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      d. A480, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      e. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      f. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      g. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      h. B221,Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 DEFINITIONS

A. Standard Duty: Will support live load of 150 psf.

B. Heavy Duty: Will support live load of 300 psf.

C. H-20 loading: As defined in AASHTO Guidelines.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Floor access doors:
    a. Bilco Company.
    b. Babcock Davis Associates.
    c. Dur-Red Products.
    d. Halliday Products.
    e. USF Fabrication Inc.
2. H-20 loading doors:
    a. Bilco Company.
    b. Dur-Red Products.
    c. Halliday Products.
    d. USF Fabrication Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Aluminum:
1. Sheet and Plate: ASTM B209.
2. Extruded shapes: ASTM B221.

B. Steel:
1. Sheet Metal: G90 Galvanized, ASTM A653.
2. Fabrications: Hot-Dip Galvanized, ASTM A123.
3. Hardware: Hot-Dip Galvanized, ASTM A153.

C. Stainless Steel: ASTM A240 or A666.

2.3 MANUFACTURED UNITS

A. General:
1. All access doors shall be provided by the same manufacturer when possible.
2. Coat all aluminum components in contact with concrete or masonry with manufacturer's standard bituminous coating.

B. Standard Duty Floor Access Doors:
1. Frame: 1/4 IN mill finished aluminum.
    a. Fabricate frame with built-in neoprene cushion and strap anchors bolted to exterior.
2. Cover: 1/4 IN mill finished diamond plate aluminum.
    a. Reinforce cover with aluminum stiffeners.
        1) Live load: 150 psf.
        2) Deflection: Maximum 1/150 of span.
    b. Fabricate doors to open to 90 degrees and automatically lock into open position.
3. Hardware:
    a. All hardware to be stainless steel.
    b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
    c. Slam lock and removable key handle.
    d. Bolt hinges to underside of door.
        1) Pivot on torsion bars.
4. SlamBilco Company, Type "K" or "KD."
    a. Size(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.

C. Heavy Duty Floor Access Doors:
1. Frame: 1/4 IN mill finish aluminum channel with anchor tabs.
    a. 1-1/2 IN DIA drain coupling.
2. Cover:
    a. 1/4 IN mill finished diamond plate aluminum.
    b. Reinforce cover with aluminum stiffeners.
        1) Live load: 300 psf.
        2) Deflection: Maximum 1/150 of span.

3. Hardware:
    a. All hardware to be stainless steel.
    b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
    c. Slam lock and removable key handle.
4. Bilco Company, Type "J-AL" or "JD-AL."
    a. Size(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.

D. H-20 Loading Doors:
1. Frame: 1/4 IN mill finish aluminum channel with anchor tabs.
    a. 1-1/2 IN DIA drain coupling.
2. Cover:
    a. 1/4 IN mill finished diamond plate aluminum.
    b. Reinforce cover with aluminum stiffeners.
        1) Reinforced for AASHTO H-20 wheel loading for use in off street applications.
        2) Deflection: Maximum 1/150 of span.
3. Hardware:
    a. All hardware to be stainless steel.
    b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
    c. Slam lock and removable key handle.
4. Bilco Company, Type "J H-20" or "JD H-20."
    a. Size(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.

E. Floodtight Access Door:

2.4 ACCESSORIES

A. Secondary Fall Protection System:
1. Design and install system such that when in the open position, no part of the system obstructs the clear opening size listed in the SCHEDULES Article in PART 3 of this Specification Section.
2. Platform: Design grating to meet OSHA 29 CFR 1910.23 requirements for protection for floor openings.
3. Finish:
    a. Powder coated.
    b. Color: Safety Orange or Safety Yellow.
4. Hardware:
    a. Stainless steel Type 316.
    b. Tamper proof Type 316 stainless steel bolts.
5. Provide positive latch to hold grating in upright position.
6. Size: Size grating platform to allow 6 IN clear space on each unhinged side for visual observation.
7. Provide padlock hasp for Owner provided padlock.
8. Double leaf openings:
    a. Provide two (2) individual grating platforms hinged on the same side of the hatch frame but independent from one another.
        1) Provide each platform with a padlock hasp and positive latch to hold grating in upright position.
9. Install secondary fall protection system at the factory.

B. Load Rating Plates:
1. Minimum 18 GA Type 316 stainless steel, ASTM A666.
2. Engraved with maximum design live load allowed for unit on which it will be mounted.
3. Display load in English units as well as metric units.
4. Size as required for text as needed.
5. Text:
    a. Font: Helvetica Narrow, all caps.

b. Size: 1/4 IN height.
c. Depth of engraving: 3 mils.

6. Finish:
   a. Text:
      1) Black epoxy baked on paint.
      2) Plate to have finish conductive to paint application.
   b. Coat entire plate with baked on clear coat on front and back side.
7. Attach to top of all floor or vault access doors using stainless steel screws in location determined by manufacturer.
   a. Provide a neoprene gasket under the plate to separate the stainless steel from the aluminum cover or frame.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 SCHEDULES

A. Floor Access Door Schedule: See Drawings.

END OF SECTION

SECTION 08332
STEEL ROLLING OVERHEAD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel rolling overhead doors.
      a. Motor operated.
      b. Insulated.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11005 - Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      c. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. Underwriters Laboratories (UL):
      a. UL 325, Door, Drapery, Gate, Louver and Window Operators and Systems.

B. Qualifications:
   1. Installer to be licensed or approved in writing by door manufacturer.

1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's standard color charts.
   3. Schedule of doors using same reference number for openings as indicated on Drawings.
   4. Motor operator and accessories technical data including complete wiring and control diagrams.
   5. Certifications:

a. Certification of installer qualifications.

B. Samples:
1. Actual metal color samples of manufacturer's full line of colors available.

C. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.

D. Informational Submittals:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Steel rolling overhead doors:
a. The Cookson Company.
b. Cornell Iron Works.
c. Wayne Dalton.
d. Overhead Door Corp.
e. Raynor.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Door Curtain and Hood: Galvanized steel, ASTM A653, G-60.

B. Insulation: Closed cell polyurethane foam.
1. CFC free.

C. Weatherproofing: Neoprene or vinyl.

D. Guides, Head Plates and Pipe Barrel: Galvanized steel, ASTM A123/A123M.

E. Fasteners: Same material as door construction.

2.3 ACCESSORIES

A. Motor Operator:
1. Minimum 1/2 HP, 115/1/60.
a. Motor shall be sized by door manufacturer for door size indicated on Drawings.
b. Provide manufacturer's standard reversing controller with motor thermal protection if motor is not internally protected as specified in Specification Section 11005.
2. Instant reversing with electric reversing safety edge and weather seal on bottom of door. Photo electric sensor entrapment protection.
a. Provide complete wiring connections for instant reversing safety edge photo electric sensor entrapment protection to motor operator including all intermediate junction boxes, conduit, disconnects, wiring and low voltage wiring.
3. Opening and closing rate: Between 2/3 and 1 FPS.
4. Standard oiltight three (3) pushbutton control(s).
a. NEMA 4/13.

2.4 FABRICATION

A. Door Curtain:

1. Non-insulated flat profile:
    a. 2-5/8 IN high.
    b. Minimum 22 GA.
    c. Galvanized steel endlocks.
2. Insulated flat profile with interlocking face sheets:
    a. 2-5/8 IN high.
    b. Exterior face: Minimum 22 GA.
    c. Interior face: Minimum 24 GA.
    d. Galvanized steel endlocks.
    e. Core: Insulated.
3. Weather stripping:
    a. Guide sealing adjustable weatherstripping at jambs and lintel (exterior doors only).
4. Bottom bar: Reversing electric safety edge with weatherseal. Reversing electric safety edge. Photo electric sensor entrapment protection.
5. Finish: Factory prime and finish coats.
    a. Prime coat: Minimum 0.2 mil baked-on prime paint.
    b. Finish coat: Minimum 0.6 mil baked-on polyester powder coat.
    c. Color: To be selected by Engineer from manufacturer's complete offering.

B. Hood:
1. Minimum 24 GA.
2. Provide full length air baffle weatherstripping at all exterior doors.
3. Finish: Match door curtain.

C. Guides:
1. Mounting:
    a. Interior face of wall.
2. Manufacturer's standard structural angle guide system for size of door specified.
    a. Cold-rolled guides are not acceptable.
    b. Furnish wind locks.
3. Finish: Match door curtain.

D. Head Plates:
1. Galvanized steel plate mounted to guides.
2. Sized to support counter balance assembly, curtain, motor operator and hood.
3. Finish: Match door curtain.

E. Counterbalance Assembly:
1. Pipe barrel:
    a. Galvanized steel pipe shaft.
    b. Maximum deflection: 0.03 IN/FT.
2. Torsion springs:
    a. Oil-tempered helical torsion springs on cast anchors.
    b. 100,000 cycle.
3. Adjustable tension wheel.

F. Trim Pieces: Material and finish to match curtain.

G. Wind Load: 20 psf minimum.

H. Operation:
1. Motor operated with chain operator backup.

I. Insulated door system: Overhead Door Corp. "625" Series.

2.5 SOURCE QUALITY CONTROL

A. Air Infiltration: 1.98 CFM/SF of door when tested on a 10 FT x 10 FT door in accordance with ASTM E283 with 25 mph wind load.

B. Products and installation shall comply with UL 325.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Installation shall be done by manufacturer's authorized representative.

C. Provide all required trim, weatherstripping, closures etc., for complete weather tight installation.

D. Adjust for proper counter balance.

E. Seal along bottom of vertical track (guides), seal the vertical joint between the two (2) separate track angles (if not filled by welding) and seal all holes in vertical track (not being used for fasteners) to provide a completely weather tight track and door system.
   1. At fastener locations provide steel washers under bolt head to completely cover the slotted holes in the vertical track.
      a. Finish of steel washer shall match finish of track (guides).

F. Electrical disconnect and conduit and wiring from standard three (3) pushbutton control to motor operator is provided in the Electrical Design.

G. Provide bracing for motor operator to eliminate vibration.

3.2 ADJUSTMENT

A. Prior to occupancy, adjust door for smooth operation.

END OF SECTION

SECTION 08600
ALUMINUM ACCESS HATCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Description:
   1. This section specifies access hatches with fall protection grates.

B. See Drawings for locations and dimensions.

1.2 QUALITY ASSURANCE

A. Equipment to be the product of a single manufacturer.

B. Demonstrate at least 3 years of continuous successful experience in ten similar applications.

1.3 SUBMITTALS

A. Contract Document Coordination.
   1. Provide copies of the following contract documents, with addenda updates, that apply to the equipment in this section marked to show specific changes necessary for the supplied equipment. If no changes are required, the document shall be marked “No Changes Required”.
      a. This specification section and referenced sections.
      b. Mechanical Arrangement and Detail Drawings.
      c. Product Technical Information.

B. Shop Drawings.
   1. Elevation and plan view of each hatch.
   2. Details of safety grates.
   3. Detail of frame, including mounting of neoprene gasket.
   4. Detail of lifting mechanisms.
   5. Detail of hold open arms and guides.

C. Operations and Maintenance Information.

1.4 SITE CONDITIONS

A. As specified in Section 01601.

1.5 WARRANTY

A. Comply with minimum contract requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturers: One of the following or equal:
   1. Bilco, to match existing.
   2. Or approved equal.

2.2 ACCESS HATCHES, COMPONENTS, AND MATERIALS

A. Sizes:
   1. As indicated on the Drawings and in the schedule.

2. Sizes indicated reflect the clear opening required for each hatch.

B. Access Hatches:
1. Double leaf (DL) or single leaf (SL) as indicated on the Drawings and in the Schedule.
2. Provide each leaf with a minimum of two compression spring lifting mechanisms designed to prevent entry of dirt and foreign matter into the compression spring housing.
3. Provide a recessed locking mechanism and flush lift handles.
4. Leafs: Diamond pattern, milled aluminum, 1/4 IN thickness, ASTM B 221, Alloy 5086.
5. Leaf Gaskets: EPDM or neoprene gasket, mechanically attached to the access hatch frame.
6. Type 316 stainless steel hardware throughout.

C. Hatch Hinges:
1. Heavy forged aluminum with 1/4 IN diameter stainless steel hinge pins provided, designed to pivot so the cover does not protrude into the channel frame.
2. Specifically designed for horizontal installation.
3. Through bolted to the covers with tamperproof Type 316 stainless steel lock bolts and through bolted to the frame with Type 316 stainless steel bolts and locknuts.

D. Lifting mechanisms: Compression spring-type mechanism within a telescoping tube. Provide automatic hold-open arms with release handles. Attach lower tube of lifting mechanism to a flanged support shoe fastened to a formed 1/4 IN gusset support plate.

E. Locking Mechanisms:
1. Exterior: Provide removable turn/lift handle with spring loaded ball detent to open the cover. Protect latch release by a flush, gasketed, removable screw plug.
2. Interior: Provide Type 316 stainless steel snap lock with fixed handle mounted on the underside of the cover.

F. Frame: Aluminum channel frame, 1/4 IN thickness, ASTM B221 alloy 6063-T5, with a perimeter anchor flange with anchor tabs around the perimeter.

G. Provide a 1-1/2 IN drainage coupling, zinc plated and chromate sealed, in a corner of the channel frame.

H. Finish: Mill-finish. Apply coating specified in Section 09905 to the exterior of the embedded frame where aluminum is in contact with concrete.

2.3 FALL PROTECTION GRATE COMPONENTS AND MATERIALS

A. Underlying fiberglass safety grates to allow inspection of the wet well while providing fall-through protection.

B. Safety grates:
1. Fiberglass molded in one piece with load bearing bars in both directions to allow for use without continuous side support.
2. Openings between flat bars shall be not less than 4 IN x 4 IN to facilitate visual inspection.
3. Provided with a hinging system that will lock the grate in the 90° open position.
4. Provide a stainless steel release handle and stainless steel hold open arm.
5. High visibility yellow in color.

2.4 DESIGN REQUIREMENTS

A. Structural:
1. Standard Weight Design Requirements: Design access hatch with 1/4 IN aluminum plate, reinforced to withstand a live load of 300 pounds per square foot with a maximum deflection of 1/150 of the span.
2. Traffic Loading Design Requirements: Design access hatch with 1/4 IN aluminum diamond pattern plate, reinforced to withstand an H-20 highway load with a maximum deflection of 1/150 of the span.
3. Design fall protection grates to withstand a live load of 300 lb/ft^2 with a maximum deflection of 1/150 of the span.

B. Performance
   1. Smooth and easy opening and closing with controlled operation throughout the entire arc of opening and closing, regardless of ambient temperature.
   2. Design lifting mechanism to retard downward motion of the cover when closing to prevent quick closing and slamming.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01600.

3.2 INSTALLATION

A. Install in accordance with the manufacturer's instructions.

B. Install access hatch with frame set level and flush with the surrounding surface.

C. Protect the exterior of hatch frames in contact with concrete as specified in Section 09905.

D. Connect a 1-1/2 IN diameter copper drain pipe to the drainage coupling on the hatch frame and route the drain pipe to the nearest drain.

END OF SECTION

SECTION 08700
FINISH HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finish hardware.
   1. Inspection and testing of door operation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 08110 - Metal Doors and Frames.

1.2 QUALITY ASSURANCE

A. All door hardware shall be provided by a single hardware supplier.
   1. Hardware is to be provided under this Specification Section, unless noted otherwise, for doors specified in:
      a. Specification Section 08110.

B. Referenced Standards:
   1. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
      a. A156.1, Butts and Hinges.
      b. A156.3, Exit Devices.
      c. A156.6, Architectural Door Trim.
      d. A156.16, Auxiliary Hardware.
      e. A156.18, Materials and Finishes.
      f. A156.21, Thresholds.
   2. Door and Hardware Institute (DHI).
   3. Steel Door Institute (SDI).
   4. Building code:
      a. Title 24, Part 2 California Building Code.

C. Qualifications:
   1. Installation shall be inspected by a certified Architectural Hardware Consultant (AHC).

1.3 DEFINITIONS

A. AHC: Architectural Hardware Consultant, certified by DHI.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

C. All weather: Capable of operation from -50 to +120 DegF.

D. Active Leaf: Right-hand leaf when facing door from keyed side unless noted otherwise on Drawings.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Qualifications

a. AHC qualifications and certification.
b. No submittals will be reviewed until Engineer has received AHC certification.

3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
4. Schedule of all hardware being used on each door.
   a. Number hardware sets and door references same as those indicated on Drawings.
5. Technical data sheets on each hardware item proposed for use.
6. Certification from AHC stating all door hardware has been reviewed by AHC and verified to be compatible with doors and frames.
7. Warranty information for all hardware devices having extended warranties.

B. Informational Submittals:
   1. Certifications:
      a. Certification from AHC stating all door hardware has been provided per approved Shop Drawings, has been installed in accordance with manufacturer's recommended installation instructions and all doors have been inspected and tested and found to be in proper working order.

1.5 WARRANTY

A. Provide all individual manufacturers' extended warranties as advertised.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Locksets and latchsets:
      a. Corbin/Russwin.
      b. Best Access Systems.
   2. Hinges:
      a. Stanley Works.
      b. Hager Hinge Co.
      c. McKinney Manufacturing Co.
   3. Door stops and holders:
      a. Trimco.
      b. Rockwood.
      c. Ives.
   4. Weatherstripping and thresholds:
      a. Pemko Manufacturing Co.
      b. Reese Enterprises, Inc.
      c. Zero Weatherstripping, Inc.
      d. National Guard Products, Inc.
   5. Exit devices:
      a. Von Duprin, Inc.
      b. Corbin/Russwin.
      c. Precision.
      d. Sargent.
   6. Door bolts, coordinators and strikes:
      a. Ives.
      b. Trimco.
      c. Hager.
      d. Rockwood.
      e. Dorma.
   7. Other materials: As noted.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. General: As indicated in the FABRICATION Article in PART 2 of this Specification Section.

B. Fasteners: Stainless steel or aluminum.

C. Thresholds: Aluminum.

D. Keys: Brass or bronze.

E. Weatherstripping Seals: Polypropylene, neoprene, or silicone.

F. Pulls and Push Plates: Stainless steel.

2.3 ACCESSORIES

A. Strikes:
   1. Curved lips.
      a. Extended lips when required.
   2. Furnish strike boxes.
   3. Appropriate for function and hardware listed.

2.4 FABRICATION

A. Hardware - General:
   1. Generally prepare for Phillips head machine screw installation.
   2. Exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of other work as closely as possible.
   3. Provide concealed fasteners unless thru bolted.
   4. Through bolt closers on all doors.
   5. Furnish items of hardware for proper door swing.
   6. Furnish lock devices which allow door to be opened from inside room without a key or any special knowledge.

B. Hardware:
   1. Provide stainless steel dustproof strikes for all doors with manual flush bolts or other bolts into floor.
   2. Provide following ANSI/BHMA A156.18 finishes:
      a. BHMA 630, satin stainless steel or BHMA 626, satin chromium plated over nickel.

C. Bored Locks and Latches:
   1. ANSI/BHMA A156.2, Series 4000, Grade 1.
   2. Minimum latch bolt projection shall be ½ IN.
   3. Functions: F82 (Entry / Office): Turn / push button locking. Pushing and turning button locks outside lever requires use of key until button is manually unlocked. Pushing button locks outside lever until unlocked with key or inside lever is turned. Deadlocking latchbolt operated by inside lever at all times.
   4. Lockset trim: Provide lever handles in lieu of knobs. Levers shall return to within ½ IN of the door face. Levers shall comply with California Title 19 – Public Safety, and California Building Code requirements. Provide Roses or Escutcheon Plates as required.

D. Lock Cylinders:
   1. ANSI/BHMA A156.5, Grade 1. Provide cylinders for new locks that are fully compatible with products of the Best Lock Corporation. Cylinders shall include interchangeable cores with seven pin tumblers which are removable by a special control key.

E. Hinges:
   1. Butt hinges:
      a. ANSI/BHMA A156.1.
         1) A5111: Stainless steel, full-mortise, anti-friction bearing, Grade 1.
      b. Ball bearing.
      c. Flat button tips.
      d. Butt hinges:
         1) Hager BB1199.
         2) McKinney T4B3386.
      e. Hinge size:
         1) 4.5 IN x 4.5 IN.

F. Door Stops:
   1. ANSI/BHMA A156.16.
      a. Floor stop: Rockwood No. 467 with molded rubber bumper.

G. Door Pulls and Push Plates:
   1. ANSI/BHMA A156.6., stainless steel.
   2. Push plate: 4 x 16 IN, square corner, flat plate, with beveled edges, J301.
   3. Push/Pull set:
      a. 4 IN x 16 IN square corner flat plate with beveled edges and 3/4 IN DIA x 12 IN long pull.
      b. Provide 2-1/2 IN clearance.

H. Thresholds:
   1. ANSI/BHMA A156.21.
   1. One-piece unit.
   2. Height: 1/2 IN high maximum.
   3. Provide required bolt cutouts.

I. Exit Devices:
   1. ANSI/BHMA A156.3, Grade 1, vertical rod type with strikes.

J. Weatherstripping:
   1. Weather seal at jambs and head:
      a. Self-adhesive strip: Pemko S88 compression bulb.
      b. Color: Black.
   2. Sweep at bottom of doors:
      a. Pemko 18100 NB nylon brush.
      b. Color: Clear anodized.
   3. Weather seal astragal at meeting edges of pairs of doors:
      a. Permko 180 4 IN nylon brush.
      b. Color: Clear anodized.

K. Keying:
   1. Establish keying with Owner.
      a. Provide and set up complete visible card indexed system with key tags and control slips.
      b. Tag and identify keys.
      c. Provide two (2) keys for each lock or cylinder.
      d. Master key and key in groups as directed.
      e. Provide construction master keys for all exterior doors.

L. Bolts:
   1. ANSI/BHMAA 156.16.
   2. Surface bolts: Ives SB1640 Series with top and bottom strikes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's installation instructions.
   1. Perform installation by or under the direct supervision of an AHC.

B. Provide all hardware in accordance with Building Code.

C. Fit hardware before final door finishing.

D. Permanently install hardware after door finishing operations are complete.

E. Use SDI mounting heights for hardware.

F. Butt Hinges:
   1. Provide non-removable pin (NRP) at exterior doors.
   2. Quantities: See schedules, Section 3.3.

G. Provide weather seal, door sweep and threshold at all exterior doors and where scheduled on interior doors.
   1. Set thresholds in a full bed of sealant.
   2. Mount door sweeps on exterior face of door.
   3. Mount weather seal astragal at meeting edges of pairs of doors on the exterior face of the doors.

H. Mount kickplates on push side of doors.

3.2 FIELD QUALITY CONTROL

A. Adjust and check each operating item of hardware to assure proper operation or function.
   1. Lubricate moving parts with lubricant recommended by manufacturer.

B. During week prior to startup, make a final check and adjustment of all hardware items.
   1. Clean and lubricate as necessary to assure proper function and operation.
   2. Adjust door control devices to compensate for operation of heating and ventilating equipment.

C. Inspection and Testing:
   1. AHC shall inspect and test all door assemblies and provide written certification that door assemblies are in proper working order.
      a. Door assemblies required to swing in the direction of egress shall be inspected and tested in accordance with NFPA 101.
   2. Submit documentation and certification of testing in accordance with the certifications paragraph in the SUBMITTALS Article in PART 1 of this Specification Section.

3.3 SCHEDULES

A. The number inside the ( ) after the product designation indicates the number per opening for each group scheduled.

B. Descriptive Hardware and Finish Numbers Refer to BHMA/ANSI A.156 Series.
   1. Hardware Group No. 1 - Door No(s): 14-101 and 61-102
      a. Hinges - 4-1/2 x 4-1/2 inch, Full Mortise, Ball Bearing, 5-knuckle, A5111, NRP, BHMA 630, (3 Pair)
      b. Exit Device – Vertical Rod, BHMA 630, Compatible Strikes (1 Each - Active Leaf Only)
      c. Lockset Trim - Lever Operator and Rose, BHMA 626, (1 Set - Active Leaf Only)
      d. Door Pull and Push Plate – 1 each, BHMA 630, (1 Set - Inactive Leaf Only)
      e. Cylinder/Core – Cylinder compatible with Exit Device and BEST compatible Interchangable Core, 7-Pin Tumbler, (1 Each - Active Leaf Only)
      f. Surface Bolts - Stainless Steel, Top and Bottom, with Dustproof Strikes, BHMA 630 (1 Each - Inactive Leaf Only)

g. Threshold Plate - 1/4-inch by 6 inch Aluminum, Beveled Edges, Mill Finish, J37330, (1 Each)
h. Bottom Sweep - Surface-applied,, Aluminum, Nylon Brush, (1 Each Leaf)
i. Perimeter Gaskets – Heavy Duty, Aluminum, Neoprene/Silicone Seal, (1 Set Each Leaf)
j. Astragal Gasket - Surface-applied, Aluminum, Nylon Brush, (1 Each)
k. Door Stop - (1 Each Leaf)

2. Hardware Group 2 – Door No: 61-103
   a. Hinges - 4-1/2 x 4-1/2 inch, Full Mortise, Ball Bearing, 5-knuckle, A5111, NRP, BHMA 630, (3 Pair)
   b. Exit Device – Vertical Rod, BHMA 630, Compatible Strikes (1 Each –Active Leaf Only)
   c. Lockset Trim - Lever Operator and Rose, BHMA 626, (1 Set - Active Leaf Only)
   d. Door Pull and Push Plate – BHMA 630, (1 Set - Inactive Leaf Only)
   e. Cylinder/Core – Cylinder compatible with Exit Device and BEST compatible Interchangable Core, 7-Pin Tumbler, (1 Each - Active Leaf Only)
   f. Surface Bolts - Stainless Steel, Top and Bottom, with Dustproof Strikes, BHMA 630 (1 Set - Inactive Leaf Only)
   g. Threshold Plate - 1/4-inch by 6 inch Aluminum, Beveled Edges, Mill Finish, J37330, (1 Each)
   h. Door Stop – (1 Each Leaf)
3. Hardware Group 3 – Door No(s): 61-102, 61-104, 61-105 and 61-106
   a. Hinges - 4-1/2 x 4-1/2 inch, Full Mortise, Ball Bearing, 5-knuckle, A5111, NRP, BHMA 630, (1-1/2 Pair)
   b. Lockset - Bored, UL Listed, BHMA 626, Compatible Strike, ANSI F82 Entry Function, (1 Each)
   c. Cylinder/Core – BEST compatible Interchangable Core, 7-Pin Tumbler, (1 Each)
   d. Threshold Plate - 1/4-inch by 6 inch Aluminum, Beveled Edges, Mill Finish, J37330, (1 Each)
   e. Bottom Sweep - Surface-applied, Aluminum, Nylon Brush, (1 Each)
   f. Perimeter Gaskets - Heavy Duty, Aluminum, Neoprene/Silicone Seal (1 Set)
   g. Door Stop - (1 Each)
4. Hardware Group 4 – Door No 14-102
   a. Hinges - 4-1/2 x 4-1/2 inch, Full Mortise, Ball Bearing, 5-knuckle, A5111, NRP, BHMA 630, (1-1/2 Pair)
   b. Exit Device – Vertical Rod, BHMA 630, Compatible Strikes (1 Each)
   c. Lockset Trim - Lever Operator and Rose, BHMA 626, (1 Set)
   d. Cylinder/Core – Cylinder compatible with Exit Device and BEST compatible Interchangable Core, 7-Pin Tumbler, (1 Each)
   e. Threshold Plate - 1/4-inch by 6 inch Aluminum, Beveled Edges, Mill Finish, J37330, (1 Each)
   f. Bottom Sweep - Surface-applied, Aluminum, Nylon Brush, (1 Each)
   g. Perimeter Gaskets - Heavy Duty, Aluminum, Neoprene/Silicone Seal (1 Set)
   h. Door Stop - (1 Each)

END OF SECTION

SECTION 09201
METAL FURRING AND LATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal furring and lathing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. C645, Standard Specification for Non-Structural Steel Framing Members.
      c. C841, Standard Specification for Installation of Interior Lathing and Furring.
      d. C847, Standard Specification for Metal Lath.
      e. C1063, Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
      f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2009 Edition including all amendments, referred to herein as Building Code.
      b. California Building Code (CBC).

B. Qualifications:
   1. Installer to have minimum of five (5) years current, continuous experience installing systems and components specified.

1.3 SYSTEM DESCRIPTION

A. Plaster suspension system complete with all inserts, hangers, lath, metal furring, primary load carrying members, secondary load carrying members, corner beads, casing beads, control and expansion joints, vents, reveals, moldings, screeds and any other plaster accessory required to provide a complete, finished plaster suspension system.

B. System to be designed for:
   1. Dead load of plaster system specified.
   2. Additional 20 LB/SF live load.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Erection drawings showing location of each component and detail referenced.
      a. Provide plans, details/sections of all components relating specifically to this project.
         1) Show interface of surrounding structure, attachment and all other accessories required to create a water and air tight (when required) system.
      b. Minimum scale of plans: 1/8 IN = 1 FT.
      c. Minimum scale of details/sections: 1-1/2 IN = 1 FT.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.
c. Product data sheet on each component showing profile, dimensions, gage or thickness and finish.

B. Samples:
1. Provide one (1) 6 IN long sample of each trim component specified or required in finish specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Metal furring and lathing:
a. Amico.
b. Dale/Incor.
c. Dietrich Industries, Inc.
d. National Gypsum Co.
e. U S Gypsum Co.
f. Or equal.
2. Vents, moldings, screeds, etc.:
a. Amico.
b. Dale/Incor.
c. Fry Reglet Corp.
d. National Gypsum Co.
e. USG.
f. MM Systems.
g. Or equal.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. General:
1. Inserts and hangers:
a. Steel.
b. ASTM A653, G60 galvanized.
2. Accessories: Zinc alloy.

B. Primary Carrying Channels:
1. 16 GA roll-formed steel channels.
2. Minimum 1-1/2 IN deep.
3. ASTM A653, G60 galvanized.

C. Metal Furring Channels:
1. Minimum 20 GA steel.
2. ASTM C645.
3. Minimum 7/8 IN deep "hat sections".
a. Adjust depth to suit condition as required.
4. ASTM A653, G60 galvanized.

D. Metal Lath:
1. ASTM C847.
2. Flat or ribbed lath.
3. Paper backed:
a. Vapor retardant paper: Grade B, Style 1, fire rated with flame spread rating of 25 per ASTM E84.

b. Paper backing to be factory bonded to metal lath.
4. ASTM A653, G60 galvanized.
5. Weight required for type and support spacing with minimum weight 2.75 LBS per square yard.

E. External Corner Beads:
1. ASTM A653, G60 galvanized.
2. Small nose corner bead with rigid nose.
3. 3/16 IN maximum ground, with expanded flanges minimum 2-1/2 IN wide.
4. Arch-type corner bead designed for cutting and bending in field when required for curved conditions.

F. Casing Beads:
1. Minimum 24 GA steel.
2. ASTM A653, G60 galvanized.
3. Square edge with minimum 2-1/2 IN expanded flange.

G. Control and/or Expansion Joints:
1. Minimum 24 GA steel.
2. ASTM A653, G60 galvanized.
3. "Double V" type expansion and contraction screed with expanded flanges having total minimum width of 4 IN.

H. Vents, Corner Molding, Reveals, Screeds:
1. Minimum 24 GA steel.
2. ASTM A653, G60 galvanized.
3. Expanded flanges.

PART 3 - EXECUTION

3.1 PREPARATION

A. Touch up abraded galvanized surfaces prior to installation.
1. See Section 09905.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and ASTM C841 and ASTM C1063.

B. Furring and Suspension Systems:
1. Install complete system including hangers, ties, and runners to provide support for plaster bases.
a. Where control or expansion joints or other accessories are indicated on Drawings, provide separate supports on each side of joint.
b. Do not bridge joints with metal furring.
c. Where curved furring is required, install shop fabricated units.
2. Suspend hangers from structure per ASTM C841 or ASTM C1063.
a. Where anchorage, spacing, or location does not provide for acceptable grid support, provide additional carrying components.
3. Locate hangers plumb in relation to main runners.
a. Avoid contact with pipe and duct insulation.
b. Do not pass hangers through ducts.
c. Alter spacing of hangers to avoid ducts and other obstructions.
1) Do not splay hangers.
d. Do not exceed maximum allowable ceiling areas to be supported by each hanger.
4. Install extra hangers to support light fixtures, diffusers, grilles, access panels and other items resting in or on ceilings.
5. Provide additional ceiling framing as required to form and frame openings.

C. Lath:
   1. Install per ASTM C841 and ASTM C1063 requirements and recognized local plastering guidelines.
   2. Provide intermediate metal furring supports if required.
   3. Locate end laps over supports.
      a. Lap minimum 1 IN.
      b. Stagger end laps over different supports.
   4. Wire to furring along edges maximum 12 IN OC.
      a. Where diamond mesh lath is used lath maybe bent around corners.

D. Plaster Accessories:
   1. Install per recognized local plastering guidelines and as indicated on Drawings.
   2. Attach accessories to bases or substrates with galvanized fasteners spaced maximum 8 IN OC.
      a. Nail to masonry or concrete.
   3. Use single length beads wherever length of run does not exceed longest standard stock length available.
      a. Miter or cope at corners.
      b. Set beads with maximum tolerance of 1 in 100 from plumb or level.
      c. Shim as required and align joints with concealed splices or tie plates.
   4. Install corner beads at all external corners.
   5. In addition to ASTM C841 and ASTM C1063 requirements, isolate casing bead from contact with metal window or door frames with minimum 1/4 IN thick foam insulating tape or by use of casing bead with integral compressible vinyl gasket.
   6. Control and expansion joints:
      a. Install specified control and expansion joint accessories.
      b. Miter all intersections and fasten together to prevent individual pieces from pulling apart during handling or construction.
   7. Install bendable arch-type corner beads where external corners are curved.
   8. Where plaster abuts dissimilar construction use modified or semi-square edge casing bead.
   9. At perimeters where edges of plaster are exposed use square casing beads.
   10. Touch-up paint all scratches, nicks, etc., in the painted finish on all plaster accessories and exposed surfaces after plaster operations have been completed.

END OF SECTION

SECTION 09905
PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. High performance industrial coatings (HPIC).
2. Architectural paints (AP).
3. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
4. Minimum surface preparation requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. ASTM International (ASTM):
   a. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   b. D4259, Standard Practice for Abrading Concrete.
   c. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
   d. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   e. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. National Association of Pipe Fabricators (NAPF):
   a. 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
   b. 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings.
3. National Bureau of Standards (NBS):
   a. Certified Coating Thickness Calibration Standards.
4. National Fire Protection Association (NFPA):
   a. 101, Life Safety Code.
5. National Sanitation Foundation International (NSF).
6. Steel Door Institute/American National Standards Institute (SDI/ANSI):
   a. A250.10, Test Procedure and Acceptance Criteria For Prime Painted Steel Surfaces for Steel Doors.
7. The Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Paint Thickness with Magnetic Gages.
   b. SP 1, Solvent Cleaning.
   c. SP 2, Hand Tool Cleaning.
   d. SP 3, Power Tool Cleaning.
   e. SP 16, Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-ferrous Metals.
8. The Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 5/NACE No. 1, White Metal Blast Cleaning.
   b. SP 6/NACE No. 3, Commercial Blast Cleaning.
   c. SP 7/NACE No. 4, Brush-off Blast Cleaning.
   d. SP 10/NACE No. 2, Near-White Blast Cleaning.
   e. SP 12/NACE No. 5, Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
   f. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Coating manufacturer's authorized representative shall provide written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
   2. Applicators shall have minimum of 5 years experience in application of similar products on similar project.
      a. Provide references for minimum of three (3) different projects completed in last five (5) years with similar scope of work.
      b. Include name and address of project, size of project in value (painting) and contact person.

C. Miscellaneous:
   1. Furnish paint through one (1) manufacturer unless noted otherwise.
   2. Coating used in all corridors and stairways shall meet requirements of NFPA 101 and ASTM E84.

D. Deviation from specified mil thickness or product type is not allowed without written authorization of Engineer.

E. Material shall not be thinned unless approved, in writing, by paint manufacturer's authorized representative.

1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified or in Specification Section 11005.

C. Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to condensation, spillage or splash of a corrosive material such as water, wastewater, or chemical solution; or exposure to corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range of 5 to 9.
   1. For purposes of this Specification Section, corrosive environments include:
      a. Influent Headworks Process Area below top slab.
      b. Grit Removal Process Area below top slab.
      c. Primary Clarifiers.
      d. Flow Split and Distribution Boxes.
      e. Aeration Basins.
      f. Secondary Clarifiers.
      g. Gravity Sludge Thickener.
      h. Effluent Pumping Station.

D. Highly Corrosive Environment: Immersion in, or not more than 6 IN above, or subject to condensation, spillage or splash of a highly corrosive material such as water, wastewater, or chemical solution; or exposure to highly corrosive, caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions with pH range below five (5) or above nine (9).
   1. For purposes of this Specification Section, highly corrosive environments include:
      a. Chlorine contact Basins.
      b. Chemical Storage and Feed Areas.

E. Exposed Exterior Surface:
   1. Surface which is exposed to weather but not necessarily exposed to view as well as surface exposed to view.
   2. Exterior surfaces are considered corrosive environment.
      a. The following areas are considered highly corrosive:

1) All chemical unloading stations and areas within 10 FT-0 IN of containment areas.
2) All chemical unloading station containment areas.
3) All areas within a 6 FT radius of chemical tank vents.

F. Finished Area: An area that is listed in or has finish called for on Room Finish Schedule or is indicated on Drawings to be painted.

G. Immersion Surface:
1. Any surface immersed in water or some other liquid.
2. Surface of any pipe, valve, or any other component of the piping system subject to condensation including the pipe support system.

H. Paint includes the following:
1. High performance industrial coatings (HPIC) include: Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

I. Surface Hidden from View: Surfaces such as those within pipe chases, surfaces between top side of ceilings (including drop-in tile ceilings) and underside of floor or roof structures above, surfaces under overhanging walkways if over five feet above adjacent walking surfaces

J. HPIC: High performance industrial coatings.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Applicator experience qualifications.
   a. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's application instructions.
   c. Manufacturer's surface preparation instructions.
   d. If products being used are manufactured by Company other than listed in the MATERIALS Article of this Specification Section, provide complete individual data sheet comparison of proposed products with specified products including application procedure, coverage rates and verification that product is designed for intended use.
   e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
   f. Coating manufacturer's recommendation on abrasive blasting.
   g. Manufacturer's recommendation for universal barrier coat.
   h. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
4. Manufacturer's statement regarding applicator instruction on product use.
5. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by Senior Corrosion Specification Specialist employed by the coating manufacturer.

B. Samples:
1. Manufacturer's full line of colors for Engineer's preliminary color selection.
2. After preliminary color selection by Engineer provide two (2) 3 x 5 IN samples of each final color selected.

C. Operation and Maintenance Manuals:
1. See Section 01342 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:
   1. Name or type number of material.
   2. Manufacturer's name and item stock number.
   3. Contents, by volume, of major constituents.
   4. Warning labels.
   5. VOC content.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, only the following manufacturers are acceptable:
   1. High performance industrial coatings:
      a. Tnemec.
      b. ICI Devoe.
      c. Carboline Protective Coatings.
      d. Sherwin Williams.
      e. Dampney Company, Inc.
      f. PPG Industries/Amercoat.
      g. Or equal.

B. Submit request for substitution in accordance with Specification Section 01640.
   1. Product VOC content will be an important factor when determining acceptability of substitution.

2.2 MATERIALS

A. For unspecified materials such as thinner, provide manufacturer's recommended products.

B. Paint Systems - General:
   1. P = prime coat.
   2. F1, F2 . . . Fn = first finish coat, second finish coat . . . . nth finish coat, color as selected by Engineer.
   3. If two (2) finish coats of same material are required, Contractor may, at his option and by written approval from paint manufacturer, apply one (1) coat equal to mil thickness of two (2) coats specified.

C. HPIC products listed in the MATERIALS Article, Paint Systems paragraph are manufactured by Tnemec.
   1. Products of other listed manufacturers are acceptable for use providing the product is of the same generic resin, requires comparable surface preparation, has comparable application requirements, meets the same VOC levels or better, provides the same finish and color options and will withstand the atmospheric conditions of the location where it is to be applied.
   2. AP products listed in the MATERIALS Article, Paint Systems paragraph are manufactured by PPG Paints.

D. Paint Systems (Systems not shown are not used):
   1. HPIC SYSTEM #1 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Finish Coat(s) (for ferrous metals in non-corrosive environment).
      a. Prime coat:
         1) P1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
      b. Finish coat(s):
         1) Interior:

a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
b) F2 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).

2) Exterior:
a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
b) F2 = 1 coat, 2.5 mils, Series 1080 Endura-Shield. W.B.(Waterborne Acrylic Polyurethane).

2. HPIC SYSTEM #2 - Zinc-Rich Urethane Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Finish Coat(s) (for ferrous metals in corrosive environment).
a. Prime coat:
1) P1 = 1 coat, 3.5 mils, Series 90-97 Tneme-Zinc (Zinc-Rich Urethane).
b. Finish coat(s):
1) Interior:
a) F1 = 1 coat, 6 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
2) Exterior:
a) F1 = 1 coat, 6 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
b) F2 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B.(Waterborne Acrylic Polyurethane).

3. HPIC SYSTEM #3 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s) (for PVC, FRP, CPVC piping).
a. Prime coat:
1) P1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
b. Finish coat(s):
1) Interior:
a) F1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
2) Exterior:
a) F1 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).

4. HPIC SYSTEM #5 - Modified Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy or Waterborne Acrylic Polyurethane Top Coat(s) (for field painting of factory finished ferrous metals).
a. Prime coat:
1) P1 = 1 coat, 2.0 mils, Series 135 Chembuild (Modified Polyamidoamine Epoxy).
b. Finish coat(s):
1) Interior:
a) F1 = 1 coat, 2.5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
2) Exterior:
a) F1 = 1 coat, 2.0 mils, Series 1080 Endura-Shield W.B. (Waterborne Acrylic Polyurethane).

5. HPIC SYSTEM #8 - Air Dry Silicone Copolymer Primer with Silicone Copolymer Top Coat (for air pipe).
a. Prime coat:
1) P1 = 1 coat, 2.0 mils, Dampney Thurmalox 260C Series (Air Dry Silicone Copolymer).
b. Finish coat:
1) Interior or exterior:
a) F1 = 1 coat, 2.0 mils, Dampney Thurmalox 260C Series (Air Dry Silicone Copolymer).

6. HPIC SYSTEM #12 - HDP Acrylic Polymer Primer and Top Coat.
a. Prime coat:
1) P1 = 1 coat, 2.5 mils, Series1029 Enduratone (HDP Acrylic Polymer).
b. Finish coat:
1) Interior:
a) F1 = 1 coat, 2.5 mils, Series1029 Enduratone (HDP Acrylic Polymer).

7. HPIC SYSTEM #19 - Polyamidoamine Epoxy Coating.
a. Prime coat:

1) P1 = 1 coat, 5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).

8. HPIC SYSTEM #35 - Polyamine Novolac Epoxy Primer with Polyamine Novolac Epoxy Top Coat (for steel surfaces).
   a. Prime coat:
      1) P1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      2) P1 (vertical surface) = 1 coat, 8 to 10 mils, Series 282 Tneme-Glaze.
   b. Finish coat:
      1) F1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      2) F1 (vertical surface) = 1 coat, 8 to 10 mils, Series 282 Tneme-Glaze.
9. HPIC SYSTEM #36 - Epoxy Modified Surfacer/Filler with Polyamine Novolac Epoxy Top Coats.
   a. Filler/surfacer coat:
      1) Filler = 1 coat, 0.0625 IN thick, Series 218 Mortar Clad.
   b. Prime coat:
      1) P1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      2) P1 (vertical surface) = 1 coat, 6 to 8 mils, Series 282 Tneme-Glaze.
   c. Finish coat:
      1) F1 (horizontal surface) = 1 coat, 10 to 12 mils, Series 282 Tneme-Glaze.
      2) F1 (vertical surface) = 1 coat, 6 to 8 mils, Series 282 Tneme-Glaze.
10. HPIC SYSTEM #43 - Polyamidoamine Epoxy Primer with Polyamidoamine Epoxy Top Coat (for field painting fusion bonded epoxy pipe, valves, etc.).
   a. Prime coat:
      1) P1 = 1 coat, 2.5 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).
   b. Finish coat:
      1) Interior:
         a) F1 = 1 coat, 3 mils, Series L69 Epoxoline (Polyamidoamine Epoxy).

PART 3 - EXECUTION

3.1 ITEMS TO BE PAINTED

A. General:
   1. Paint the following surfaces in a corrosive or highly corrosive area, whether exposed to view or not:
      a. Conduit.
      b. Ducts.
      c. Galvanized metal surfaces.

B. Exposed Exterior Surfaces including:
   1. Piping, valves, fittings, and hydrants except when covered by pipe jacketing and supports.
      a. Field welded connections of factory painted piping.
      b. Pipe insulation jacketing.
   2. Ductwork and supports.
      a. Duct.
   3. Conduit, device boxes, junction boxes and covers, pull boxes and covers and supports when attached to a surface required to be painted.
   4. Miscellaneous ferrous metal surfaces.
   5. Hollow metal doors and frames.
   6. Steel pipe bollards (not galvanized).
   7. Structural steel including steel joists and trusses.
   8. Metal roof deck and canopies.

C. Interior Areas:
   1. Piping, valves, fittings, supports, and hydrants except when covered by pipe jacketing and supports.

a. All bituminous coated ductile iron pipe to have coating completely removed prior to painting.
b. Field welded connections of factory painted piping.
c. Pipe.

2. Conduit, device boxes, junction boxes and covers, pull boxes and covers and supports when mounted on surface required to be painted.
3. Miscellaneous ferrous metal surfaces.
4. Hollow metal doors and frames and borrowed light window frames.
5. Ferrous metal angle supports at top of concrete walls.
6. Steel components of concrete lintels (plain or galvanized).
   a. Steel components shall be completely painted (with both prime and finish coats) prior to installing in the wall.
7. Structural steel.
   a. May include: Pipe supports, duct supports, monorail beam extensions from inside a building and supporting structure, canopy structures, as well as other structural steel items.
8. Steel trusses (including bridging).
9. Steel joists (including bridging).
10. Field welded connections of factory painted structural steel.
11. Galvanized metal surfaces specifically noted to be painted.
12. Outside of ferrous metal tankage.
    a. The following tankage is to be painted:
       1) Hydropneumatic surge tank(s).
13. Steel pipe bollards not galvanized.
14. Cast iron pipe plumbing vents through roof.

3.2 ITEMS NOT TO BE PAINTED

A. General: Do not paint items listed in this Article unless specifically noted in the Contract Documents to be painted.

B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.

C. Electrical Equipment:
   1. Do not field paint electrical equipment except where painting is specifically stated elsewhere in these Contract Documents, or where the equipment is subject to a corrosive environment and is specifically noted to be painted.

D. Other Items:
   1. Stainless steel surfaces except:
      a. Piping where specifically noted to be painted.
      b. Banding as required to identify piping.
   2. Aluminum surfaces except:
      a. Where specifically shown in the Contract Documents.
      b. Where in contact with concrete.
      c. Where in contact with dissimilar metals.
   3. Fiberglass surfaces except:
      a. Fiberglass piping where specifically noted to be painted.
      b. Piping supports where specifically noted to be painted.
   4. Interior of pipe, ductwork, and conduits.
   5. Moving parts of mechanical and electrical units where painting would interfere with the operation of the unit.
   6. Code labels and equipment identification and rating plates.
   7. Exterior concrete or precast concrete surfaces.
   8. Masonry.
   9. Clad aluminum, clad steel, anodized aluminum, PVDF coated aluminum and PVDF coated steel.

3.3 SCHEDULE OF ITEMS TO BE PAINTED AND PAINTING SYSTEMS

A. Concrete:
   1. Interior of open top concrete chemical containment areas and sumps, tanks and boxes subject to corrosive or highly corrosive environment and not requiring NSF approval: SYSTEM #36.

B. Steel:
   1. Structural:
      a. Immersion or non-immersion surfaces subject to corrosive environment: SYSTEM #35.
      b. Immersion surfaces subject to corrosive environment and not requiring NSF approval: SYSTEM #2.
      c. Non-immersion surfaces subject to corrosive environment: SYSTEM #7.
      d. All other surfaces (non-corrosive dry environment): SYSTEM #1.

C. Miscellaneous ferrous metals (non-corrosive dry environment): SYSTEM #1.
   1. Not for coating galvanized steel, steel (hollow metal) doors, steel (hollow metal) door and window frames, and products with approved factory finishes.

D. Ferrous metals subject to corrosive environment: SYSTEM #2.
   1. Includes ferrous metal components of equipment located in corrosive environments such as bar screens, grit washers, clarifier covers and mechanisms, slide gates, gravity thickener mechanisms, bare steel handrails and guardrails, piping, stairs, tank or equipment bridges, pumps, and similar items.
   2. Does not include items subject to contact with potable water.

E. Galvanized Metals:
   1. Field touch-up where top coat is required: SYSTEM #3, prime and first finish coat only.
      a. Prime paint only the damaged area.
   2. Assembled galvanized steel items: SYSTEM #3.
   3. Field touch-up of galvanized surfaces not requiring a finish top coat: SYSTEM #41.
      a. Paint only damaged areas.
   4. Galvanized pipe bollards: SYSTEM #3.

F. Steel (hollow metal) doors and frames primed in the factory in accordance with SDI/ANSI A250.10.
   1. For doors and frames in non-corrosive environments: SYSTEM #5.

G. Steel equipment with existing paint coating or factory-applied prime or finish coating not complying with this Specification Section: SYSTEM #5.
   1. Includes equipment specifically indicated in the Contract Documents to be painted.
   2. Factory-applied coats to remain.
   3. Steel skin of overhead, industrial bi-fold and sliding doors.

H. Plastic Surfaces:
   1. PVC, FRP, and CPVC surfaces: SYSTEM #3.
      a. Includes tankage and piping.

I. Electrical Conduit:
   1. Galvanized: SYSTEM #3.
   2. PVC coated: SYSTEM #3.

J. Pipe, Valves, and Fittings:
   1. Bare steel pipe bollards: SYSTEM #2.
   2. Steel, cast-iron, and uncoated ductile iron: SYSTEM #2.
   3. Steel aeration piping: SYSTEM #8.

K. Pipe and duct insulation: SYSTEM #12.

L. Aluminum buried in concrete, between dissimilar metals and dissimilar materials: SYSTEM #19.

M. Aluminum colored pipe thread touch-up, and aluminum colored finish where top coat is not required: SYSTEM #21.
   1. Not for coating aluminum material.

N. Field painting of fusion bonded epoxy coated piping, valves, couplings, etc.: SYSTEM #43.

3.4 PREPARATION

A. General:
   1. Verify that atmosphere in area where painting is to take place is within paint manufacturer's acceptable temperature, humidity and sun exposure limits.
      a. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
         1) Provide temporary dehumidification equipment properly sized to maintain humidity levels required by paint manufacturer.
         2) Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 HR basis.
            a) Vent exhaust gases to exterior environment.
            b) No exhaust gases shall be allowed to vent into the space being painted or any adjacent space.
   2. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
      a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Engineer.
   3. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.
   4. Adhere to manufacturer's recoat time surface preparation requirements.
      a. Surfaces that have exceeded coating manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional coating in accordance with manufacturer's published recommendations.
         1) Minimum SSPC SP 7/NACE No. 4 unless otherwise approved by Engineer.

B. Protection:
   1. Protect surrounding surfaces not to be coated.
   2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
   1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations and NAPF.
      a. All piping, pumps, valves, fittings and any other component used in the water piping system that requires preparation for painting shall be prepared in accordance with requirements for immersion service.
         1) Pipe: NAPF 500-03-04.
         2) Fittings: NAPF 500-03-05
      b. Prepare all areas requiring patch painting in accordance with recommendations of manufacturer and NAPF.
      c. Remove bituminous coating per piping manufacturer, paint manufacturer and NAPF recommendations.
         1) The most stringent recommendations shall apply.
   2. Complete fabrication, welding or burning before beginning surface preparation.
      a. Chip or grind off flux, spatter, slag or other laminations left from welding.
      b. Remove mill scale.

c. Grind smooth rough welds and other sharp projections.

3. Solvent clean in accordance with SSPC SP 1 or detergent and low-pressure water clean in accordance with SSPC SP 12/NACE No. 5 all surfaces scheduled to receive additional SSPC surface preparation.
4. Surfaces subject to corrosive or highly corrosive environment and all surfaces subject to immersion service:
   a. Near-white blast clean in accordance with SSPC SP 10/NACE No. 2.
5. All interior and exterior structural steel not included in corrosive, highly corrosive or immersion service surfaces:
   a. Minimum commercial blast clean in accordance with SSPC SP 6/NACE No. 3.
6. Surfaces of steel joists and steel trusses:
   a. Commercial blast clean the major portion of the truss in accordance with SSPC SP 6/NACE No. 3.
   b. Power tool or hand tool clean tight connection areas and other difficult to access areas in accordance with SSPC SP 2 or SSPC SP 3.
7. Steel surfaces scheduled to receive SYSTME #35:
   a. White metal blast clean in accordance with SSPC SP 5/NACE No. 1.
   b. Provide 2-1/2 to 3 mil anchor profile for SYSTEMS #24 and #35.
8. Restore surface of field welds and adjacent areas to original surface preparation.
9. Black iron piping: Remove surface varnish by solvent or waterjet and detergent cleaning or brush-off blast cleaning in accordance with SSPC SP 7/NACE No. 4.

E. Hollow Metal:
1. Clean in accordance with SSPC SP 1 or SSPC SP 12/NACE No. 5 and in accordance with hollow metal manufacturer.

F. Galvanized Steel and Non-ferrous Metals:
1. Solvent clean in accordance with SSPC SP 1 followed by brush-off blast clean in accordance with SSPC SP 16 to remove zinc oxide and other foreign contaminants.
   a. Provide uniform 1 mil profile surface.

G. Preparation by Abrasive Blasting:
1. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of paint coatings.
   a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.
2. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before painting.
3. Perform additional blasting and cleaning as required to achieve surface preparation required.
   a. Prior to painting, reblast surfaces allowed to set overnight and surfaces that show rust bloom.
   b. Surfaces allowed to set overnight or surfaces which show rust bloom prior to painting shall be reinspected prior to paint application.
4. Profile depth of blasted surface: Not less than 1 mil or greater than 2 mils unless required otherwise by coating manufacturer.
5. Provide compressed air for blasting that is free of water and oil.
   a. Provide accessible separators and traps.
6. Confine blast abrasives to area being blasted.
   a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
   b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.
7. Protect nameplates, valve stems, rotating equipment, motors and other items that may be damaged from blasting.
8. Reblast surfaces not meeting requirements of these Specifications.

9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.
10. Properly dispose of blasting material contaminated with debris from blasting operation not scheduled to be reused.

H. All Plastic Surfaces and Non-Ferrous Surfaces Except Galvanized Steel:
1. Sand using 80-100 grit sandpaper to scarify surfaces.

3.5 APPLICATION

A. General:
1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
   a. Application equipment must be inspected and approved in writing by coating manufacturer.
   b. Hollow metal shall be spray applied only.
2. Temperature and weather conditions:
   a. Do not paint surfaces when surface temperature is below 50 DegF unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and paint manufacturer's authorized representative.
   b. Avoid painting surfaces exposed to hot sun.
   c. Do not paint on damp surfaces.
3. Immediately after surface has been inspected and accepted by NACE certified coatings inspector, apply structural steel and miscellaneous steel prime coat in the factory.
   a. Finish coats shall be applied in the field.
   b. Prime coat referred to here is prime coat as indicated in this Specification.
      1) Structural steel and miscellaneous steel prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.
4. Provide complete coverage to mil thickness specified.
   a. Thickness specified is dry mil thickness.
   b. All paint systems are "to cover." In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern.
   c. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
5. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.
6. Apply materials under adequate illumination.
7. Evenly spread to provide full, smooth coverage.
8. Work each application of material into corners, crevices, joints, and other difficult to work areas.
9. Avoid degradation and contamination of blasted surfaces and avoid intercoat contamination.
   a. Clean contaminated surfaces before applying next coat.
10. Smooth out runs or sags immediately, or remove and recoat entire surface.
11. Allow preceding coats to dry before recoating.
   a. Recoat within time limits specified by coating manufacturer.
   b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.
12. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
13. Coat all aluminum in contact with dissimilar materials.
14. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses.
15. Backroll concrete and masonry and plaster surfaces with a roller if paint coatings are spray applied.

B. Prime Coat Application:
   1. Prime all surfaces indicated to be painted.
      a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.
   2. Ensure field-applied coatings are compatible with factory-applied coatings.
      a. Ensure new coatings applied over existing coatings are compatible.
      b. Employ services of coating manufacturer's qualified technical representative.
         1) Certify through material data sheets.
         2) Perform test patch.
      c. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
      d. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system listed in the MATERIALS Article, Paint Systems paragraph of this Specification Section.
         1) All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Owner.
   3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.
   4. Apply zinc-rich primers while under continuous agitation.
   5. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.
   6. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
   7. Touch up damaged primer coats prior to applying finish coats.
      a. Restore primed surface equal to surface before damage.
   8. All surfaces of steel lintels and steel components of concrete lintels used in wall construction shall be completely painted with both prime and finish coats prior to placing in wall.

C. Finish Coat Application:
   1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
   2. Touch up damaged finish coats using same application method and same material specified for finish coat.
      a. Prepare damaged area in accordance with the PREPARATION Article of this Specification Section.

3.6 COLOR CODING

A. Color and band piping in accordance with the SCHEDULE Article of this Specification Section.
   1. Band piping using maximum of three (3) different colors at 20 FT maximum centers.
   2. Factory painted piping shall be color banded in the factory per the Schedule in the SCHEDULE Article of this Specification Section.
   3. Place bands:
      a. Along continuous lines.
      b. At changes in direction.
      c. At changes of elevation.
      d. On both sides of an obstruction (e.g., wall, ceiling) that painted item passes through.
   4. Band width for individual colors (pipe diameter measured to outside of insulation, if applicable):
      a. Piping up to 8 IN DIA: 2 IN minimum.
      b. Piping greater than 8 IN up to 24 IN DIA: 4 IN minimum.
      c. Piping greater than 24 IN up to 48 IN DIA: 6 IN minimum.
      d. Piping greater than 48 IN DIA: 8 IN minimum.
   5. Coordinate with Section 10400, paragraph 3.2 A.1.

3.7 FIELD QUALITY CONTROL

A. Contractor to provide protection for surfaces painted with epoxy coatings to prevent chalking.
   1. Surfaces showing chalking will not be accepted regardless of condition of paint film.

B. Maintain Daily Records:
   1. Record the following information during application of each coat of paint applied:
      a. Date, starting time, end time, and all breaks taken by painters.
      b. For exterior painting:
         1) Sky condition.
         2) Wind speed and direction.
      c. Air temperature.
      d. Relative humidity.
      e. Moisture content and surface temperature of substrate prior to each coat.
      f. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.
      g. Record environmental conditions, substrate moisture content and surface temperature information not less than once every four (4) hours during application.
         1) Record hourly when temperatures are below 50 DegF or above 100 DegF.
   2. Record the following information daily for the paint manufacturer's recommended curing period:
      a. Date and start time of cure period for each item or area.
      b. For exterior painting:
         1) Sky conditions.
         2) Wind speed and direction.
      c. Record environmental conditions not less than once every 12 hours.
         1) Record once every four (4) hours when ambient temperature is below 35 DegF.
      d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.
   3. Format for daily record to be computer generated.

C. Measure wet coating with wet film thickness gages.

D. Measure coating dry film thickness in accordance with SSPC PA 2 using Mikrotest gage calibrated against NBS "Certified Coating Thickness Calibration Standards."
   1. Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.

E. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

F. Measure substrate humidity with humidity gage specifically designed for such.

G. Provide wet paint signs.

3.8 CLEANING

A. Clean paint spattered surfaces.
   1. Use care not to damage finished surfaces.

B. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.

C. Remove surplus materials, scaffolding, and debris.

3.9 SCHEDULE

A. Pipe Bollards: 35GR-Black with 02SF-Safety Yellow stripping diagonally 4 IN wide and 8 IN on center.

B. Piping and Pipe Banding Color Schedule:
   1. Match existing piping and banding colors.
      a. Refer to Specification Section 10400 for the piping system and banding material and refer to this Specification Section.
      b. Match existing color schemes.

END OF SECTION

SECTION 10200
LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Louvers and vents.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. Air Movement and Control Association (AMCA).
   3. ASTM International (ASTM):
      a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Drawing showing location of each louver or vent, indicating size and arrangement of blank-off plates if required.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Color chart showing manufacturer's full line of colors including exotic and special colors for color selection by Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Louvers:
      a. Airolite Co.
      b. Construction Specialties, Inc.
      c. Ruskin Manufacturing.
      d. Industrial Louvers, Inc.
      e. American Warming.

2.2 MANUFACTURED UNITS

A. Louvers:
   1. 6 IN deep.
   2. Drainable with blades at 37-1/2 degrees.
   3. Continuous blade appearance.
   4. ASTM B221 extruded aluminum, alloy 6063T5, minimum 0.081 IN thick.
   5. Minimum free area: 8.58 SF for 4 x 4 FT louver.
   6. Maximum pressure drop: 0.10 IN of water at 700 fpm.

7. Water penetration: 0.01 OZ/SF at 873 fpm.
8. AMCA certified.
9. Ruskin "ELF 6375DX".
10. Insect screen:
    a. 18-16 mesh aluminum.
    b. Install in standard aluminum frame.

B. Anchors, Fasteners, Reinforcing: Aluminum or stainless steel.

C. Finish:
1. Architectural Class 1 coating per AA DAF 45.
    a. AA-M12C22A42 medium bronze anodized.

D. Size: Refer to Mechanical Drawings for louver size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchoring and bracing accessories as required.

C. Seal around perimeter on exterior and interior.
1. See Section 07900.

D. Install 0.040 IN aluminum flashing at sill to match louver.

END OF SECTION

SECTION 10400
IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items, and hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.
   2. Instrumentation, Systems, and Automation Society (ISA).
   3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. Z535.1, Safety Color Code.
      b. Z535.2, Environmental and Facility Safety Signs.
      c. Z535.3, Criteria for Safety Symbols.
      d. Z535.4, Product Safety Signs and Labels.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Catalog information for all identification systems.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. W.H. Brady Co.
   2. Panduit.
   3. Seton.
   4. National Band and Tag Co.
   5. Carlton Industries, Inc.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:
   1. Materials:
      a. Aluminum or stainless steel.
      b. Stainless steel shall be used in corrosive environments.
   2. Size:
      a. Diameter: 1-1/2 IN minimum.
      b. Thickness: 0.035 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:
   1. Materials: Stainless steel.
   2. Size:
      a. 3-1/2 IN x 1-1/2 IN minimum.
      b. Thickness: 0.036 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

C. Type A3 - Metal Tape Tags:
   1. Materials: Aluminum or stainless steel.
   2. Size:
      a. Width 1/2 IN minimum.
      b. Length as required by text.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Embossed.
   4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:
   1. Materials: Fiberglass reinforced plastic.
   2. Size:
      a. Surface: 2 x 2 IN minimum.
      b. Thickness: 100 mils.
   3. Fabrication:
      a. 3/16 IN mounting hole with metal eyelet.
      b. Legend: Preprinted and permanently embedded and fade resistant.
   4. Color:
      a. Background: Manufacturer standard or as specified.
      b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:
   1. Materials: Fiberglass reinforced or durable plastic.
   2. Size:
      a. Surface: As required by text.
      b. Thickness: 60 mils minimum.
   3. Fabrication:
      a. Rounded corners.
      b. Drilled holes in corners with grommets.
      c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.

4. Color:
    a. Background: Manufacturer standard or as specified.
    b. Lettering: Black.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Phenolic Name Plates:
1. Materials: Phenolic.
2. Size:
    a. Surface: As required by text.
    b. Thickness: 1/16 IN.
3. Fabrication:
    a. Two (2) layers laminated.
    b. Legend: Engraved through top lamination into bottom lamination.
    c. Two (2) drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:
1. Materials: Vinyl tape or vinyl cloth.
2. Size:
    a. Surface: As required by text.
    b. Thickness: 5 mils minimum.
3. Fabrication:
    a. Indoor/Outdoor grade.
    b. Weather and UV resistant inks.
    c. Permanent adhesive.
    d. Legend: Preprinted.
    e. Wire markers to be self-laminating.
4. Color: White with black lettering or as specified.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:
1. Materials: Polyolefin.
2. Size: As required by text.
3. Fabrication:
    a. Legend: Preprinted.
4. Color: White background, black printing.

I. Type F - Underground Warning Tape:
1. Materials: Polyethylene.
2. Size:
    a. 6 IN wide (minimum).
    b. Thickness: 3.5 mils.
3. Fabrication:
    a. Legend: Preprinted and permanently imbedded.
    b. Message continuous printed.
    c. Tensile strength: 1750 psi.
4. Color: As specified.

J. Type G - Stenciling System:
1. Materials:
    a. Exterior type stenciling enamel.
    b. Either brushing grade or pressurized spray can form and grade.
2. Size: As required.
3. Fabrication:
    a. Legend: As required.
4. Color: Black or white for best contrast.

K. Underground Tracer Wire:
   1. Materials:
      a. Wire:
         1) 12 GA AWG.
         2) Solid.
      b. Wire nuts: Waterproof type.
      c. Split bolts: Brass.

2.3 ACCESSORIES

A. Fasteners:
   1. Bead chain: #6 brass, aluminum or stainless steel.
   2. Plastic strap: Nylon, urethane or polypropylene.
   3. Screws: Self-tapping, stainless steel.
   4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
   1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
   1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:
   1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
   2. Continuous pass from each valve box and above grade at each structure.
   3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
   4. 1,000 FT maximum spacing between valve boxes.
   5. If split bolts are used for splicing, wrap with electrical tape.
   6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.
   7. Use continuous strand of wire between valve box where possible.
      a. Continuous length shall be no shorter than 100 FT.

3.2 SCHEDULES

A. Process Systems:
   1. General:
      a. Provide arrows and markers on piping.
         1) At 20 FT maximum centers along continuous lines.
         2) At changes in direction (route) or obstructions.

3) At valves, risers, "T" joints, machinery or equipment.
4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.

b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
1) If flow is in both directions use double headed arrow markers.

c. Apply tapes and stenciling in uniform manner parallel to piping.

2. Trenches with piping:
a. Tag type: Type F - Underground Warning Tape
b. Location: Halfway between top of piping and finished grade.
c. Letter height: 1-1/4 IN minimum.
d. Natural gas or digester gas:
1) Color: Yellow with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”
b) Second line: “BURIED GAS LINE BELOW”

e. Potable water:
1) Color: Blue with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”
b) Second line: “BURIED WATER LINE BELOW”

f. Storm and sanitary sewer lines:
1) Color: Green with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”
b) Second line: “BURIED SEWER LINE BELOW”

g. (Nonpotable) water piping, except 3 IN and smaller irrigation pipe:
1) Color: Green with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”
b) Second line: “BURIED NONPOTABLE WATER LINE BELOW”

h. Chemical feed piping (e.g., chlorine solution, polymer solution, caustic solution, etc.):
1) Color: Yellow with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”
b) Second line: “BURIED CHEMICAL LINE BELOW”

i. Other piping (e.g., compressed air, irrigation, refrigerant, heating water, etc.):
1) Color: Yellow with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”
b) Second line: “BURIED PIPE LINE BELOW”

3. Yard valves, buried, with valve box and concrete pad:
a. Tag type: Type A2 - Rectangle Metal Tags.
b. Fastener: 3/16 IN x 7/8 IN plastic screw anchor with 1 IN #6 stainless steel pan head screw.
c. Legend:
1) Letter height: 1/4 IN minimum.
2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).

4. Valves and slide gates:
a. Tag type:
1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
2) Indoor noncorrosive:
a) Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.
3) Indoor corrosive:
a) Stainless steel Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.

b. Fastener:
    1) Type A1: Chain of the same material.
    2) Type B1: Stainless steel chain.
c. Color: Per ASME A13.1 corresponding to the piping system.
d. Legend:
    1) Letter height: 1/4 IN minimum.
    2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).

5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.):
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Tags and Signs.
        3) Type G - Stenciling System.
    b. Fastener:
        1) Self.
        2) Screws.
        3) Adhesive.
    c. Legend:
        1) Letter height: 1/2 IN minimum.
        2) Equipment designation as indicated on the Drawings (e.g., “Primary Sludge Pump P-xxx”).
6. Piping systems:
    a. Tag type:
        1) Outdoor locations: Type G - Stenciling System.
        2) Indoor locations:
            a) Type D - Self-Adhesive Tape Tags and Signs.
            b) Type G - Stenciling System.
    b. Fastener: Self.
    c. Color: Per ASME A13.1.
    d. Legend:
        1) Letter height: Manufacturers standard for the pipe diameter.
        2) Mark piping in accordance with ASME A13.1.
        3) Use piping designation as indicated on the Drawings.
        4) Arrow: Single arrow.
7. Process tanks (over 1000 GAL) and basins, (e.g., chemical storage, clarifiers, trickling filters, digesters, etc):
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type G - Stenciling System.
    b. Fastener:
        1) Screw.
        2) Self.
    c. Location as directed by Owner.
    d. Legend:
        1) Letter height: 4 IN minimum.
        2) Equipment designation as indicated on the Drawings (e.g., “Clarifier CL-xxx”).
8. Tanks (less than 1000 GAL) (e.g., break tanks, chemical tanks, hydro-pneumatic tanks, air receivers, etc.):
    a. Tag type:
        1) Type D - Self-Adhesive Tape Tags and Signs.
        2) Type G - Stenciling System.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 2 IN minimum.
        2) Equipment designation as indicated on the Drawings (e.g., “Polymer Storage Tank Txxx”)

9. Equipment that starts automatically:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener:
        1) Type B2 - Screw or adhesive.
        2) Type D - Self.
    c. Size: 5 IN x 7 IN
    d. Location: Multiple locations.
    e. Legend:
        1) OSHA Warning Sign.
        2) Description of Warning: “THIS MACHINE STARTS AUTOMATICALLY”.

B. Instrumentation Systems:
    1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
        a. Tag type:
            1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
            2) Indoor noncorrosive:
                a) Type A1 - Round Metal Tags.
                b) Type B1 - Square Nonmetallic Tags.
            3) Indoor corrosive:
                a) Stainless steel Type A1 - Round Metal Tags.
                b) Type B1 - Square Nonmetallic Tags.
        b. Fastener:
            1) Type A1: Chain of the same material.
            2) Type B1: Stainless steel chain.
        c. Legend:
            1) Letter height: 1/4 IN minimum.
            2) Equipment ISA designation as indicated on the Drawings (e.g., “FIT-xxx”).
    2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):
        a. Tag type: Type C - Phenolic Name Plates.
        b. Fastener: Screws.
        c. Legend:
            1) Letter height: 1/2 IN minimum.
            2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").
    3. Components inside equipment enclosure, (e.g., PLC’s, control relays, contactors, and timers):
        a. Tag type: Type D - Self-Adhesive Tape Tags.
        b. Fastener: Self.
        c. Legend:
            1) Letter height: 3/16 IN minimum.
            2) Description or function of component (e.g., "PLC-xxx” or “CR-xxx").
    4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
        a. Tag type: Type C - Phenolic Name Plates.
        b. Fastener: Screws.
        c. Legend:
            1) Letter height: 1/4 IN minimum.
            2) Component ISA tag number as indicated on the Drawings (e.g., “HS-xxx”).

C. HVAC Systems:
    1. General:
        a. Provide arrows and markers on ducts.
            1) At 20 FT maximum centers along continuous lines.
            2) At changes in direction (route) or obstructions.
            3) At dampers, risers, branches, machinery or equipment.

4) Where ducts pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.

b. Position markers on both sides of duct with arrow markers pointing in flow direction.

1) If flow is in both directions use double headed arrow markers.

c. Apply tapes and stenciling in uniform manner parallel to ducts.

2. HVAC Equipment (e.g., unit heaters, exhaust fans, air handlers, etc.):

a. Tag type:

1) Type B2 - Nonmetallic Signs.

2) Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1 IN minimum.

2) Equipment designation as indicated on the Drawings (e.g., "EF-xxx").

3. Ductwork:

a. Tag type:

1) Type D - Self-Adhesive Tape Tags and Signs.

2) Type G - Stenciling System.

b. Fastener: Self.

c. Legend:

1) Letter height: 1 IN minimum.

2) Description of ductwork, (e.g., “AIR SUPPLY”).

3) Arrows: Single arrow.

4. Enclosure for instrumentation and control equipment, (e.g., fan control panels, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/2 IN minimum.

2) Equipment designation as indicated on the Drawings (e.g., "FAN CONTROL PANEL FCP-xxx").

5. Wall mounted thermostats:

a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener: Self.

c. Legend:

1) Letter height: 3/16 IN minimum.

2) Description of equipment controlled (e.g., "UH-xxx" or AHU-xxx").

6. Components inside equipment enclosure, (e.g., controller’s, control relays, contactors, and timers):

a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener: Self.

c. Legend:

1) Letter height: 3/16 IN minimum.

2) Description or function of component (e.g., "CR-xxx").

7. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/4 IN minimum.

2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., “HS-xxx”).

D. Electrical Systems:

1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.

a. Tag type: Type F - Underground Warning Tape.

b. Letter height: 1-1/4 IN minimum.

c. Location:

1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.
2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.

d. Electrical power (e.g., low and medium voltage):
1) Color: Red with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”.
b) Second line: “BURIED ELECTRIC LINE BELOW”.

e. Communications (e.g., telephone, instrumentation, LAN, SCADA):
1) Color: Orange with black letters.
2) Legend:
a) First line: “CAUTION CAUTION CAUTION”.
b) Second line: “BURIED COMMUNICATION LINE BELOW”.

2. Switchgear, switchboards and motor control centers:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Main equipment legend:
1) Letter height:
a) First line: 1 IN minimum.
b) Subsequent lines: 3/8 IN minimum.
2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").
3) Second line:
a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
b) The source of power room number is only required when there are multiple electrical rooms, if the source is in another building, the building name or number shall be used.
4) Third line: System voltage and phase (e.g., “480/277 V, 3PH”).

d. Main and feeder device legend:
1) Letter height: 3/8 IN minimum.
2) Description of load (e.g., “MAIN DISCONNECT”, "PUMP Pxxx" or "PANELBOARD HPxxx").

3. Panelboards and transformers:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height:
a) First line: 3/8 IN minimum.
b) Subsequent lines: 3/16 IN minimum.
2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").
3) Second line (panelboards only): System voltage and phase (e.g., “208/120V, 3PH”).

4. Transfer switches:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height:
a) First line: 3/8 IN minimum.
b) Subsequent lines: 3/16 IN minimum.
2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").

5. Safety switches, separately mounted circuit breakers and motor starters, VFD’s, etc.:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:

1) Letter height: 1/4 IN minimum.
2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").

6. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/2 IN minimum.
      2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").
7. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
   a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 3/16 IN minimum.
      2) Description or function of component (e.g., "M-xxx", "CR-xxx" or "TR-xxx").
8. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").
9. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
   a. Tag type: Type D - Self-Adhesive Tape Tags.
   b. Fastener: Self.
   c. Tag conductor at both ends.
   d. Legend:
      1) Letter height: 1/8 IN minimum.
      2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.
10. Conductors in handholes and manholes.
    a. Tag type: Type A3 - Metal Tape Tags.
    b. Fastener: Nylon strap.
    c. Tag conductor at both ends.
    d. Legend:
       1) Letter height: 1/8 IN minimum.
       2) Circuit number or wire number as scheduled on the Drawings.
11. Grounding conductors associated with grounding electrode system in accordance with the following:
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Legend:
       1) Letter height: 1/8 IN minimum.
       2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").
12. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
    a. Tag type: Type D - Self-Adhesive Tape Signs.
    b. Fastener: Self.
    c. Legend: Per NFPA 70.
13. Entrances to electrical rooms:
    a. Tag type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size: 5 IN x 7 IN.
    d. Location: Each door to room.

e. Legend:
   1) OSHA Danger Sign.
   2) Description of Danger: “HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY”.

14. Equipment where more than one (1) voltage source is present:
    a. Tag type:
       1) Type B2 - Nonmetallic Signs.
       2) Type D - Self-Adhesive Tape Signs.
    b. Fastener:
       1) Screw or adhesive.
       2) Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Exterior face of enclosure or cubical.
    e. Legend:
       1) OSHA Danger Sign.
       2) Description of Danger: “MULTIPLE VOLTAGE SOURCES”.

3.3 HAZARD AND SAFETY SIGNS

A. Provide 25 Hazard and Safety Signs:
   1. Type B2.
   2. Inscription as directed by Owner.
   3. Location as directed by Owner.

END OF SECTION

SECTION 10441
WARNING SIGNS

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies exit and accident prevention signs. International signs shown on drawings.

1.2 OPERATING AND DESIGN REQUIREMENTS

A. General:

1. Accident prevention signs shall conform as to design with OSHA Section 1910.145 of Subpart J, Part 1910, Chapter XVII, Title 29 of the Code of Federal Regulations. Exit signs shall conform with Section 1910.37(g) of the OSHA Safety and Health Standard for General Industry, Article 10, Section 10.113 of the Uniform Fire Code, and where applicable with local fire regulations.

B. Design Requirements:

1. Size: Sign size shall be as follows:
   Size A: 14 IN x 20 IN
   Size B: 10 IN x 14 IN
   Size C: 7 IN x 10IN
   Size D: 4 IN x 8 IN

2. Type: The sign type shall be as follows:

TYPE	MESSAGE
I	CAUTION—AUTOMATIC EQUIPMENT MAY START AT ANY TIME
II	DANGER—480 VOLTS
IV	NOTICE—NON POTABLE WATER—DO NOT DRINK
V	NO SMOKING
IX	DANGER—CONFINED SPACE ENTRY
X	DANGER—CONFINED SPACE – HAZARDOUS ATMOSPHERE
XI	EAR PROTECTION REQUIRED BEYOND THIS POINT
XII	CAUTION—HIGH TEMPERATURE
XIII	RESTRICTED AREA – AUTHORIZED PERSONNEL ONLY
XVI	LOCK OUT SWITCH BEFORE WORKING ON EQUIPMENT
XVII	DANGER—FOREIGN VOLTAGE
XXII	CAUTION —MOVING MACHINERY
XXIV	EXIT
XXV	CAUTION—WATER LEVEL CAN CHANGE RAPIDLY
XXVI	DANGER - ARC FLASH AND SHOCK HAZARD

1.3 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01340 and shall include the following information:

1. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (▤) shall denote full compliance with a paragraph

as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

2. Samples: Submit 2 sets, typical of sign type. One set of samples will be retained by the CM, other returned to Contractor.
3. Color samples of each color, 150 mm x 150 mm (6 IN x 6 IN). Show anticipated range of color and texture.
4. Sample of typeface, arrow, and symbols in a typical full size layout.
5. Manufacturer's Literature: Manufacturer's printed specifications, anchorage details, installation and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Sign lettering shall be single stroke and shall contrast in color with the background. For those messages for which there are international symbols, the international symbols shall be used. Chain mounted signs shall have lettering on both sides.

2.2 MATERIALS

A. Signs shall be rigid 0.100 IN thick fiberglass with embedded fade-proof legends, suitable for post mounting.

B. Signs shall match existing typeface.

2.3 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION – AUTOMATIC EQUIPMENT MAY START AT ANY TIME" (Type I). Letters shall be black on a yellow background. Signs shall be installed near guarded moving parts and shall match existing.

B. Install two Type I and two Type XXII signs on each side of conveyor, equally spaced along the length.

PART 3 - EXECUTION

3.1 SIGNS SHALL BE DISTRIBUTED AS FOLLOWS

LOCATION	NUMBER	SIZE	TYPE	MOUNT
All 480v Junction Boxes	-	C	II	Cover
All 480V Switchgear	-	B	II	Cover
	-	D	XXVI	Cover
All 480V Motor Control Centers	-	B	II	Cover
	-	D	XXVI	Cover
All Dry Type Transformers	-	B	II	Equipment
All PLC Enclosures	-	C	XVII	Inside Cover

LOCATION	NUMBER	SIZE	TYPE	MOUNT
All Panelboards	-	D	XXVI	Cover
Aeration Basins	14	C	I	Equipment
	14	C	II	Equipment
	6	C	IV	Stand
	15	B	IX	Handrail
Headworks Area and Solids Handling Building	15	C	I	Equipment
	11	C	II	Equipment
	2	C	IV	Stand
	1	C	IV	Wall
	2	B	V	Wall/Stand
	3	B	X	Hatch
	1	C	XI	Door
	1	A	XIII	Door
	11	C	XVI	Equipment
	5	C	XXIV	Exterior Doors

END OF SECTION

SECTION 10520
FIRE EXTINGUISHER AND CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire extinguishers, and cabinets.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. National Fire Protection Association (NFPA):
      a. 10, Standard for Portable Fire Extinguishers.
   3. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
   4. Warnock Hersey (WH).

B. All cabinets must meet projection limitations per ADA.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
   1. See Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver and install filled and charged extinguishers just prior to building occupancy.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fire extinguishers, and cabinets:
      a. Amerex Corporation.
      b. Ansul Fire Protection.
      c. Walter Kidde.
      d. Potter - Roemer Inc.
      e. Or equal.
   2. Fire extinguisher signs:
      a. Seton.
      b. Or equal.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Fire Extinguisher Cabinet (FEC-1):
   1. Recessed mounting, with narrow flat trim.
   2. 22 GA epoxy-coated steel box.
   3. Epoxy coated steel door and trim.
      a. Door to have narrow, vertical, 1/4 IN clear acrylic glazing panel.
   4. Provide FIRE EXTINGUISHER decal, color as selected.
   5. Provide all required closures.
   6. Provide 20 LB 2A-10:BC extinguisher.
   7. J L Industries "Ambassador" series.

B. Wall Brackets:
   1. Bracket type to fit specified extinguisher, with correct mounting accessories to fit substrate.
   2. Furnish bracket for each extinguisher not in cabinet.
   3. Bracket to be finished in red or black enamel.

C. Fire Extinguisher (FEXT):
   1. Steel bodied, all metal top (head) and valves.
   2. Multi-purpose dry chemical, UL rated 2A-10:BC.
   3. Provide hose and horn on each.
   4. Furnish one extinguisher for each fire extinguisher (FEXT) location.
   5. Finish: Red with epoxy finish coat.
   6. Provide "FIRE EXTINGUISHER" sign for each extinguisher location.
      a. SETON #21999 for single face and #22001 for double-faced signs.
   7. Meeting NFPA 10.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install units with extinguisher top not over 48 IN above floor.

C. Install FEC with top of unit at 60 IN above floor.

D. Fire extinguisher locations shown on Drawings are approximate locations. Verify all extinguisher mounting locations with local Fire Marshal.

E. Mount "FIRE EXTINGUISHER" sign above or adjacent to each extinguisher as directed by the Engineer.

END OF SECTION

SECTION 10731
CANOPIES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services required for fabrication and installation of a canopy as indicated in the drawings.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Applicator/erector qualifications:
   1. Minimum of 5 years experience fabricating and installing like systems.

1.3 DESIGN CRITERIA

A. Structural considerations: Comply with California Administrative Code, Title 22 and Title 24.

B. Design Loads:
   1. Design System and anchorage to meet Design Loads.
      a. Wind Load: Use the greater of the following:
         1) Wind Pressures as required per local building code based on wind speed, exposure factor and importance factor noted in the Structural Drawings.
         2) 195 kPa 40 PSF.
      b. Snow or Roof Load: Use the greater of the following:
         1) Snow load listed on Design Requirements on Structural Drawings.
         2) Snow load defined by Building Code as locally adopted and amended.
         3) Adjust both of the above snow load values for possible drift conditions.
         4) 20 PSF minimum.
      c. Limit deflection to L/175 and allowable stress with a safety factor of 1.65
         1) Comply with local Building Code where more restrictive.

C. Thermal Expansion and Structural Movement:
   1. Expansion and contraction, caused by changes in surface temperature equal to DT (delta T).
      a. DT for this project: 200 DegF.
      b. Thermal contraction/expansion in this range shall not cause buckling, stresses on glass, failure of joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects over this temperature range.
      c. Operating windows and doors shall function normally over this temperature range.
   2. Structural movements of building structure:
      a. Inter-story drift caused by wind or earthquake forces.
         1) h/400 or 1/2 IN maximum.
      b. Live load deflection of the supporting members.
         1) L/360 or 3/4 IN maximum.

D. Drainage:
   1. Design Wall System to intercept, collect, contain, and drain water (which may infiltrate system) harmlessly to exterior.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Detailed for entire system.

B. Samples:
   1. Fabric for color selection.

C. Project Information:
   1. Engineering calculations indicating design moments, shears, and other forces sealed by registered Engineer, licensed to practice Structural Engineering in the State of California.
   2. Submit concurrent with Shop Drawings.
   3. Manufacturer's installation instructions and recommendations.
   4. Certification of installer qualifications.

D. Contract Closeout Information:
   1. Warranty.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery pre-assembled units in maximum possible sizes.

B. Store and handle to preclude damage.

1.6 WARRANTY

A. Warrant color fastness and structural integrity for 5 years.

B. Warranty signed jointly by manufacturer, installer and Contractor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Awnings and canopies, framing system:
   1. Base:
      a. Astrup.
      b. Or equal.
   2. Optional:
      a. Awnings & Architecture.
      b. Mapes.
      c. Or equal.

B. Awnings and canopies, fabric:
   1. Base:
      a. Sunmaster.
      b. Or equal.
   2. Optional:
      a. Sombrella.
      b. Mercedes.
      c. Or equal.

C. Other manufacturers desiring approval comply with Section 01640.

2.2 MATERIAL

A. Frame work:
   1. Extruded aluminum, square tubing, uniframe.
   2. Minimum 2 IN tubes with minimum 0.065 IN walls.
   3. Weld and grind smooth.
   4. Anodized clear.

B. Canopy posts:
   1. Extruded aluminum, square tubing.
   2. Minimum 4 IN tubes with minimum 0.125 IN walls.

3. Weld and grind smooth.
4. Anodized clear [bronze].

C. Fabric:
1. 100 percent woven, solution dyed acrylic.
2. Sunmaster, Argonaught or Unitex.

D. Thread: UV resistant, color matched to fabric.

E. Lacing: UV resistant, color matched to fabric.

F. Grommets: Brass.

2.3 FABRICATION

A. Prefabricate frames in shop in maximum possible sizes.

B. Fabricate fabric in 1 piece for field installation.
1. Leave no exposed cut edges.
2. Double hem all edges.
3. Perform all sewing with lockstitch.
4. Install grommets, nominal 6 IN OC, evenly spaced.

PART 3 - EXECUTION

3.1 INSPECTION

A. Start of work constitutes acceptance of conditions.

3.2 PREPARATION

A. Correct unsatisfactory substrates prior to start of work.

3.3 INSTALLATION

A. Install to walls with secure fasteners to withstand design loading.

B. Install posts in sleeves with nonshrink grout and sealant.

C. Attach fabric to frame using aluminum extrusions.

D. Tighten by lacing in place.

3.4 ADJUSTMENT/CLEANING

A. Just prior to completion, clean as required.

END OF SECTION

SECTION 11005
EQUIPMENT: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. ASTM International (ASTM):
      a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.
      b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   4. Hydraulic Institute (HI):
      a. 9.6.4, Centrifugal and Vertical Pumps for Vibration Measurements and Allowable Valves.
   5. International Electrotechnical Commission (IEC).
   6. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
   7. International Organization for Standardization (ISO):
      a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances.
   8. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Enclosures for Industrial Control and System.
      c. MG 1, Motors and Generators.
   9. InterNational Electrical Testing Association (NETA):
      a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
   10. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 430, Motors, Motor Circuits, and Controllers.
   11. National Institute for Certification in Engineering Technologies (NICET).
   12. National Institute of Standards and Technology (NIST).
   13. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
   14. Underwriters Laboratories, Inc. (UL).
      a. 508, Standard for Safety Industrial Control Equipment.
      b. 508A, Standard for Safety Industrial Control Panels.
   15. Vibration Institute.

B. Vibration Testing Program:
   1. Testing firm:
      a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.

b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.

2. Field personnel:
   a. Minimum of one (1) year field experience covering all phases of field vibration testing and data gathering.
   b. Qualified Vibration Category I certification from the Vibration Institute.
3. Analysis personnel:
   a. Minimum three (3) years combined field testing and data analysis experience.
   b. Qualified Vibration Category II certification from the Vibration Institute.

C. Infrared Thermography Testing Program:
1. Testing firm:
   a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
   b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
   a. Minimum of one (1) year field experience covering all phases of field thermography testing and data gathering.
   b. Supervisor certified by NETA or NICET.
3. Analysis personnel:
   a. Minimum three (3) years combined field testing and data analysis experience.
   b. Supervisor certified by NETA or NICET.

D. Electrical Equipment and Connections Testing Program:
1. Testing firm:
   a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration , and adjusting of systems.
   b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
   a. Minimum of one (1) year field experience covering all phases of electrical equipment inspection, testing, and calibration.
   b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
   c. Supervisor certified by NETA or NICET.
3. Analysis personnel:
   a. Minimum three (3) years combined field testing and data analysis experience.
   b. Supervisor certified by NETA or NICET.

E. Miscellaneous:
1. A single manufacturer of a "product" to be selected and utilized uniformly throughout Project even though:
   a. More than one (1) manufacturer is listed for a given "product" in Specifications.
   b. No manufacturer is listed.
2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS 6 designations shown on Electrical Power Drawings.
3. Variable speed equipment applications: The driven equipment manufacturer shall have single source responsibility for coordination of the equipment and VFD system and sure their compatibility.

1.3 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Major Equipment Supports - Supports for Equipment:
   1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or;
   2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or;
   3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.

C. Equipment:
   1. One (1) or more assemblies capable of performing a complete function.
   2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.
   3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
   1. General for all equipment:
      a. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
      b. Data sheets that include manufacturer's name and complete product model number.
         1) Clearly identify all optional accessories that are included.
      c. Acknowledgement that products submitted comply with the requirements of the standards referenced.
      d. Manufacturer's delivery, storage, handling, and installation instructions.
      e. Equipment identification utilizing numbering system and name utilized in Drawings.
      f. Equipment installation details:
         1) Location of anchorage.
         2) Type, size, and materials of construction of anchorage.
         3) Anchorage setting templates.
         4) Manufacturer's installation instructions.
      g. Equipment area classification rating.
      h. Shipping and operating weight.
      i. Equipment physical characteristics:
         1) Dimensions (both horizontal and vertical).
         2) Materials of construction and construction details.
      j. Equipment factory primer and paint data.
      k. Manufacturer's recommended spare parts list.
      l. Equipment lining and coatings.
      m. Equipment utility requirements include air, natural gas, electricity, and water.
      n. Ladders and platforms provided with equipment:
         1) Certification that all components comply fully with OSHA requirements.
         2) Full details of construction/fabrication.
         3) Scaled plan and sections showing relationship to equipment.
   2. Mechanical and process equipment:
      a. Operating characteristics:
         1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
         2) Brake horsepower requirements.
         3) Copies of equipment data plates.
      b. Piping and duct connection size, type and location.
      c. Equipment bearing life certification.

d. Equipment foundation data:
    1) Equipment center of gravity.
    2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.

3. Electric motor:
    a. Motor manufacturer and model number.
    b. Complete motor nameplate data.
    c. Weight.
    d. NEMA design type.
    e. Enclosure type.
    f. Frame size.
    g. Winding insulation class and temperature rise.
    h. Starts per hour.
    i. Performance data:
        1) Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage a minimum permissible or specified terminal voltage for all motors over 50 HP.
        2) Time-current plots with acceleration versus current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 50 HP.
        3) Guaranteed minimum efficiencies at 100 percent, 75 percent, and 50 percent of full load
        4) Guaranteed minimum power factor at 100 percent, 75 percent, and 50 percent of full load.
        5) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
        6) Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
    j. Bearing data and lubrication system.
    k. Fabrication and/or layout drawings:
        1) Dimensioned outlined drawing.
        2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).
    l. Certifications:
        1) When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
        2) When utilized with a variable frequency controller, certify motor is inverter duty and the controller and motor are compatible.
            a) Include minimum speed at which the motor may be operated for the driven machinery.
    m. Electrical gear:
        1) Unless specified in a narrow-scope Specification Section, provide the following:
            a) Equipment ratings: Voltage, continuous current, kVa, watts, short circuit with stand, etc., as applicable.
        2) Control panels:
            a) Panel construction.
            b) Point-to-point ladder diagrams.
            c) Scaled panel face and subpanel layout.
            d) Technical product data on panel components.
            e) Panel and subpanel dimensions and weights.
            f) Panel access openings.
            g) Nameplate schedule.
            h) Panel anchorage.

4. Systems schematics and data:
    a. Provide system schematics where required in system specifications.
        1) Acknowledge all system components being supplied as part of the system.

2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
3) Provide technical data for each system component showing compliance with the Contract Document requirements.
4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.

5. For factory painted equipment, provide paint submittals in accordance with Specification Section 09905.
6. Qualifications for :
   a. Vibration testing firm and personnel.
   b. Infrared thermography testing firm and personnel.
   c. Electrical equipment and connections testing firm and personnel.
7. Testing plans, in accordance with PART 3 of this Specification Section:
   a. Vibration testing.
   b. Thermography testing.
   c. Electrical equipment and connection testing.

B. Operation and Maintenance Manuals:
1. See Specification Section 01 3304 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
1. Sample form letter for equipment field certification.
2. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
3. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
4. Field noise testing reports if such testing is specified in narrow-scope Specification Sections.
5. Notification, at least one (1) week in advance, that motor testing will be conducted at factory.
6. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
7. Motor test reports.
8. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
9. Provide three (3) bound final written reports documenting vibration monitoring and testing for specified equipment.
   a. Include the acceptance criteria of all equipment tested.
   b. Provide individual tabbed sections for information associated with each piece of tested equipment.
10. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
11. Testing and monitoring reports in accordance with PART 3 of this Specification Section.
12. Certification that driven equipment and VFD are compatible.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Motors:
    a. Baldor.
    b. General Electric.
    c. Marathon Electric.
    d. Reliance Electric.
    e. Siemens.
    f. Teco-Westinghouse.
    g. U.S. Motors.
    h. Or approved equal.

2.2 MANUFACTURED UNITS

A. General:
1. Furnished equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
2. Execute pre-demonstration requirements in accordance with Specification Section 01650.
3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
4. Provide testing of electrical equipment and connections in accordance with Division 16.
5. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
    a. Contract Drawings and Specifications.
    b. Related construction change documentation.
    c. Approved Shop Drawings.
    d. Approved Operation and Maintenance Manuals.
    e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plans:
1. Approved in accordance with Shop Drawing submittal schedule.
2. Included as a minimum:
    a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
    b. List and description of testing and analysis equipment to be utilized.
    c. List of all equipment to be testing, including:
        1) Name and tag numbers identified in the Contract Documents.
        2) Manufacturer's serial numbers.
        3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:
1. Minimum calibration frequency:
    a. Field analog instruments: Not more than 6 months.
    b. Field digital instruments: Not more than 12 months.
    c. Laboratory instruments: Not more than 12 months.
    d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
2. Carry current calibration status and labels on all testing instruments.
3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:
1. Provide reports with tabbed sections for each piece of equipment tested.
2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
    a. Include legible copies of all forms used to record field test information.
3. Prior to start of testing, submit one (1) copy of preliminary report format for Engineer review and comment
    a. Include data gathering and sample test report forms that will be utilized.
4. In the final report, include as a minimum, the following information for all equipment tested:

a. Equipment identification, including:
   1) Name and tag numbers identified in the Contract Documents.
   2) Manufacturer's serial numbers.
   3) Other pertinent manufacturer identification,
b. Date and time of each test.
c. Ambient conditions including temperature, humidity, and precipitation.
d. Visual inspection report.
e. Description of test and referenced standards, if any, followed while conducting tests.
f. Results of initial and all retesting.
g. Acceptance criteria.
h. "As found" and "as left" conditions.
i. Corrective action, if required, taken to meet acceptance.
j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
k. Instrument calibration dates of all instruments used in testing.

5. Provide three (3) bound final reports prior to Project final completion.

E. Vibration Monitoring and Testing Program:
1. Perform vibration monitoring and testing for equipment specified in other Divisions during the Equipment Demonstration Period.
2. Provide vibration testing on equipment listed in the equipment vibration testing schedule in this specification section.
3. Additional requirements for vibration monitoring and testing equipment:
   a. Frequency response: 0.18 Hz to 25 kHz.
   b. Resolution: 6400 lines.
   c. Amplitude range: 18 bit for 96 dB dynamic range.
   d. Supports measurements of acceleration, velocity, displacement, envelope demodulation for bearing defect detection.
   e. Capable of two-place computer balancing.
   f. Requirements for vibration sensor:
      1) Sensitivity: +/- 5 percent at 25 DegC= 100 mV/g.
      2) Acceleration range: 80 g peak.
      3) Amplitude nonlinearity: 1 percent.
      4) Frequency response:
         a) +/- 5 percent = 3-5000 Hz.
         b) +/- 10 percent = 1-9000 Hz.
      5) Permanently attach vibration test and monitoring mounting pads to mechanical equipment at location recommended by the equipment manufacturer or as recommended by the testing firm.
      6) Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G2.5 criteria.
      7) Acceptability of pumping equipment to be based on HI 9.6.4 criteria.
      8) Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

F. Infrared Thermography Testing Program:
1. Perform infrared thermography testing for equipment specified in other Divisions during the Equipment Demonstration Period.
   a. Perform on all rotating and reciprocating equipment having drivers 25 HP or greater.
   b. Perform on electrical equipment and connections: See Specification Section 16080.
2. Additional requirements for infrared thermography monitoring and testing equipment:
   a. Temperature range: -10 to 350 DegC.
   b. Accuracy: +/-2 percent or 2 DegC, whichever is greater.
   c. Repeatability: +/-1 percent or 1 DegC, whichever is greater.
   d. Temperature indication resolution: 0.1 DegC.
   e. Minimum focus distance: 0.3 meters.

f. Output in color palettes: JPEG, BMP, or other digital format compatible with Windows.

3. Perform inspection per ASTM E1934.
   a. Operate VFD driven equipment at 100 percent speed during thermographic inspection.
4. Acceptability of electrical connections and components based on temperature comparison between components and ambient air temperatures not greater than 10 DegC per ASTM E1934.
5. Acceptability of motors and equipment bearings based on temperature rise not greater than 5 DegC above the equipment and/or bearing manufacturers published criteria.
6. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

G. Electrical Equipment and Connections Testing Program:
   1. Perform testing on Division 16 equipment and connections in accordance with Division 16 requirements.
   2. Testing of motors:
      a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors 5 HP or above.
      b. Bump motor to check for correct rotation.
   3. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

H. Other Testing:
   1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.
   2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
      a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

I. Electric Motors:
   1. Where used in conjunction with adjustable speed AC or DC drives, provide motors that are fully compatible with the speed controllers.
   2. Design for frequent starting duty equivalent to duty service required by driven equipment.
   3. Design for full voltage starting.
   4. Design bearing life based upon actual operating load conditions imposed by driven equipment.
   5. Size for altitude of Project.
   6. Furnish with stainless steel nameplates which include all data required by NEC Article 430.
   7. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.
   8. AC electric motors less than 1/3 HP:
      a. Single phase, 60 Hz, designed for the supply voltage shown on the Drawings.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
      c. Built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element with stainless steel enclosure.
   9. AC electric motors 1/3 to 1 HP:
      a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
         1) For single phase motors, provide built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.
   10. AC electric motors 1-1/2 to 10 HP:
      a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.

c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.

11. AC electric motors greater than 10 HP:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Oil or grease lubricated antifriction bearings conforming to ABMA standards.
        1) Design bearing life for 90 percent survival rating at 50,000 HRS of operation for motors up to and including 100 HP.
        2) For motors greater than 100 HP, design bearing life for 90 percent survival rating at 100,000 HRS of operation.
    c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
    d. Thermal protection:
        1) For motors 300 HP and above resistance type temperature detector (RTD) complete with monitor and alarm panel having a normally closed contact that will open on overtemperature.
            a) Two (2) thermal sensing devices per phase in each phase hot-spot location.
            b) Monitor and alarm panel:
                (1) For constant speed motors, install panel in and energize from the motor starter equipment.
                (2) For variable speed motors, install panel in and energize from the variable speed drive equipment.
12. Severe duty motor to have the following minimum features:
    a. All cast iron construction.
    b. Gasketed conduit box.
    c. Epoxy finish for corrosion protection.
    d. Hydroscopic varnish on windings for corrosion protection.
    e. Drain plug and breather.

J. NEMA Design Squirrel Cage Induction Motors:
1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.
2. Motors to meet NEMA MG 1 (NEMA Premium) efficiencies.
3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.
4. For use on variable frequency type adjustable speed drives, provide:
    a. Induction motors that are in compliance with NEMA MG 1, Part 31.
    b. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
    c. Insulated drive end bearing on all motors.
    d. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 100 HP and larger.
    e. An insulated bearing carrier on the non-drive end for vertical shaft motors 100 HP and larger.
    f. Shaft grounding ring on all motors driven by a VFD:
        1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
        2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DegC ambient.
6. Design motors for continuous duty.
7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 percent greater than the maximum HP requirements of the driven equipment over its entire operating range.
    a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.

8. Motor enclosure and winding insulation application:
   a. The following shall apply unless modified by specific Specification Sections:

MOTOR LOCATION	MOTOR ENCLOSURE / WINDING INSULATION
Unclassified Indoor Areas	DPFG (for horizontal motors), WP-I (for vertical motors) Standard Insulation
Wet indoor Areas	TEFC, Standard Insulation WP-II (for vertical motors)
Wet outdoor Areas	TEFC, Extra Dip and Bake for Moisture WP-II (for vertical motors)
Corrosive Areas	TEFC, Severe/ Chemical Duty
Class I, Division 1 Areas	Explosion Proof, Approved for Class I Division 1 Locations
Class I, Division 2 Areas	Explosion Proof, Approved for Division 1 Locations or TEFC with maximum external frame temperature compatible with the gas in the area

NOTE: Provide TENV motors in the smaller horsepower ratings where TEFC is not available.

9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.

K. Submersible Motors: Refer to individual narrow-scope Specification Sections for submersible motor requirements.

L. V-Belt Drive:
   1. Provide each V-belt drive with sliding base or other suitable tension adjustment.
   2. Provide V-belt drives with a service factor of at least 1.6 at maximum speed.
   3. Provide staticproof belts.

2.3 COMPONENTS

A. Gear Drives and Drive Components:
   1. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
   2. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
   3. Design drive units for 24 HR continuous service, constructed so oil leakage around shafts is precluded.
   4. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of AGMA.
   5. Gear reducers:
      a. Provide gear reducer totally enclosed and oil lubricated.
      b. Utilize antifriction bearings throughout.
      c. Provide worm gear reducers having a service factor of at least 1.20.
      d. Furnish other helical, spiral bevel, and combination bevel-helical gear reducers with a service factor of at least 1.50.

2.4 ACCESSORIES

A. Guards:
   1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
   2. Interior applications:
      a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
      b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.
      c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.

3. Exterior applications:
    a. Construct from 16 GA stainless steel or aluminum.
    b. Construct to preclude entrance of rain, snow, or moisture.
    c. Roll to conform to shaft or coupling surface.
    d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:
1. Cast-in-place anchorage:
    a. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment.
    b. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
    c. Provide two (2) nuts for each bolt.
2. Drilled anchorage:
    a. Adhesive anchors per Specification Section 05505.
    b. Epoxy grout per Specification Section 03308.
    c. Threaded rods same as cast-in-place.

C. Data Plate:
1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.
2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

D. Gages:
1. Provide gages in accordance with Specification Section 13442.
2. Provide at the following locations:
    a. Inlet and outlet of all reciprocating, centrifugal and positive displacement mechanical and process equipment.
    b. At locations identified on Drawings.
3. Utilize tapping sleeves for mounting per Specification Section 15060.

E. Lifting Eye Bolts or Lugs:
1. Provide on all equipment 50 LBS or greater.
2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.

F. Platforms and Ladders:
1. Design and fabricate in accordance with OSHA Standards.
2. Fabricate components as specified in narrow scope specification sections.
3. Provide platform surface: Non-skid grating, unless specified otherwise in narrow-scope Specification Sections.

2.5 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.
1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.
   1. Provide drain connection for 3/4 IN PVC tubing.

G. Machine the mounting feet of rotating equipment.

H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that can not be properly prepared and painted.
   1. When such back to back fabrication can not be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.
   2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Specification Section 07900.

I. Critical Speed:
   1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.
   2. Excessive vibration is sufficient cause for equipment rejection.
   3. Ratio of all rotative speeds to critical speed of a unit or components: Greater than 1.2.

J. Control Panels Engineered and Provided with the Equipment by the Manufacturer:
   1. Manufacturer’s standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.
   2. NEMA or IEC rated components are acceptable, whichever is used in the manufacturer’s standard engineered design, unless specific requirements are required in the specific equipment Specification Section.
   3. Affix entire assembly with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to delivery.
      a. Control panels without an affixed UL 508A label shall be rejected.

2.6 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:
   1. Provide factory-applied paint coating system(s) for all electrical equipment components except those specified in Specification Section 09905 to receive field painting.
      a. Field painted equipment: See Specification Section 09905 for factory applied primer/field paint compatibility requirements.

B. Field paint other equipment in accordance with Specification Section 09905.
   1. See Specification Section 09905 for factory applied primer/field paint compatibility requirements.

2.7 SOURCE QUALITY CONTROL

A. Motor Tests:
   1. Test motors in accordance with NEMA and IEEE standards.
   2. Provide routine test for all motors.
   3. The Owner reserves the right to select and have tested, either routine or complete, any motor included in the project.
      a. The Owner will pay all costs, including shipping and handling, for all motors successfully passing the tests.
      b. The Contractor shall pay all costs, including shipping and handling, for all motors failing the tests.
      c. If two (2) successive motors of the same manufacturer fail testing, the Owner has the right to reject all motors from that manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab-mounted equipment.

C. For equipment having drainage requirements such as seal water, provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain.
   1. Route clear of major traffic areas and as approved by Engineer.

D. DO NOT construct foundations until major equipment supports are approved.

E. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.

F. Equipment Base:
   1. Construct level in both directions.
   2. Take particular care at anchor bolt locations so these areas are flat and level.

G. Machine Base:
   1. Mount machine base of rotating equipment on equipment base.
      a. Level in both directions, using a machinist level, according to machined surfaces on base.
   2. Level machine base on equipment base and align couplings between driver and driven unit using steel blocks and shims.
      a. Size blocks and shims to provide solid support at each mounting bolt location.
         1) Provide area size of blocks and shims approximately 1-1/2 times area support surface at each mounting bolt point.
      b. Provide blocks and shims at each mounting bolt.
         1) Furnish blocks and shims that are square shape with "U" cut out to allow blocks and shims to be centered on mounting bolts.
      c. After all leveling and alignment has been completed and before grouting, tighten mounting bolts to proper torque value.

H. Couplings:
   1. Align in the annular and parallel positions.
      a. For equipment rotating at 1200 rpm or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.
         1) Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 6 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.
      b. For equipment rotating at speeds greater than 1200 rpm allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.
   2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
   3. Check surfaces for runout before attempting to trim or align units.

I. Grouting:
   1. After machine base has been shimmed, leveled onto equipment base, couplings aligned and mounting bolts tightened to correct torque value, place a dam or formwork around base to contain grouting between equipment base and equipment support pad.
      a. Extend dam or formwork to cover leveling shims and blocks.
      b. Do not use nuts below the machine base to level the unit.
   2. Saturate top of roughened concrete subbase with water before grouting.
      a. Add grout until entire space under machine base is filled to the top of the base underside.

b. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.

3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.
   a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.
   b. When the grout has fully hardened (after a minimum of seven (7) days) tighten all anchor bolts to engage equipment base to grout, shims, and equipment support pad.
   c. Recheck driver-driven unit for proper alignment.

3.2 INSTALLATION CHECKS

A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.
   1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.

B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:
   1. Has been properly installed and lubricated.
   2. Is in accurate alignment.
   3. Is free from any undue stress imposed by connecting piping or anchor bolts.
   4. Has been operated under full load conditions and that it operated satisfactorily.
      a. Secure and deliver a field written report to Owner immediately prior to leaving jobsite.

C. No separate payment shall be made for installation checks.
   1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.3 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

A. Identify equipment and install hazard warning signs in accordance with Specification Section 10400.

3.4 FIELD PAINTING AND PROTECTIVE COATINGS

A. For required field painting and protective coatings, comply with Specification Section 09905.

3.5 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape stripped ends of conductors and associated connectors with electrical tape.
   1. Wrapping thickness shall be 150 percent of the conductor insulation thickness.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

3.6 FIELD QUALITY CONTROL

A. Furnish equipment manufacturer services as specified in the individual equipment Specifications.

B. Inspect wire and connections for physical damage and proper connection.

C. After installation and prior to energizing the motor, provide insulation resistance test of all motors 5 HP and above.

1. Conduct test with 500 or 1000 Vdc megger.
2. Test each phase separately.
3. Disconnect all extraneous leads to the motor.
4. Comply with NEMA MG 1 safety requirements and test procedures.

D. Bump motor to check for correct rotation:
1. Ensure motor has been lubricated.
2. Check prior to connection to driven equipment.

E. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs and cross member that are cast welded or bolted, shall be tested for a natural frequency of vibration after equipment is mounted.
1. Keep the ratio of the natural frequency of the structure to the frequency of the disturbing force out of the range from 0.5 to 1.5.

F. Equipment Vibration Monitoring and Testing:
1. Utilize an Engineer approved testing agency to perform vibration monitoring and testing on equipment defined in the schedule at the end of this Section.
2. Permanently attach vibration test and monitoring mounting pads to the equipment at locations recommended by the equipment manufacturer or as recommended by the vibration testing agency.
3. Utilize mounting pads suitable for permanent installation and for incorporation into a predictable maintenance program.
4. For variable speed equipment provide vibration testing at 1 Hz increments throughout entire operating range.
5. Diagnosis to include, but is not limited to the following:
   a. Unbalance.
   b. Misalignment.
   c. Bent shaft.
   d. Journal bearing related problems.
   e. Rolling contract bearing problems.
   f. Mechanical looseness.
   g. Resonance.
   h. Foundation flexibility.
   i. Electrically induced problems.
   j. Pump problems.
   k. Fan problems.
   l. Coupling problems.
   m. Drive belt problems.
   n. Gear problems.
   o. Centrifugal compressor problems.
   p. Electric motor induced vibration from VFD or VFD carrier frequency.
6. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency, ISO 1940 Balance Quality Grade 6.3 as a minimum.
7. Tolerances for pumping equipment shall be per HI published standards.
8. Repair or replace equipment shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
9. Document testing with written report.
   a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.

3.7 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01650.

3.8 EQUIPMENT VIBRATION TESTING SCHEDULE

EQUIPMENT NAME	TAG NO.	SPECIFICATION REFERENCE
Final Effluent Pump 1	91 PMP 001	11073
Final Effluent Pump 2	91 PMP 002	11073
Final Effluent Pump 3	91 PMP 003	11073

END OF SECTION

SECTION 11060
PUMPING EQUIPMENT: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pumping equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Hydraulic Institute (HI):
      a. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

B. Fully coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

C. Pump/motor and VFD coordination: See Specification Section 11005.

1.3 DEFINITIONS

A. The abbreviations are defined as follows:
   1. IPS: Iron Pipe Size.
   2. NPSHR: Net Positive Suction Head Required.
   3. TDH: Total Dynamic Head.
   4. TEFC: Totally Enclosed Fan Cooled.
   5. VFD: Variable Frequency Drive.

B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005.
   3. Product technical data including:
      a. Performance data and curves with flow (gpm), head (FT), horsepower, efficiency, NPSH requirements, submergence requirement.
      b. Pump accessory data.
      c. Bearing supports, shafting details and lubrication provisions.
         1) Bearing life calculations.
         2) Critical speed calculations.
      d. Solids passage information.
   4. Certifications:
      a. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.
   5. Test reports:
      a. Factory hydrostatic test.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:

1. Certifications:
    a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Pumps:
        a. See individual pump Specification Sections.
    2. Mechanical seals:
        a. Chesterton.
        b. Garlock.
        c. Or as noted in the individual pump Specification Sections.
    3. Seal water station:
        a. Chesterton.
        b. John Crane.
        c. AESSEAL.
        d. Or approved equal.

2.2 CENTRIFUGAL PUMP DESIGN

A. Provide units with increasing head characteristics from the end run out portion of the curve to shut-off condition.

2.3 ACCESSORIES

A. See Specification Section 11005.

B. Each Unit:
    1. Lifting eye bolts or lugs.
    2. Plugged gage cock connection at suction and discharge nozzles.
    3. Tapped and plugged openings for casing and bearing housing vents and drains.
    4. Fittings for properly adding flushing lubricant.
    5. Pressure relief fittings for grease lubrication.

C. Packing Seal:
    1. Provide packing unless mechanical seal is specified in narrow-scope pump sections.
    2. Minimum of five (5) rings graphite impregnated synthetic packing.
    3. Provide minimum 1/4 IN DIA supply tap and 1/2 IN DIA minimum drain tap.
    4. Provide split Teflon or bronze water seal ring.
    5. Adjustable split follower cast iron or bronze gland.

D. Mechanical Seals:
    1. Provide as specified in the narrow-scope pump sections.
    2. Provide rotating balanced O-ring type.
    3. Provide water lubrication - cooling.
    4. Materials:
        a. Metal parts except springs: 316 stainless steel.
        b. Springs: Hastelloy C.
        c. Seal faces: Unfilled carbon graphite versus silica-free Grade 99.5 ceramic.
        d. Elastomers: Viton.

E. Seal Water Station:
    1. Provide one (1) unit per pump with manual shut-off valve on all pumps with seals.
    2. Features:

a. Pressure regulating.
b. Flow regulating.
c. Cleanable flow tube(s) while in service.
d. Hose barb connection.
e. Liquid filled pressure gage.

3. Materials of construction:
   a. Flowmeter tubes: Polysulfone.
   b. Unit body: Polyoxymethylene.
   c. Pressure gage: 316 stainless steel case and wetted parts.
   d. Pressure regulating valve: 316 stainless steel.
   e. Flow regulating valve: 316 stainless steel.
   f. Tube fittings: 316 stainless steel.
   g. Mounting brackets: 316 stainless steel.
4. Service:
   a. Temperatures up to 150 DegF.
   b. Pressure up to 140 psig.
5. Connection:
   a. Hose barb threaded to pump.
   b. Hose barb to seal water unit.
   c. Reinforced polyurethane hose:
      1) Minimum size: 3/8 IN ID.
      2) Minimum pressure rating:
         a) At 180 DegF: 115 psi.
         b) At 73 DegF: 200 psi.
      3) Minimum wall thickness: 1/8 IN.
   d. Non-potable water to shut-off valve: Cooper with bronze isolation valve.
6. Mounting:
   a. To pump or pipe flange with stainless steel bracket.
   b. Maximum distance from non-potable water to shut-off ball valve to seal water station and seal water station to pump seal, 2 FT each direction.

2.4 FABRICATION

A. Pump Support:
   1. Design base to support weight of drive, shafting and pump.
   2. Comply with HI vibration limitations.
   3. Mount horizontal pump, motor and coupling on single piece drip lip type baseplate.
   4. Mount vertical pumps on single piece pedestal baseplate.
   5. Fabricate to withstand all operating loads transmitted from the pump and drive.

2.5 SOURCE QUALITY CONTROL

A. If specifically required in the individual pump specification sections, provide factory tests:
   1. All units:
      a. Conduct tests in accordance with HI.
         1) Shut-off head and design condition: Positive unilateral performance tolerance meeting Grade 1U per HI 14.6.
      b. Hydrostatic test at 150 percent of shut-off head for a minimum of 5 minutes.
   2. Adjustable speed units:
      a. Head (FT) verses flow (gpm) pump curves:
         1) Maximum, minimum and two (2) equally spaced intermittent speeds.
         2) Efficiencies along each curve.
         3) Brake horsepower along each curve.
   3. Constant speed units:
      a. Head (FT) versus flow (gpm) pump curves:
         1) Efficiencies along curve.
         2) Brake horsepower along each curve.

4. Results certified by a registered professional engineer.

B. Statically and dynamically balance each pump per HI standards.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 11005.

B. Floor or Pad-Mounted Units (Non-Submersible):
1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
2. Assure no unnecessary stresses are transmitted to equipment flanges.
3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
7. Assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
   a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
   b. Realign as necessary, install flange bolts and make equipment connection.
8. Field paint units as defined in Specification Section 09905.
9. Provide pressure gage on discharge of all pumps and on suction and discharge of all non-submersible units.

C. Submersible Units:
1. Assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
   a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
   b. Realign as necessary, install flange bolts and make equipment connection.
2. Field paint units as defined in Specification Section 09905.
3. Provide pressure gage on discharge of all pumps and on suction and discharge of all non-submersible units.

3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:
1. Inspect equipment covered by this Specification Section.
2. Supervise pre-start adjustments and installation checks.
3. Conduct initial startup of equipment and perform operational checks.
4. Instruct Owner's personnel for the specified minimum number of hours at jobsite per Specification Section 01060 on operation and maintenance of each of following pumping equipment:

END OF SECTION

SECTION 11061

PUMPING EQUIPMENT: NON-CLOG CENTRIFUGAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-clog centrifugal pumps.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   3. American National Standards Institute (ANSI).
   4. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A278, Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F.
      e. A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
      f. A744, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11060.
   3. Source quality control test reports.
   4. Certifications: Certification statement of solids passage.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Non-clog centrifugal pumps:
      a. Fairbanks-Morse.
      b. Morris.
      c. Worthington.
      d. Or approved equal.

2.2 MATERIALS

1. Pump volute:
   a. Cast iron, ASTM A48, Class 30 (minimum).
2. Impeller:
   a. Cast iron, ASTM A48, Class 30 (minimum).
3. Shaft:
   a. Carbon steel, ASTM A108-C1141.
4. Impeller wear rings: Stainless steel, AISI 416.
5. Shaft sleeve: Stainless steel, ASTM A743, GR CA-40 (450-484 Brinell).
6. Stuffing box, gland bolts and nuts: 316 stainless steel.
7. Packing: Non-asbestos material.
8. Frame: Cast iron, ASTM A48.
9. Bearing housing: Cast iron, ASTM A48.
10. Baseplate: Cast iron, ASTM A48.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
   1. RAS Pumps 1 through 4 (42PMP001, 42PMP002, 42PMP003, 42PMP004):
      a. Design condition: 1,100 gpm at 20 FT TDH with minimum pump efficiency of 60 percent.
      b. Shutoff condition: 0 gpm at 35 FT TDH.
      c. Pump configuration: As shown on Drawings.
      d. Nameplate driver horsepower: 10, inverter duty.
      e. Drive type: Variable frequency.
      f. Drive configuration: Flexible coupled.
      g. Minimum solids passage: 3 IN DIA.
      h. Suction size 6 IN DIA minimum, discharge size 6 IN DIA minimum.
      i. Maximum net positive suction head required (NPSHR): 5 FT.
   2. WAS Pumps 1 through 2 (42PMP031, 42PMP032):
      a. Design condition: 50 gpm at 10 FT TDH with minimum pump efficiency of 32 percent.
      b. Secondary condition: 100 gpm at 12 FT TDH with minimum pump efficiency of 35 percent.
      c. Third condition: 35 gpm at 7.5 FT TDH with minimum pump efficiency of 30 percent.
      d. Shutoff condition: 0 gpm at 22 FT TDH.
      e. Pump configuration Horizontal.
      f. Maximum pump speed: 1200 rpm.
      g. Maximum nameplate driver horsepower: 5.
      h. Drive type: Constant speed.
      i. Drive configuration: Flexible coupled.
      j. Minimum solids passage: 3 IN diameter.
      k. Suction size 3 IN diameter minimum, discharge size 3 IN diameter minimum.
      l. Maximum net positive suction head required: 20 FT.

B. Assure increasing head characteristic from secondary design condition to shutoff condition.

C. Provide pumps with net positive suction head requirements that are less than the available net positive suction head available at design condition specified.

D. Assure adjustable speed pump operation in a stepless fashion over full operating range.

2.4 ACCESSORIES

A. See Section 11060.

2.5 FABRICATION

A. General:
   1. Pump casing strength to withstand 150 percent of shutoff head.
   2. Single suction non-clog type pump fabrication.
   3. Built-together units not acceptable.
   4. Fabricate casing for impeller removal without disturbing suction and discharge piping.
   5. Tap and plug openings for minimum 1/2-IN IPS suction and discharge gage connections.
      a. Tap in discharge nozzle shall serve as a vent when gage is not used.
   6. Provide volute and suction clean out hand hole.

B. Suction and Discharge:
   1. ANSI Class 150, 150 LB rated flanged nozzles for suction and discharge

C. Impeller:
   1. Three-vane impeller with smooth water passages to minimize clogging.
   2. Secure to keyed shaft by stainless steel connector.
   3. Install replaceable type wear rings and adjustable shims.
   4. Impeller adjustment (manufacturer's option):
      a. Alternate A:
         1) Replaceable case and impeller wear rings allowing a minimum of 1/4 IN wearing surface.
         2) Impeller wear ring with a Brinell hardness of 190-220.
         3) Fronthead/casing wear ring with Brinell hardness of 300-350.
      b. Alternate B:
         1) Externally adjustable shims or jackscrews with locking device to take up impeller wear using split ring shims and to be installed at top bearing housing for vertical units.

D. Shaft Seal:
   1. Provide stuffing box with integral cover.
   2. Minimum five (5) rings of packing complete with seal cage and split-type gland.
   3. Provide space for conversion to mechanical seals at later date.
   4. Provide sealing/flushing liquid connection to stuffing box in convenient locations.

E. Shafting and Sleeves:
   1. Size shaft to transmit full driver output.
   2. Accurately machine and construct shaft.
   3. Incorporate shaft sleeve (minimum Brinell hardness of 180) in stuffing box area to protect shaft from pumped liquid.
   4. Provide positive shaft seal between shaft sleeve and shaft for full length of sleeve.
   5. Fabricate shaft for maximum deflection of 0.002 IN measured at the stuffing box.
   6. For vertically configured units with extended shafts, provide shafting and appurtenances meeting these additional requirements:
      a. Designed for continuous 24 HR duty at all speeds within the pump operating range.
      b. Utilize vertical self-aligning couplings to connect shaft to pump and driver.
      c. Provide minimum one (1) intermediate bearing support.
      d. Furnish one (1) slip spline to allow endwise movement.
      e. Furnish all steady bearings and supports required for extended staff applications.
      f. Provide lubrication system for shafting which permits greasing from accessible locations.

F. Bearings, Bearing Support, and Frame:
   1. Provide bearing housings complete with grease seals and provisions to preclude moisture and foreign matter from entering both ends of the frame.
   2. Tap 3/4 IN drain hole in frame to convey leakage from packing gland.
   3. Supply bearings for a minimum ABMA L-10 life of 100,000 HRS at design condition.

4. Furnish radial inboard bearings of either ball or roller type suitable to sustain all loads encountered in service conditions.
5. Provide axial thrust outboard bearings of deep groove single or triple row ball type or angular contact double row ball type suitable for thrust loads in two (2) planes.

G. Rotation:
1. Pump rotation to conform with piping arrangement shown on Drawings.

H. Motors:
1. 460 volt, 3 phase, 60 HZ.
2. Inverter duty where driven by a VFD.
3. TEFC, 1.15 service factor.

2.6 SOURCE QUALITY CONTROL

A. All Pumps:
1. Hydrostatically test volute at 150 percent of shut off head.
   a. Furnish documentation of test.

B. Factory test one (1) pump of each service category:
1. Measure head (FT) versus flow (gpm).
2. Furnish characteristic curve and include efficiency and horsepower.
3. Certify curves by registered professional engineer.

2.7 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish Owner the following extra parts for each pump:
   a. Shaft sleeve: One (1) each.
   b. Bearing sets: One (1) set.
   c. Full gasket kits: One (1) set.
   d. Packing: Two (2) sets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 11060.

3.2 FIELD QUALITY CONTROL

A. See Section 11060.

END OF SECTION

SECTION 11063
PUMPING EQUIPMENT: SAMPLING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Self-priming centrifugal pumps.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 11060 - Pumping Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Requirements in Specification Section 11060.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Self-priming centrifugal pumps:
      a. AMT.
      b. Goulds.
      c. Gorman Rupp.
      d. Or equal.

2.2 MATERIALS

A. Sample Pumps: 71PMP013, 71PMP014, 71PMP015, 71PMP016, 71PMP017, and 71PMP018.
   1. Service: Municipal wastewater chlorinated with sodium hypochlorite and dechlorinated with sodium bisulfite.
   2. Materials of construction: Materials of all parts intact with pump liquid should be chemical and corrosion resistant for presence of sodium hypochlorite and sodium bisulfite.
   3. Pump volute casing: Cast iron, ASTM A48, Grade 30.
   4. Impeller: Cast iron, ASTM A48, Grade 30 or ductile iron, Grade 60-40-18.

5. Cover plate: Cast iron, ASTM A48, Grade 30.
6. Wear plate: Steel, AISI 1015 or cast iron, Grade 30.
7. Shaft: Steel, AISI 4140.
8. Shaft sleeves: Stainless steel, AISI 304.
9. Buna-N mechanical seal and O-ring.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
   1. Sample pumps:
      a. Design condition: 10 gpm at 30 FT TDH.
      b. Pump configuration: Horizontal.
      c. Nameplate driver horsepower: 1/2 or 3/4.
      d. Drive type: Constant speed.
      e. Drive configuration: Close coupled.
      f. Minimum solids passage: 1/4 IN.
      g. Suction size 1 IN DIA minimum, discharge size 1 IN DIA minimum.
      h. Total dynamic suction lift: 18 FT.
      i. Maximum priming lift: 15 FT.
      j. Pump elevation: 112 FT MSL.
      k. Maximum temperature of liquid: 80 DegF.

2.4 ACCESSORIES

A. See Section 11060.
   1. Provide mechanical shaft seal with oil reservoir.

2.5 FABRICATION

A. General:
   1. Equip with removable cover plates allowing complete access to pump interior.
   2. Fit with replaceable wear plates.
   3. Assure entire rotating assembly including bearings, shaft seal, and impeller may be removed as a unit without disturbing pump volute or piping.

B. Impeller:
   1. Two-vane, semi-open, non-clog type with integral pump out vanes on the back shroud.
   2. Provide for external adjustment of the impeller to the wear plate.

C. Shaft and Sleeve:
   1. Size shaft to transmit full drive output.
   2. Accurately machine and construct shaft.
   3. Contain shaft within bearing pedestal of ample size to contain ball thrust bearing and radial bearing of adequate size to withstand all imposed loads.
   4. Incorporate shaft sleeve to protect shaft from pumped liquid.

D. Bearings:
   1. Oil lubricated.

E. Rotation:
   1. Pump rotation to conform with piping arrangement shown on Drawings.

2.6 SOURCE QUALITY CONTROL

A. All Pumps:
   1. Hydrostatically test volute at 150 percent of shut off head.
      a. Furnish documentation of test.

B. Factory test one pump of each service category:
   1. Measure head (FT) versus flow (gpm).
   2. Furnish characteristic curve and include efficiency and horsepower.

3. Certify curves by registered professional engineer.

2.7 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish the Owner the following extra parts for each pump service category (total 2 sets):
   a. Shaft sleeve: One set.
   b. Bearings: One set.
   c. Gaskets: One full set.
   d. Spare mechanical seal: One set.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements of Section 11060.

3.2 FIELD QUALITY CONTROL

A. See Section 11060.

END OF SECTION

SECTION 11065
PUMPING EQUIPMENT: SUMP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sump pumps.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 11060.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
   1. See GC 2.1-05 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pedestal-mounted sump pumps:
      a. Aurora.
      b. Fairbanks - Morse.
      c. Wilson - Snyder.
      d. Chicago Pump.
      e. Paco.
      f. Weil.
      g. Or approved equal.

2.2 MATERIALS

A. Aeration Basin Drainage/Scum Pumps:
   1. Pump casing:
      a. Cast iron, ASTM A48, Class 35A.
   2. Impeller:
      a. Cast iron, ASTM A48, Class 35A.
   3. Shaft:

a. Stainless steel, AISI Type 316.
4. Strainer:
a. Cast iron, ASTM A48, Class 35A.
5. Impeller wear rings:
a. Bronze, ASTM B62.
6. Baseplate: Cast iron.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
1. Aeration Basin Drainage/Scum Pumps:
a. Design condition: 500 gpm at 25 FT TDH.
b. Shutoff condition: 51 FT.
c. Pump configuration: Vertical.
d. Nameplate driver horsepower: 5 HP.
e. Drive type: Constant speed.
f. Drive configuration: Direct coupled.
g. Minimum solids passage: 6 IN.
h. 460V, 3 phase.

2.4 ACCESSORIES

A. Controls:
1. Float switch assembly:
a. Stainless steel float and rod.
b. Provide manufacturer's standard pump float switches.
1) Pump start when water level reaches 15 IN above floor of sump.
2) Pump stop when water level is 11 IN above floor sump.
2. Pot electrical connections watertight.
3. Mount switch assembly support to baseplate so switches are minimum 1 FT above baseplate.
4. Floats shall be integral to pump.

2.5 FABRICATION

A. General:
1. Pump casing uniform and free from blowholes or other defects and designed to withstand 150 percent of shutoff head.
2. Equipped with bolted-on strainer with opening equal to specified solids passage of pump.
3. Mount each motor on pedestal base fitted with sealed thrust bearing located a minimum of 6 IN above baseplate.
4. Provide cord and 3-prong plug for plugging into weatherproof electrical outlet.

B. Suction and Discharge:
1. Threaded NPT connections of the following diameters:

SERVICE CATEGORY	DISCHARGE (IN)
Aeration Basin Drainage/Scum Pump	6

C. Impeller:
1. Enclosed.
2. Key to pump shafts with same material as shaft.
3. Provide positive means of external axial adjustment of shaft and impeller.

D. Shaft Seal:
1. Provide mechanical seal.
2. Seal material: ceramic, carbon and Buna.

E. Bearings:
   1. Grease lubricated through separate nylon tube lubrication lines terminating at baseplate.
   2. Provide two line bearings as follows:

F. Baseplate:
   1. Design to support maximum operating weight of pumps with a maximum permissible deflection of 1/8 IN.
   2. Minimum thickness 3/8 IN.

2.6 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Furnish Owner with the following extra parts for each pump service category:
      a. One full gasket set.
      b. One full bearing set.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements of Section 11060.

3.2 FIELD QUALITY CONTROL

A. See Section 11060.

END OF SECTION

SECTION 11068

PUMPING EQUIPMENT: VORTEX (TORQUE-FLOW)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vortex (torque-flow) pumps.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. American National Standard Institute (ANSI).
   3. American Society for Testing and Materials (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A532, Standard Specification for Abrasion-Resistant Cast Irons.
   4. Hydraulic Institute Standards (HI).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 11005 and Section 11060.

B. Operation and Maintenance Manuals:
   1. See Section 01342.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Severe duty pumps:
      a. Wemco (Model C).
      b. Morris (Model 6100).
   2. Primary sludge Pumps:
      a. Wemco Hidrostal.
      b. Or equal.

2.2 MATERIALS

A. Grit Pumps (13PMP001 and 13PMP002) and Primary Sludge Pumps (25PMP001, 25PMP002, 25PMP003, and 25PMP004):
   1. Casing: Super Ni-Hard, ASTM A532 or 28 percent Chrome Iron, ASTM A532, Class 3, Type A (minimum Brinnell Hardness of 650).
   2. Impeller: Same as casing.
   3. Wearplate: Same as casing.
   4. Suction Piece: Same as casing.
   5. Baseplate or pedestal base: Steel.
   6. Shaft: Steel AISI 4140 or 1141.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
   1. Grit Pumps (13PMP001 and 13PMP002):
      a. Design condition: 250 gpm at 30 FT TDH.
      b. Shutoff condition: 0 gpm at 37 to 42 FT TDH.
      c. Pump configuration: Horizontal.
      d. Maximum pump speed: 800 rpm.
      e. Nameplate driver horsepower: 15 hp maximum.
      f. Drive type: Constant speed.
      g. Drive configuration: Overhead motor base with V-belt sheeves.
      h. Minimum solids passage: 4 IN.
      i. Maximum Net Positive Suction Head Required (NPSHR): 8 FT.
      j. Suction 4 IN DIA minimum, discharge 3 IN DIA minimum.
   2. Primary Sludge Pumps (25PMP001, 25PMP002, 25PMP003, and 25PMP004):
      a. Design condition: 175 gpm at 65 FT TDH.
      b. Shutoff condition: 100 gpm at 80 to 63 FT TDH.
      c. Pump configuration: Horizontal.
      d. Maximum pump speed: 2,650 rpm.
      e. Nameplate driver horsepower: 5 hp maximum.
      f. Drive type: Constant speed.
      g. Drive configuration: Overhead motor base with belt drive.
      h. Maximum solids passage: 2 IN.
      i. Suction 4 IN DIA minimum, discharge 3 IN DIA minimum.

2.4 ACCESSORIES

A. See Section 11060.

2.5 FABRICATION

A. General:
   1. Entire wet end shall be cast Ni-Hard iron or 28 percent chrome iron, 650 Brinnell Hardness.
   2. Two-piece radial split design casing.
   3. Separate and removable suction piece.
   4. Completely open from suction to discharge requiring no impeller face plates.
   5. Allow removal of impeller without disturbing the discharge piping.
   6. Cast case of the following minimum thickness for severe duty units:
      a. 3 IN pump size: 9/16 IN.
   7. Suction piece (severe duty units):
      a. Provide following minimum thickness at the areas of greatest wear:
         1) 3 IN pump size: 1 IN.

B. Suction and Discharge:
   1. ANSI, Class 150 flanged.

C. Impeller:
   1. Mount completely out of flow path between inlet and outlet so that solids do not flow through impeller.
   2. Key to shaft and secure with impeller bolt locked against reverse rotation or tapered babbitt fit to pump shaft for shear protection, locked in place with impeller bolt and collet.
   3. Recessed type with semi-open design.
   4. Cup-type such that blade ends are surrounded by an integral rim. Flow must be directed to center of volute, minimizing particle impact and reducing wear and degradation.
   5. Taper rim from a maximum thickness of at least 7/8 IN at the tip of the discharge portion of the impeller vane to a minimum thickness of at least 1/2 IN on the backside of the vane.
   6. Taper vane from a minimum thickness of 1-1/8 IN at the bottom of the cup to a minimum thickness of 1/2 IN at the top of the vane.

7. Provide replaceable rear liner or removable wearplate back of impeller designed to direct flow from behind impeller to center of volute for maximum protection of casing.
8. Provide wearplate/rear liner separate from stuffing box.
9. Statically and dynamically balance per HI Standards.

D. Mechanical Seal:
1. A single mechanical seal.
2. Product lubricated.
3. Design for +/- 0.025 IN radial shaft deflection and +/- 0.04 IN axial shaft deflection.
4. Materials:
   a. Adapter: ASTM A532 Class 3 Type A Hi-chrome iron heat-treated to 600 Brinell.
   b. Rotary holder: ASTM A743 CD4MCU stainless steel.
   c. Stationary holder: ASTM A743 CD4 MCU stainless steel.
   d. Seal shaft sleeve: ASTM A743 CD4 MCU stainless steel.
   e. Rotary face: Tungsten carbide with 6 percent cobalt.
   f. Stationary face: silicon carbide.
   g. Cone spring: Viton.
   h. O-rings and elastomers: Viton.
   i. Set screws, keys: 316 stainless steel.
5. Provide drainable reservoir beneath seal area.
6. Tap reservoir seal water drainage piping.

E. Bearings:
1. Provide oil bath lubricated bearings with oil reservoir.
2. Seal oil reservoir with labyrinth seal at both ends.
3. Ball-type bearings.
4. Design to safely handle radial and thrust loads.
5. Equip bearing housing with a pressure venting device and oil fill, level and drain taps.
6. Minimum B10 life of 100,000 HR.

2.6 SOURCE QUALITY CONTROL

A. All Pumps:
1. Hydrostatically test volute at 150 percent of shut off head.
   a. Furnish documentation of test.

B. Factory test one pump of each service category.
1. Measure head (FT) versus flow (gpm).
2. Furnish characteristic curve and include efficiency and horsepower.
3. Certify curves by a professional engineer registered in the State of California.

2.7 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish Owner the following extra parts for each pump service category:
   a. One full gasket set.
   b. One bearing set.
   c. Mechanical seal repair kit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements of Section 11060.

3.2 FIELD QUALITY CONTROL

A. See Section 11060.

END OF SECTION

SECTION 11069
PUMPING EQUIPMENT: PROGRESSING CAVITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material, design, fabrication and installation requirements for progressing cavity pumps.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   3. American National Standards Institute (ANSI).
   4. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A536, Standard specification for Ductile Iron Castings.
   5. Hydraulic Institute (HI).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process
   2. Requirements in Specification Section 11060.
   3. Source quality control test reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process .
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Progressing cavity pumps:
      a. Moyno.
      b. Netzsch.
      c. Seepex.
      d. Or approved equal.

2.2 MATERIALS

A. Gravity Thickened Sludge Pumps (61PMP024, 61 PMP025), Thickened Sludge Pumps (61 PMP003, 61PMP013): Primary Scum Pump (23PMP001):
   1. Pump body: Cast iron.
   2. Rotor: AISI 316 stainless steel.
   3. Stator:
      a. Buna-N or nitrile rubber.

4. Base plate: Fabricated steel.
5. Stuffing box gland: Ductile iron.
6. Lantern ring: 316 stainless steel.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
1. Gravity Thickened Sludge Pumps (61PMP024, 61PMP025):
   a. Design condition: 150 gpm at 15 psig and 300 rpm.
   b. Secondary condition: 50 gpm at 10 psig and 150 rpm.
   c. Nameplate driver horsepower: 5 HP.
   d. Drive type: Variable frequency.
   e. Drive configuration: Right angle belt.
   f. Solids content: 3 percent.
   g. Suction: 6 IN DIA minimum, discharge 6 IN DIA minimum.
2. Thickened Sludge Pumps (61PMP003, 61PMP013):
   a. Design condition: 50 gpm at 180 psi at 150 rpm.
   b. Secondary condition: 50 gpm at 155 psi at 100 rpm.
   c. Nameplate driver horsepower: 10 HP.
   d. Drive type: Variable frequency.
   e. Drive configuration: Right angle belt.
   f. Solids content: 9 percent.
   g. Suction: 6 IN DIA minimum (hopper type configuration), discharge 6 IN DIA minimum.
3. Primary Scum Pump (23PMP001):
   a. Design condition: 150 gpm at 30 psi at 150 rpm.
   b. Secondary condition: 50 gpm at 20 psi at 100 rpm.
   c. Nameplate driver horsepower: 5 HP.
   d. Drive type: Constant speed.
   e. Drive configuration: Direct coupled.
   f. Solids content: 0.5 percent.
   g. Suction: 6 IN DIA minimum, discharge 6 IN DIA minimum.

2.4 ACCESSORIES

A. See Section 11060.

B. Provide adjustable pressure switch on the pump stator housing for switching off the pump upon over pressure.

2.5 FABRICATION

A. Pump Body:
1. Provide body containing two (2) inspection ports 180 degrees apart.
2. Cradle mount pump to permit suction port to be rotated at 90 degree increments perpendicular to pump centerline.

B. Rotor:
1. Harden to minimum Rockwell C-57.

C. Stator:
1. Construct by bonding rubber-type material to inside of a steel tube.
2. Minimum 65 durometer hardness (Shore A).

D. Drive Train:
1. Include crown gear-type or pin-type universal joints, seals, connecting rod, driveshaft, and shaft bearings.
2. Connect rotor drive shaft by a connecting rod equipped with two (2) crowned gear-type or pin type factory grease lubricated and positively sealed universal joints.

a. Joint unconditionally guaranteed by manufacturer to meet 10,000 HR operation at the required performance conditions.

3. Use universal joints to transmit thrust and torque while allowing the rotor to move through an eccentric path.
4. Joint shall be positively sealed and encased in a series 300 stainless steel cover to protect it from tramp metal and glass.
5. Mount drive shaft in two (2) ball or tapered roller bearings.
6. Bearing ABMA L-10 life: 50,000 HRS at design operating conditions specified.
7. Provide fittings for grease or oil lubrication of bearings.
8. Stuffing box:
   a. Design for grease lubrication.
   b. Permit gland adjustment and repacking without dismantling pump.

E. Suction and Discharge:
1. Provide ANSI, Class 150, rated flanged.

F. Provide open throat suction flange (for 61PMP003 and 61PMP013).

G. Base Plate: Provide common base plate for pump, drive and motor.

2.6 SOURCE QUALITY CONTROL

A. Testing:
1. Perform Level I test for each pump as defined by HI standards to assure conformance to manufacturer's commercial performance criteria.
2. Perform hydrostatic test for each pump in compliance with HI standards.
3. Perform required net inlet pressure test as defined by HI standards to verify compliance with specified performance criteria for the specified viscosity and pump speed.
   a. For variable speed pumps, perform tests for the maximum, minimum, and three (3) intermediate speeds equally spaced between the maximum and minimum.

2.7 MAINTENANCE MATERIALS

A. Furnish Owner the following extra parts for each pump category:
1. One (1) shaft sleeve (if required).
2. One (1) rotor.
3. One (1) stator.
4. One (1) connecting rod with bushings.
5. One (1) set of connecting rod joint assemblies.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 11060.

3.2 FIELD QUALITY CONTROL

A. See Section 11060.

END OF SECTION

SECTION 11073

PUMPING EQUIPMENT: VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Vertical Turbine Pumps for installation at the Effluent Pump Station and Chlorine Contact Basin (3W Pumps).

B. Equipment List:

TAG NUMBER	ITEM
91PMP001	Final Effluent Pump 1
91PMP002	Final Effluent Pump 2
91PMP003	Final Effluent Pump 3
72PMP001	3W Pump 1
72PMP002	3W Pump 2

C. Impeller Design: Vertical turbine.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. American National Standards Institute (ANSI).
   3. American Society of Mechanical Engineers (ASME):
      a. B16.1, Cast Iron Pipe Flanges and Flanged Fittings - Classes 25, 125 and 250.
   4. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
      c. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      d. A582, Standard Specification for Free-Machining Stainless Steel Bars.
      e. B148, Standard Specification for Aluminum - Bronze Sand Castings.
      f. B505, Standard Specification for Copper-Base Alloy Continuous Castings.
      g. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   5. Hydraulic Institute (HI):
      a. Standards for Centrifugal, Rotary and Reciprocating Pumps.

B. ISO 9001 Quality System:
   1. Compliance by pump manufacturer is required.
   2. Submit documentation of compliance prepared by independent certification agency approved by International Organization for Standardization.
   3. Do not ship equipment before compliance documentation review has been completed by Engineer.

C. Experience:
   1. Provide products of a single manufacturer who has been regularly engaged in the design and manufacture of the equipment.
   2. Demonstrate that the quality is equal to equipment made by those manufacturers specified.
   3. Supplied complete units that have been in successful operation, at similar installations, for at least ten (10) years.

D. Coordinate with the variable frequency drive supplier (See Section 16265) to provide the latter with the data required to size the variable frequency drives.

E. Unit Responsibility:
   1. Assign unit responsibility, as defined in Section 11005 to the pump manufacturer for the equipment specified in this section.

1.3 SUBMITTALS

A. Comply with Section 01340.

B. Contract Document Coordination
   1. Provide copies of the following contract documents, with addenda updates, that apply to the equipment in this section marked to show specific changes necessary for the supplied equipment. If no changes are required, the document shall be marked “No Changes Required”.
      a. This specification section and referenced sections.
      b. Process and Instrumentation Diagrams.
      c. Control Wiring Diagrams.
      d. Mechanical Arrangement and Detail Drawings.
      e. Control Loop Description (Section 13441).

C. Product Technical Information
   1. Comply with Section 11005.
   2. Comply with Section 11060.

D. Operating Characteristics:
   1. Provide performance data curves showing head, capacity, horsepower demand, NPSH required, recommended NPSH margin, and pump efficiency over the entire operating range of the pump.
   2. Indicate separately the head, capacity, horsepower demand, overall efficiency, and the minimum submergence required at the rated flow conditions and the maximum and minimum flow conditions.

E. Shop Drawings:
   1. Comply with Section 11005.
   2. Comply with Section 11060.

F. Equipment anchorage calculations as specified in Section 11005.

G. Certifications and Reports
   1. Comply with Section 11060.
   2. ISO 9001 Certification.

H. Critical speed analysis report, as specified in Paragraph 2.4 A.

I. Operation and Maintenance Information:
   1. Comply with Section 01342.

J. Factory Performance Test:
   1. Provide signed, dated, and certified factory test data in report form.
   2. Submit report for review and approval before shipment.
   3. Comply with Paragraphs 2.9 A & B.

1.4 WARRANTY

A. Comply with warranty requirements specified in the General Conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Weir Floway, (Final Effluent Pumps Model 19FKH).
   2. Flowserve, (Final Effluent Pumps Model 18ENY).

2.2 MATERIALS

A. Pump shaft: 416 stainless steel, ASTM A582 (416).

B. Bowls: Cast iron, ASTM A48, Class 30, Epoxy Lined.

C. Bowl bearings: Bronze B584, ASTM B505 (932).

D. Impeller: Bronze, ASTM B148 (952).

E. Suction bell: Cast iron, ASTM A48, Class 30.

F. Suction bell bearing: Bronze, ASTM B505 (932).

G. Bowl wear rings: Aluminum Bronze, ASTM B148, (954).

H. Impeller wear rings: Aluminum Bronze, ASTM B148, (952).

I. Column and flanges: Steel, ASTM A53, Grade B.

J. Shaft coupling: Stainless Steel, ASTM A269, Type 304.

K. Lineshaft: Stainless Steel, ASTM 582, Type 416.

L. Discharge head: Steel, ASTM A53, Grade B.

M. Sole plate: Steel, ASTM A53, Grade B.

N. Bearing retainer: Bronze, ASTM B584 (836) or Ductile Iron ASTM A536-84 GR 60-40-18.

O. Lineshaft bearing: Rubber, neoprene.

P. Lineshaft sleeve: Stainless steel, ASTM A269, Type 304.

Q. Seal housing: Cast iron, ASTM A48 Class 30.

R. Top shaft sleeve: Stainless steel, ASTM A269, Type 304.

S. Seal housing bushing: Bronze, ASTM B505 (932).

T. Basket strainer: Type 316 stainless steel.

2.3 PERFORMANCE REQUIREMENTS

A. Final Effluent Pumps, 91PMP001; 91PMP002; 91PMP003.
   1. Full speed conditions:
      a. Guaranteed design point:
         1) Discharge: 4,830 gpm.
         2) TDH: 240 FT.
         3) Minimum bowl efficiency: 75 percent.
         4) Achieve with two stage.
         5) Shutoff head: 425 FT, maximum.

b. Secondary condition (published far right of curve):
   1) Permissible range discharge: 6,600 - 7,000 gpm.
   2) Permissible range TDH: 150 - 200 FT.
c. Nominal full speed: 1,800 rpm.
d. Minimum submergence: Pump shall operate satisfactorily at submergence as low as 42 IN, as measured from the lip of the suction bell, with a maximum distance above the floor.

2. Reduced speed condition:
   a. Guaranteed design points:
      1) Reduced speed condition: 1,000 gpm at 110 FT TDH.
      2) Stable operation required.
3. Minimum solids passage: 1 IN.
4. Net positive suction head required (NPSHR): Not more than 24.7 FT at 4,830 gpm and full speed, nor more than 37.0 FT at secondary condition.
5. Pump discharge flange and column shall be 16 IN diameter.
6. Maximum allowable motor size is 450 HP. Pump motor shall be non-overloading over entire curve. Minimum allowable motor size is 400 HP.

CHARACTERISTICS	**FINAL EFFUENT PUMPS**
Number of units	3
Location	Effluent PS Wetwell
Service	Treated Effluent Raw Wastewater (continuous)
Operation	24 hrs/day
Drive	Adjustable (VFD)
Design Point (DP) @ 100 percent pump speed [2]	4,830 gpm @ 240 FT
Maximum Net Positive Suction Head Required (NPSHR) @ DP	24.7 FT
Minimum size of solids to pass	1 IN
Specific gravity of liquid	1.01
Liquid temperature	60 - 85 DegF
Minimum overall efficiency @ DP	80%
Second operating point @ 100 percent pump speed [2, 3]	6,600 – 7,000 gpm @ 150 - 200 FT TDH
Minimum overall efficiency @ second operating point	75%
Maximum NPSHR @ second operating point	37 FT
Third operating point [2]	1,000 gpm @ 110 FT
Third operating point speed (min.) (% of max. speed)	55% - 61%
Minimum overall efficiency @ third operating point	25%
Maximum pump speed (rpm)	1800 (nominal)
Minimum shutoff head @ maximum speed	325 FT
Maximum head @ runout point	20
Motor size (Hp)[1], maximum	450

CHARACTERISTICS	FINAL EFFUENT PUMPS
Discharge flange inside diameter	16 IN
Minimum pump column diameter	16 IN

[1] Contractor is responsible for sizing and all additional costs involved if larger motors are required than indicated. All items have been designed for these horsepowers including but not limited to the standby power, electrical items, and adjustable speed drives. Motor shall be non-overloading over the entire pump curve.

[2] All operating points shall be located within the manufacturer's recommended operating range and to the right of the minimum continuous flow line.

[3] Field conditions limit the maximum speed when operating a single pump due to NPSHA. NPSHA = 35.95 FT (maximum) at wetwell elevation 104.25 FT and 33.3 FT (maximum) at wetwell elevation 102.2 FT. The maximum speed of one pump shall be limited to approximately 85-95% (field set) of full speed. Two pumps at minimum speed shall match the flow of one pump at maximum speed.

B. 3W Pumps, 72PMP001 and 72PMP002:
   1. Full speed conditions:
      a. Guaranteed design point:
         1) Discharge: 232 gpm.
         2) TDH: 175 FT, or head at specified impeller trim, whichever is higher.
         3) Minimum bowl efficiency: 75 percent.
         4) Shutoff head: 320 FT.
   2. Minimum solids passage: 1 IN.
   3. Pump discharge flange shall be 6 IN diameter.

C. Additional Requirements:
   1. Provide pumps with continuously rising head characteristics, with no flat spots or reversals, over entire curve, from runout to shutoff condition. Curves with flat spots, dips, or reversals will be rejected.
   2. Provide stable performance, free from damaging cavitation, vibration, and noise.
   3. Do not exceed the motor nameplate horsepower (do <u>not</u> include service factor) at any point in the full speed characteristic pump curve.

2.4 DESIGN REQUIREMENTS

A. Critical Speeds:
   1. Design equipment which does not exhibit critical speeds within the specified range of operating speeds.
   2. Design critical speeds for the pump assembly to be at least 20 percent greater than maximum operating speed or at least 20 percent below the minimum speed.
   3. Shaft first critical speed: Not less than 20 percent above maximum operating speed.
      a. Excessive vibration is sufficient cause for rejection of the equipment.
      b. Configure mass of the unit and its distribution so that resonance at normal operating speeds is avoided.
   4. Submit critical speed analysis report signed by licensed professional engineer.

B. Equipment Anchorage:
   1. Comply with Section 11005.

2.5 COMPONENTS

A. General:
   1. Furnish units consisting of a vertical, open line shaft, turbine pump which is connected to a vertical solid shaft motor. Design unit with non-reversing ratchets.
   2. Weight of revolving parts of pump including unbalanced hydraulic thrust of impeller is carried by thrust bearing in driver.
   3. Make provision at driver shaft for adjusting impeller with reference to bowls.

B. Column:
   1. Final effluent pumps:
      a. Provide final effluent pumps with 16 IN discharge column pipe of schedule 40 steel and supply with flanged connections.
      b. Sandblast inside and outside surfaces of column and coat factory with a Scotchkote 134 fusion bonded epoxy.
      c. Flanges: ANSI B16-1 150 LB.
   2. 3W pumps:
      a. Provide discharge column pipe of schedule 40 steel and supply with flanged connections.
      b. Provide top and bottom sections of column pipes to 5 FT lengths.
      c. Provide intermediate column sections not exceeding 10 FT in length.
      d. Sandblast inside and outside surfaces of column and coat factory with a Scotchkote 134 fusion bonded epoxy.
      e. Flanges: ANSI B16-1 150 LB.

C. Open Line Shaft:
   1. Rolled and ground.
   2. Maximum length: 10 FT.
   3. Furnish renewable shaft sleeves at each bearing location.
   4. Undercutting of shafting at sleeve locations is not permitted.
   5. Provide rubber bearings at each column connection supported by retainers butted between machined faces of discharge column.

D. Pump Bowl and Suction Bell:
   1. Provide bowl and suction bell constructed of close grained cast iron, free from imperfections and accurately machined and fitted.
   2. Factory coat pump bowl water passages and exterior with an abrasion-resistant Skotchkote 134 fusion bonded epoxy, or equal. Epoxy shall be NSF 61 approved.
   3. Design to ensure easy removal of bearings and impeller.
   4. Furnish suction bell with flared end to reduce entrance losses and with a sufficient number of vanes to support lower guide bearings and weight of impeller and pump shaft when dismantling pump.
   5. Inlet suction bell (flared section) diameter to be selected by manufacturer.
   6. Furnish bowls with wear rings.

E. Bearings:
   1. Provide units with bronze sleeve bearings in each bowl and in suction bell.
   2. In bowl, provide main bronze bearing immediately above impeller and a lower bronze bearing immediately below impeller.
   3. Provide for lubrication of bowl bearings with pumped liquid.
   4. Ensure bell bearing is permanently packed type with packing to be a nonsoluble grease.
   5. Provide bronze collar for bell bearing to prevent abrasives from entering bearing.

F. Pump Shaft and Impeller:
   1. Provide pump unit shaft constructed of rolled and ground stainless steel.
   2. Furnish impellers constructed of bronze and double keyed to impeller shaft.
   3. Ensure impeller is accurately fitted and statically and dynamically balanced.
   4. Provide bronze replacement wear rings for both the bowls and impellers.
   5. Pump shaft diameter: Not less than the minimum permitted by AWWA E101 for applicable driver nameplate horsepower.
   6. Furnish impellers with wear rings.

G. Discharge Head Assemblies:
   1. Design discharge head assembly for 200 psi working pressure.
   2. Provide discharge head for above ground mounting constructed of fabricated steel with integral discharge flange.

3. Factory coat inside diameter of discharge head with Skotchkote 134 fusion bonded epoxy.
4. Furnish ASME B16.1 150 LB flange.
5. Mount discharge head on fabricated painted steel sole plate which is of sufficient size and thickness (minimum 1.25 IN) to span opening in support structure.
6. Provide bronze upper shaft bearing directly below seal housing, in the head, to eliminate any shaft whip which could damage the seal. Hard pipe seal bleedoff to wet pit below pumps.

H. Mechanical Seal:
1. Provide design suitable for product (secondary effluent) lubrication/flushing, with no external water source required.
2. Seal faces: Silicon carbide for both rotating and stationary faces.
3. Cartridge style, single seal, o-ring design.
4. All major metal parts: type 316 stainless steel.
5. O-rings: Ethylene propylene.
6. Springs: Alloy C-276 (Hastelloy).
7. Equip with stainless steel tubing drain line routed from flush-port/bleed off connection of mechanical seal through hole drilled in pump base and sole plates to permit flushing water or air to be discharged to wetwell. Construct similar to API Plan 13, except DO NOT equip line with on orifice.
8. Manufacturers:
   a. Chesterton 155.
   b. John Crane 5610.
   c. Flowserve.
   d. Or approved equal.

I. Data Plates:
1. Provide stainless steel data plate securely attached to pump.
2. Include manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.
3. Attach a special data plate to the motor frame which identifies frame and bearing numbers.

J. Basket Strainer:
1. Equip suction bell with heavy gauge woven wire “clip-on” basket strainer.
2. Make net inlet area of strainer equal to minimum four times the suction bell throat area.
3. Maximum opening: Not more than 75 percent of minimum opening of water passage through bowl and impeller.
4. Secure strainer to suction bell using bronze clips and 300 series stainless steel cap screws.

2.6 FABRICATION

A. Design pumps to operate without damage reverse rotation due to return of water through column.

B. Support weight of rotating assembly and thrust on motor bearings.

C. Design driver shaft to allow propeller adjustment relative to bowls.

D. Primary effluent pumps shall have fabricated discharge head with long mitered elbow with minimum of three (3) welded segments.

E. Support pump from baseplate sized to support entire operating pump assembly.

F. Locate shaft seal at or above baseplate.

G. Mount driver on support stand or column extension from base plate with access provided to shaft seal.

H. Balance statically and dynamically impeller in accordance with HI standards.

I. Fabricate line shaft and column in maximum 10 FT lengths.

J. Provide units with ASME B16.1, Class 150 LB rated flanged discharge.

2.7 MOTORS

A. Comply with Section 11005.
   1. Wet outdoor location.
   2. Inverter duty.

B. Size:
   1. Final effluent: 450 HP (maximum), each. 400 HP (minimum).
   2. 3W pumps: 20 HP, each.

C. 230/460V, 3 phase, 60 HZ, premium efficiency, inverter duty.

D. Solid shaft.

E. Provide four piece flanged adjustable spacer coupling. John Crane Metastream C-Series, Style 4 or equal.

F. Equip with 120 volt space heaters.

G. Provide with nonreversible ratchet device to prevent backspin of pump.

H. Nominal full speed: 1,800 rpm.

I. Provide enclosure per Section 11005.

2.8 ACCESSORIES

A. Comply with Section 11060.

2.9 SOURCE QUALITY CONTROL

A. Comply with Section 11060.

B. Factory Testing:
   1. Test capability.
      a. Manufacturer shall submit evidence of ability to perform the full speed pump testing, to the full speed runout point specified.
      b. Manufacturer shall provide evidence, in writing, that adequate power, water, and test equipment are available at the manufacturer's facility.
      c. Approval of submittals and release to manufacture will not be given until manufacturer has satisfied the Engineer of his ability to test as specified.
   2. Quality control:
      a. Manufacturers whose facility is ISO 9001 certified shall submit a copy of their ISO certificate for the record.
      b. Manufacturers without ISO 9001 facilities shall provide a copy of their Quality Control manual for review. The Engineer reserves the right to require additional Quality Control measures should the manufacturer's manual be deemed inadequate.
   3. The Engineer shall have the option to inspect impeller material and finish, impeller clearances, test floor capabilities, and overall pump construction prior to factory testing at the manufacturer's facility.
   4. Witnessed tests:
      a. One representatives of the Owner and one of the Engineer will witness all shop tests as well as inspect and check-testing equipment used at the expense of the Owner.
      b. The Contractor shall give notice to the Owner of the time of conducting all tests at least 30 calendar days prior to the proposed test date.
      c. Any additional expense due to failure of any component or any completed assembly to pass the required tests, or failure of the Contractor to be prepared to make test on the date set, shall be paid by the Contractor.

5. Equipment specified in this section shall be factory tested at the manufacturer's expense and not less than seven certified copies of the test results and actual test data shall be delivered to the Engineer. Such equipment shall not be shipped until the Engineer has reviewed the test results and advised the Contractor in writing that the equipment is approved for shipment. If test results are acceptable, the Engineer will give approval of test results. Such approval, however, shall not be considered as final acceptance, which will only be made on the basis of the results of field tests of the equipment after it is installed.
6. Factory performance and hydrostatic testing shall be performed in accordance with the latest edition of the test code of the Hydraulic Institute, except as modified herein. One pump of each size shall be tested for NPSHR. All pumps shall be tested fully assembled. Material or design upgrades as required to meet hydrostatic pressure test shall be included at no additional cost to the Owner.
7. All pumps shall be tested to verify that performance requirements are met. Tests shall be made to permit plotting head capacity, brake horsepower, and efficiency curves from minimum head to shut-off head. All curves shall be plotted against flow on the abscissa (horizontal axis).
8. The affinity laws shall be used to establish a curve for reduced speed and verify the minimum specified operating point (Operating Point 3). In addition, at least, one additional curve between minimum and maximum speed shall be established. Pumps not meeting minimum efficiency at specified minimum design point may be rejected. This test shall also be used to provide motor data at full speed and full load, including motor power input, overall efficiency, full load current, power factor, speed, and line voltage.
9. Factory pump tests shall be basis of acceptance of the hydraulic performance of the pumps and as such shall conform to Hydraulic Institute Standards ANSI/HI 11.6 (2012) (Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests). In order to be acceptable, pump must meet design point conditions of service specified within Performance Test Grade 1U per 11.6.5.4 (no negative tolerance acceptable). Other operating points and reduced speed point shall be met within grade 3B. Should any pump fail to pass test, it shall be reworked and retested. If after two additional tests the pump has still failed to achieve specified design points, the pump may be rejected.
10. Motors shall have tests performed at the factory, including no-load current and speed, winding resistance, locked rotor current, and high potential tests, in accordance with NEMA MG 1, and IEEE 112.
11. Motor and cable insulation shall be tested for moisture content for insulation defects.
12. Factory testing shall be performed with the top of the motor(s) exposed and accessible. The motor should be observed for noise and vibration. The various units should be compared to each other for variations in noise and vibration. Units that have issues should be corrected and retested before shipment.

C. Field Test (Functional Testing, Operational Testing, and Process Commission Testing).
1. General:
   a. Field testing shall be performed in accordance with the construction sequencing and constraint requirements of the project.
   b. The Contractor shall field test each pump and motor, and variable frequency drive. The Contractor shall provide all personnel, oil, grease, gauges, meters, test piping, calibration equipment, and other test equipment necessary to substantiate that the equipment conforms to the specifications. Contractor shall submit a field test procedure with proposed instrumentation for approval at least 30 days before the scheduled test date. The Contractor shall provide the Owner with the test date two weeks prior to said test date.
   c. The final adjustments and inspections shall be witnessed by factory-trained and authorized service personnel other than sales representatives. Manufacturer shall provide factory-trained service personnel to oversee adjustment of all of the said equipment supplied by the manufacturer.

d. Head shall be measured by calibrated mercury manometers or calibrated pressure gauges on the discharge, also furnished by the Contractor. Suction head shall be measured from the wetwell level. Flow shall be measured by volume/time calculation. Other devices may be used provided they are calibrated.
e. Field test reports for each test shall be prepared by the Contractor and submitted to the Engineer.
f. Prior to the field test, Contractor shall submit for review and approval the proposed field test procedure.

2. Functional Testing:
   a. Each pump shall be field tested for operation at full speed, 90 percent speed, and minimum speed (third operating point speed). The head shall be varied at each speed to obtain enough points (minimum of four) to establish the pump curve. Each pump shall be operated for a minimum of 90 minutes, unless sufficient flow is not available. Then the duration of the testing may be reduced to accommodate the amount of water that can be backed up into the collection system.
   b. 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 operational test shall be redone for that unit after all parts operate satisfactorily.
   c. Vibration Testing:
      1) Each pump with its specified motor shall be tested for vibration compliance with the specified vibration limits per HI 11.6. 9.4b (2012) for field testing limits.
      2) Vibration tests and vibration signatures shall be performed by a professional qualified in acquisition and analysis of vibration data and is retained by the Contractor for this work, independent of the pump manufacturer.
      3) Each pump and variable speed drive system shall be tested separately without duplicate equipment running. Tests shall be conducted at various speeds between maximum and minimum. All testing shall be done in the presence of the Engineer. Each pump and motor shall be tested for vibration in the field during Functional Testing.
      4) The Contractor shall be responsible for vibration testing. Test results shall be documented in accordance with HI requirements. Copies of test results shall be submitted to the Engineer for review. Should the vibration field test results exceed the limits specified, the Contractor shall correct the deficiencies. After corrections have been completed, the vibration testing shall be rerun and the results resubmitted to the Engineer for review. Corrections shall continue until results meet the specifications. The complete vibration signature of each pump and motor bearing shall be recorded and the original recording given to the Engineer.

3. Operational Testing:
   a. A field operational test shall be made of the entire pumping system, including instruments, controls, motor, pump, drive, and valves, to ensure compliance with the performance specified herein.
   b. Each pump shall be operated with another pump of the same size for a minimum of four (4) hours (at full speed and minimum speed) to demonstrate the proper functioning of the entire pumping system. Consult Owner to determine if sufficient flow is available prior to testing.
   c. All expenses for conducting the testing shall be paid by the Contractor. All equipment and instrumentation required for the pump testing shall be provided by the Contractor.
   d. 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. Proper operation of control devices, limit switches, level

switches, and alarm devices shall be demonstrated. If process conditions cannot be manipulated to demonstrate operation of alarm or control switches, then they shall be actuated artificially to effect the required demonstration. Demonstration shall include verification that all indicators and read-outs are functioning as required. All parts shall operate satisfactorily in all respects and in accordance with the specified requirements for the full duration of the test period.

2.10 MAINTENANCE MATERIALS

A. Special Tools:
   1. Provide 1 – full set of manufacturer's special tools which are necessary for the replacement of parts and the adjustment of the equipment.

B. Spare Parts:
   1. Provide the following spare parts for each size pump:
      a. 1 – suction case bearing set.
      b. 1 – set of bowl and discharge case bearings.
      c. 1 – set of line shaft bearings.
      d. 2 –complete mechanical seals.
      e. 2 – sets of all gaskets and O-rings.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01600.

B. Comply with manufacturer's instructions.

3.2 INSTALLATION

A. See Section 11005 and Section 11060.

B. Align, connect, and install each pump in accordance with the manufacturer's written instructions.

C. Leveling:
   1. Level foundation plate by means of steel wedges (steel plates and steel shims) with taper not greater than 1/4 IN per foot.
   2. Use double wedges to provide a level sole plate bearing surface for the discharge head pump and driver base.
   3. Install wedges so that there is no change of level or springing of the foundation plate when the anchor bolts are tightened. Set discharge head and pump assembly onto foundation plate and bolt to foundation plate.
   4. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.
   5. After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the foundation plate and the concrete foundation with a poured, non-shrinking grout.
   6. Remove wedges after grout is set and pack void with grout.
   7. Connect discharge piping without imposing strain to pump flanges.

3.3 FIELD QUALITY CONTROL AND TESTING

A. See Section 11005 and Section 11060.

3.4 MANUFACTURER'S INSPECTION AND CERTIFICATION

A. Provide factory trained technician to check installation and test initial operation.

3.5 FIELD PAINTING

A. Touch up all shipping damage to the paint as soon as the equipment arrives at the job site.

B. Prior to assembly, coat all stainless steel bolts and nut threads with a non-seizing compound.

C. Field paint non-factory coated, exposed items as specified in Section 09905.

3.6 MANUFACTURER/VENDOR SUPPLIED SERVICES

A. The manufacturer shall maintain staff of qualified service representatives at a facility located in the United States. These representatives shall be full time employees of the manufacturer that actually fabricates the pump. Employees of a company representing the manufacturer or re-selling another manufacturer's equipment do not qualify.

B. The manufacturer shall also have local representation within 100 miles of the plant site. The local representative shall be available to facilitate requests for technical support.

3.7 TRAINING

A. Comply with Section 01650.

END OF SECTION

SECTION 11076

PUMPING EQUIPMENT: SUBMERSIBLE NON-CLOG

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Submersible non-clog pumps - wet pit application.
      a. Influent pumps 1 – 4 (12PMP301, 12PMP302, 12PMP303, 12PMP304).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. American National Standard Institute (ANSI).
   3. American Society for Testing and Materials (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
   4. Factory Mutual Research Corporation (FMRC).
   5. Hydraulic Institute (HI) Standards/ANSI:
      a. HI 1.3 (2009) Rotodynamic (Centrifugal) Pumps for Design and Application.
      b. HI 9.8 (1998) Centrifugal and Vertical Pump Intake Design.
      c. HI 11.6-2012 Rotodynamic Submersible Pumps for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
   6. National Electrical Manufacturer's Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Enclosures for Industrial Controls.
   7. National Fire Protection Agency (NFPA):
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc. (UL).

1.3 SYSTEM DESCRIPTION

A. Influent wastewater pumps utilizing VFDs for pumping raw sewage.

B. Provide single source coordination/supply responsibility through the pump manufacturer for the entire system including but not limited to the following:
   1. Pumps.
   2. Motors.
   3. Lift station hardware.
   4. Base elbows.
   5. Power and control cable.
   6. Motor protection device.
   7. Guide rails.
   8. Accessories specified in this Section.

1.4 SUBMITTALS

A. Submittals shall be provided to confirm that materials to be used comply with information specified herein.

B. Submittals shall meet requirements in Section 01340, Section 11005 and Section 11060.

C. The following information shall be included in the submittal as a minimum. Submittals shall show compliance with Contract Documents:
   1. Manufacturer's predicted pump performance curves. The curves shall include a plot of head (FT) versus flow (gpm), horsepower (BHP), efficiency, and NPSHR. Include at each operating point, pump and combined pump and motor efficiencies.
   2. Shop drawings of the pumps and base elbow assemblies showing dimensions. Provide a material specification list describing materials used in the manufacturer of the pump and base elbow.
   3. Anchorage calculations.
   4. Specifications for the motor including horsepower, voltage, frequency, phase and NEMA insulation and frame classes. Control drawings and data.
   5. Spare parts list.
   6. Warranty.
   7. Letter guaranteeing proper pump operation at all design points.
   8. For variable speed applications, submit:
      a. Critical speed and half critical speed data for each pump model.
      b. Certification that the pump manufacturer is bearing coordination responsibility for the pumps, and motors for their specific application to avoid overheating and harmonic vibrations caused by rotational speed and carrier-frequency-induced rotational "cogging".
      c. Certified statement signed by a registered professional engineer that the L_{10} bearing life meet or exceed the specified requirements.

D. Operation and Maintenance Manuals:
   1. See Section 01342.

1.5 WARRANTY

A. The pump manufacturer shall warranty the units against defects in the workmanship and material for a period of five years, for both parts and labor at a prorated basis.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Submersible non-clog pumps - wet pit applications:
      a. Xylem Water Solutions USA, Inc. (Flygt).
      b. WEMCO, Inc.
      c. ABS, Inc.
      d. Or approved equal.

2.2 MATERIALS

A. Wet Pit Applications:
   1. Pump case and discharge connection elbow: Cast iron, ASTM A48, Class 35B with smooth surfaces void of blow holes and other irregularities.
   2. Motor housing: Cast iron, ASTM A48, Class 25 or Class 30.
   3. Impeller: Wear resistant high chrome per ASTM A532 111A (24 – 26 percent (rmo-HC)).
   4. Shaft: Stainless steel, ANSI Type 431 stainless steel.
   5. Wear rings: Rotating: Type 329 stainless steel, Stationary nitrile-covered steel or stainless steel.
   6. O-rings: Nitrile (Buna-N) or fluorocarbon (Viton).
   7. Fasteners: Stainless steel, type 316.
   8. Guide rails and guide bar brackets: Stainless steel, type 316.

9. Lifting chain: Stainless steel, type 316.
10. Upper and lower ring seal: Tungsten carbide or silicon carbide both faces.
11. Seal metal parts: Stainless steel, type 316.
12. Wear plate: Same material as impeller.

2.3 EQUIPMENT

A. Performance and Configuration Requirements:
   1. Influent pumps (12PMP301, 12PMP302, 12PMP303, 12PMP304):
      a. Design condition: 4,650 gpm at 35 FT TDH with minimum overall efficiency of 75 percent minimum.
      b. Secondary condition: 1,200 gpm at 33 FT TDH with minimum overall efficiency (including VFD) of 50 percent.
      c. Secondary condition: 800 gpm at 33 FT TDH with minimum overall efficiency (including VFD) of 35 percent.
      d. Minimum shutoff condition: 0 gpm at 75 FT.
      e. Minimum solids passage: 3 IN.
      f. Discharge: 10 IN or 12 IN DIA.
   2. Pump configuration:
      a. Submersible wet pit.
      b. Clockwise rotation when viewed from the driver end.
      c. Maximum pump speed: 1800 rpm.
      d. See pump bay dimensions indicated on Drawings.
   3. Drive type: Variable speed.
   4. Motor Requirements:
      a. Service Factor: 1.15.
      b. 480 V, 3 phase, 60 Hz, inverter duty, premium efficiency.
      c. Capable of 15 evenly spaced starts per hour.
      d. Maximum HP: 60.
   5. Ambient conditions:
      a. Wastewater maximum temperature 80 DegF (27 DegC).
   6. Maximum weight: 1.25 tons.

2.4 COMPONENTS

A. General:
   1. Provide pumps of the heavy duty, submersible, centrifugal non-clog type, designed and fully guaranteed of handling raw, unscreened sewage containing solids, fibrous material and grit.
   2. Each pump and motor shall be suitable for continuous operation, under submerged, partially submerged, or dry conditions. Without derating the motor, the pump shall be able to pump continuously with the motor exposed and water level at the top of the volute and under full load.
   3. Each pump shall be capable of continuous operation at full load, without cavitation, overheating of the motor, or damaging vibration in accordance with HI Standards with a minimum operating water level as designated on the Contract Drawings. The minimum operating water level will be below the top of the pump but above the top of the pump volutes.
   4. Each pump, with its motor, cable and appurtenances, shall be able to withstand continuous submergence to a minimum depth of 40 FT, when running or off, without leakage.
   5. 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.
   6. All pumps shall be identical.
   7. Provide with heavy-duty lift lugs or lifting bail designed for lifting the entire pump and motor assembly in conjunction with lifting system.

8. Contractor and manufacturer shall coordinate to verify that the installation of the pump will allow the pump to be positioned so it can be lifted straight up and through the clear openings above the pumps with hoist without manual manipulation.

B. Impeller:
1. Provide nonclog-type dynamically balanced impeller in accordance with HI Standards.
2. Provide impeller and volute wear rings to assure efficient sealing between volute and impeller.
3. Impeller shall be locked to the impeller shaft and shall isolate the shaft from the pumped fluid.
4. Type:
   a. Flygt: N series impeller.
   b. Wemco, Inc: Hidrostal screw/centrifugal impeller.
   c. ABS, Inc: Contrablock plus.

C. Shaft:
1. Design pump shaft of sufficient size to transmit full driver output.
2. Use shaft which is accurately machined and constructed with sufficient materials.
3. Design shaft for a maximum deflection of 0.002 IN measured at the stuffing box.
4. The ratio of the overhang (distance from the bottom of the lower bearing to the top of the hub of the impeller) to the motor shaft diameter at the lower bearing shall be less than 2.0.
5. Pump and motor shaft shall be a solid continuous shaft. Couplings shall not be acceptable.

D. Shaft Seal:
1. Seal shaft with two independent, tandem mounted seals mechanical seal running in an EPA approved, non-toxic oil filled chamber.
2. Oil chamber shall be designed to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The motor shall be able to operate dry without seal damage while pumping under load.
3. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.
4. Hold interface in contact by its own spring system.
5. Tungsten carbide seal face material shall be solid block construction with stainless steel springs.
6. Provide moisture detector probes, alarm, and test circuits to detect the ingress of conductive liquid past the outer seal.

E. Bearings:
1. Support shaft on upper and lower permanently lubricated bearings with a minimum ABMA L-10 life of 50,000 Hours.

F. Motors:
1. Provide pump with FM or UL listed motor designed for area classification shown on Drawings.
2. Provide motor of totally submersible design, constructed with epoxy or poly-seal encapsulated windings, air-filled or dielectric oil filled, with Class F insulation and rated for continuous duty operation.
3. Motor shall be 3 PH, 60 cycle, 480 V.
4. Assure motor is capable of running dry for extended periods without damage to motor or seal.
5. The motor horsepower provided shall be adequate for all points on the pump curve.

G. Power and Control Cables:
1. Provide power cable and control cable to pump suitable for submersible applications in wastewater and indicate same by a code or legend permanently embossed on cables.
2. Size cables in accordance with applicable NEC specifications.

3. Provide power cable and control cable of sufficient length to reach the junction box without any splices. Cable length shall be appropriate to remove pump and set pump on deck above for inspection.
4. Provide each cable with a strain relief, cord grip, and explosion proof seal installed in accordance with NEC Article 500 and latest FMRC requirements.
5. Cable motor entry shall be designed to eliminate moisture entry. Cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining success through the pump top.
6. Epoxies, silicones, or other secondary sealing systems will not be considered acceptable.

H. Motor Temperature and Seal Leak Monitoring:
1. Provide3 sensors for winding temperature and seal leakage.
2. Provide control relay equal to Flygt MiniCAS for field mounting in motor control center.

I. Coatings:
1. Provide manufacturers standard epoxy coating for submersible wastewater applications.
2. Protect all metallic surfaces coming into contact with sewage except stainless steel, high chrome steel and bronze.

J. Nameplates:
1. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall indicate clearly the following information:
   a. Manufacturer.
   b. Date of manufacture.
   c. Model and size.
   d. Serial number.
   e. Capacity.
   f. Feet of head at capacity.
   g. Speed at rated capacity.
   h. Impeller diameter.
   i. Weight.

K. Wet Pit Applications:
1. Provide sliding guide bracket integral to pump unit which properly aligns the pump discharge with the discharge connection elbow for watertight seal during pumping.
2. Guide the entire weight of the pumping unit by guide rail(s).
3. The guide rail(s) shall not support any portion of the weight of the pump.
4. Guide rails shall be connected to discharge base with a welded disc and threaded stud. Guide pipes shall be joined in a similar manner. Guide bars shall be of the diameter and length recommended by the pump manufacturer for proper installation.
5. Intermediate support brackets shall be provided as necessary to eliminate deflection of the guide bars. An intermediate guide rail bracket shall be installed when required by the pump manufacturer.
6. Design pump to allow for easy removal without entering the wet well and without removal of bolts, nuts or other fastenings.
7. Cable holder shall be attached to walkway platform. Provide sufficient quantity of cable holders for the power cables and floats. It shall be located so that the cables are accessible by the City maintenance personnel from the outside when standing on the top of the wetwell slab.
8. Provide pump unit connecting to discharge connection with a simple downward motion without rotation.
9. Provide necessary sliding guide bracket and discharge connection which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.

10. 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.
11. No portion of the pump shall bear directly on the floor or the wet well.
12. Guide rail connection to the top slab at opening shall be coordinated by the Contractor and shall not interfere with hatch.

L. Cooling System:
1. Provide an integral, self-supplying cooling system for each pump/motor unit.

2.5 ACCESSORIES

A. See Section 11060.

2.6 SOURCE QUALITY CONTROL

A. Secure from the pump manufacturer the following inspections and tests on each pump.
1. Check impeller, motor rating and electrical connections for compliance with Specification.
2. Test motor and cable insulation for moisture content or insulation defects.
3. Prior to submergence, run pump dry to establish correct rotation and mechanical integrity.
4. Run pump for 30 minutes submerged, a minimum of 6 FT under water.
5. After 2.6 A.4., perform insulation test of 2.6 A.2 again.

B. Perform factory test of head (FT) versus flow (gpm) for all pumps as specified herein.

2.7 SPARE PARTS

A. Furnish the Owner the following extra parts for each pump type:
1. 1 set of special tools (as required for pumping unit disassembly).
2. 1 impeller for each size of pump. Impeller material shall match impellers supplied with the pumps.

B. No additional compensation shall be provided for the items cited above.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 11060.

B. For wet pit pumps, permanently install discharge connection elbow in wet well along with discharge piping.

C. Seal pump cable end with a high quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

3.2 FIELD QUALITY CONTROL AND TRAINING

A. See Section 11060.

B. Inspection, Certification and Training Assistance:
1. The pump and motor manufacturer shall provide the services of a direct factory employee to satisfy the following requirements:
a. Installation, prestart inspection: Two separate visits, each for a minimum of 4 hours.
b. Start-up assistance: Three separate visits, each for a minimum of 4 hours.
c. Instruction: Two separate visits, each for a minimum of 8 hours. One visit shall be a start-up of the equipment and one visit at one year after final acceptance of the equipment by the Owner.

C. Training:

1. The manufacturer shall provide for training at the Owner's facility. This training shall include the certification for these employees from a nationally recognized organization either Factory Mutual or Underwriters Laboratory to work on these pumps and motors.

END OF SECTION

SECTION 11081
HIGH SPEED TURBO AERATION BLOWER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High speed turbo blowers including:
      a. Integral drive unit.
      b. Adjustable frequency controller.
      c. Harmonic conditioning, as required.
      d. Valves for blow-off, backflow prevention, and isolation.
      e. Inlet filter.
      f. Inlet silencer, if required.
      g. Discharge silencer.
      h. Blow-off silencer.
      i. Flexible connectors.
      j. Pressure and temperature monitoring devices.
      k. Local control panel (LCP) for each blower.
      l. Uninterruptible Power Supply (UPS) for magnetic bearings.
   2. Custom software for control of blowers and master control panel (RTU-3).

B. Equipment numbers:
   1. 51B001, 51B002, 51B003.

1.2 SYSTEM DESCRIPTION

A. Three turbo blowers to be installed. The blowers shall provide process air for Aeration Basins 1 and 2.

B. Provide blower, driver, and accessories through single manufacturer.

C. Contractor to provide and install all external piping, pipe supports, wiring, instrumentation, conduit and appurtenances not provided by the blower manufacturer for a complete functional blower system.

1.3 DEFINITIONS

A. SCFM (Standard Cubic Feet per Minute): Flow of air at standard conditions defined by the American Society of Mechanical Engineers (ASME). With quantity expressed at 68 DegF, 14.7 psi absolute pressure and 36 percent relative humidity.

1.4 MANUFACTURER'S QUALIFICATIONS

A. Acceptable blower manufacturer shall meet the minimum following criteria to be considered as a responsive and responsible manufacturer:
   1. Minimum of three separate installations operating in the United States in operation for at least 3 years.
   2. Minimum of six units operating in the United States distributed between the three installations.
   3. Minimum of 20 installations and 50 blowers (units) operating world wide.
   4. Control panel(s) meet and are labeled pursuant to UL 508.
   5. Blowers shall be NRTL nameplate certified as a complete package, to the applicable UL standards.
   6. Established base of operation in North America that furnishes experienced technical resources and service personnel to carry out start-up and trouble-shooting.

7. Service Network in North America providing responses to technical inquiries within twenty-four (24) hours and guaranteed spare parts replacement onsite within 24 hours.
8. The PLC for the master control panel shall be an Allen Bradley Control Logix or Compact Logix.
9. All communication shall be in English (i.e., service, drawings, nameplates, etc.) and all measurement and technical units shall be in English units.
10. Manufacturer shall have an established service center within eight (8) hours from Owner's facility.

B. Provide documentation that supports and demonstrates that Manufacturer meets the minimum above requirements, and that the proposed equipment meets this specification.

1.5 SUBMITTALS

A. General:
1. See Section 01340 and Section 11005 for requirements for the mechanics and administration of the submittal process.
2. Submittal shall be furnished in one complete package.
3. All submittal dimensions, calculations and other information shall be in USA English units of measure.

B. Product Data:
1. Acknowledgement that products submitted meet requirements of standards referenced.
2. Provide list of three (3) similar wastewater applications that have been in continuous operation for a minimum of three years.
3. Manufacturer's installation instructions.
4. Blower characteristics, specifications, and performance.
   a. Descriptive brochures and blower data.
   b. Factory certified performance curves indicating speed, capacity, horsepower, and efficiency over the range of operation for the complete assembled blower package including blower, motor, AFD or inverter, harmonic conditioner, cooling systems or auxiliary systems if used, inlet filters, assembled housing, and discharge up to the isolation butterfly valve.
   c. SCFM at discharge pressure for each listed design point.
   d. ICFM at EAP discharge pressure.
   e. Surge pressure and rise to surge pressure.
   f. Brake horsepower.
   g. Material list and catalog information showing the details of blower construction.
   h. Outline installation drawings for unit supplied.
   i. Blower weight and weights of each separate item of equipment.
   j. Complete bill of materials of all components and equipment supplied.
5. Furnish a detailed identification of couplings, supports, and accessories, including, but not limited to, the following:
   a. Valves and instrumentation with designated tag numbers.
   b. Mechanical and structural components.
   c. Instruments.
   d. Programmable Logic controller.
   e. Operator Interface/machine monitors.
   f. Electrical components.
6. Adjustable frequency drive (AFD):
   a. Harmonic calculations with detailed drawings and/or information showing how protection is applied to comply with harmonic limits.
   b. Harmonic filter data including dimensional data if the filter is separately mounted.
   c. Technical cut sheet for the AFD, including nameplate data, performance data, and specifications
7. Certifications:
   a. Submit data to verify and certify service life in accordance with specified parameters.

8. Manufacturer's test reports:
    a. Certified acoustical test results for each blower package.
    b. Certified report of dynamic balancing and maximum vibration amplitude.
    c. Certified blower performance test the complete assembled blower package as defined Section 11081, 1.4 B.3.b., in accordance with ASME PTC 10 or equivalent standard.
9. Factory Blower Testing:
    a. Submit a detailed test plan with complete piping and instrumentation configuration diagram per ASME PTC-10 or equivalent standard or per the proposed ASME PTC-13 for mini-turbine blowers.
        1) The "equivalent standard" test shall include, as a minimum, all the requirements for conducting a PTC-10 test, including, but not limited to, instruments, recording system, flow rate adjustment, etc.
    b. 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 per ASME PTC-10 or equivalent standard requirements.
    c. As a minimum, the detailed test plan shall include:
        1) Quality control procedures.
        2) Air-end/gearbox ASME PTC-10 or equivalent standard test procedure and method of calculating results.
        3) Functional testing of entire assembled blower package, including instrumentation, ancillary components, and LCP. Submit the actual ASME PTC-10 test report with the blower system O&M manuals.
    d. If the proposed test, PTC-13, for high speed turbine blowers is published prior to bid, then blower shall be tested in accordance with the new test procedure.
10. Provide equipment anchorage calculations as specified in Section 11005 demonstrating compliance with the applicable requirements of Section 11005.
11. Provide interconnect drawings to include harmonic conditioners.
12. Copies of software for all control panels.
13. Complete description of all controls and control panels, including complete wiring diagrams, elementary or control schematics, and panel outline drawings.
14. A list of manufacturer's recommended spare parts.
15. Surface preparation and shop paint specifications.
16. Program listing in MCP.
17. Submit technical information and cut sheet for the PLC including ladder logic, performance data, and specification. Submit copy of final loaded program and any required software on a CD.

C. Shop Drawings:
1. Unloading, handling, storage, and maintenance requirements.
2. Certified dimensional drawings of the blower unit, including cutaway views.
3. Mechanical drawings with general arrangement showing blower base dimensions, floor mounting, piping, overall weights, and weights of largest components requiring removal for maintenance.
4. Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
5. Any necessary dimensional drawings to coordinate piping layout with structural, architectural, electrical, and/or mechanical work.
6. Certified drawings of the LCP.
7. Description of process control logic and process and instrumentation diagrams.
8. Drawings of local and master panels to include:
    a. Electrical ladder diagram.
    b. Interconnect to all components outside the panel.
    c. Door layout.
    d. Interior layout.
    e. Operator Interface screens for the LCP's and MCP.

f. Preliminary input/output (I/O) listing for all control panel programmable logic controllers (PLC).
g. Operating description for LCP's and MCP: Shall operate as described in Blower Controls Description in this Section.
    1) An electronic copy of all PLC programs for the MCP, complete with tag descriptions and rung comments in the native software format.
    2) Provide Owner with PLC programming software package of he PLC used for the MCP.
    3) Provide register addresses for all data.
    4) Provide to Owner for back-up purposes software licenses of any PLC or Touchscreen OIT software that is used.
    5) Provide a list of instrument settings.
h. Transfer software licenses to Owner and provide original documentation to Owner prior to Substantial Completion.
i. Program listing.
j. Control loop diagrams.
k. See Section 01340 for additional submittal requirements.

9. Certified dimensional drawings of the blower unit, including cutaway views.
10. Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
11. Any necessary dimensional drawings to coordinate piping layout with structural, architectural, electrical, and/or mechanical work.

D. Operation and Maintenance Manuals:
1. See Section 01342 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. Operation and maintenance manual will include the following:
    a. All dimensions, calculations and other information to be in USA English units of measure.
    b. Provide a list of components and catalog cuts fully describing all items:
        1) Mechanical and structural components.
        2) Instruments.
        3) Programmable Logic Controllers (PLC).
        4) Operator Interface/machine monitors.
        5) Electrical components. Provide as left programmable settings and copies of any associated software in O&M Manual.
    c. General description of blower with all performance data, blower curves, and model.
    d. Provide detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt non-specified materials to the arrangement or details shown. Include the actual ASME PTC 10 test report.
    e. Mechanical drawings with general arrangement showing enclosure dimensions, overall weights, weights of largest components requiring removal for maintenance, and clearances required around unit for maintenance access. Indicate surface preparation and paint specifications.
    f. Description of process control logic and process and instrumentation diagrams.
    g. Drawings of all control panels to include:
        1) Electrical ladder diagram as addressed in article 1.4.D.2.h. below.
        2) Interconnect to all components outside the panel.
        3) Door layout.
        4) Interior layout.
        5) Sample Operator Interface screens for the LCP.
    h. Operating description for LCP.

i. Provide for back-up purposes a copy of the software ladder logic covering all logic and sequences of operation and provide a soft copy of all documented PLC code on CD. Provide Owner for back-up purposes with four (4) software licenses of any PLC or Touchscreen OIT software that is used. Provide a list of instrument settings.
j. Provide a detailed description of the data acquisition, monitoring, and predicted preventative maintenance software. Provide typical Operator Interface screens with detailed descriptions, the various monitors, preventative maintenance items, and data logging features.
k. Provide input/output (I/O) listing for main control panel PLC.
l. Indicate all scheduled maintenance requirements and routine inspections. Include maintenance summary forms.
m. Provide list of recommended spare parts and lubricants (if lubricants required).
n. Provide a troubleshooting guide.
o. Provide the local sales representative contact information with the company name, contact person, phone number and address.

1.6 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

C. 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.

D. 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.

E. Refer to Section 01600 for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Three high-speed, turbo blowers to be installed. The blowers shall provide process air for Aeration Trains 1 and 2.

B. Blowers shall be high speed turbo blowers.

C. Motor to be Permanent Magnet Synchronous Motor (PMSM).

D. The blower manufacturer shall supply, coordinate, start-up, and calibrate all items specified in this section.

E. After reaching operational speed, noise emission from the blower package shall not exceed 81 dBa at the machine location, at the air intake and at the discharge piping system, without any special sound attenuation installed in the blower room.
   1. Air intake filter system shall be externally mounted or internally mounted, as shown on Drawings.

F. No special foundations shall be required for installation.

G. Contractor to coordinate with manufacturer and provide and install all external piping, pipe supports, wiring, instrumentation, conduit and appurtenances not provided by the blower manufacturer, for a complete, functional blower system.

H. Acceptable blower manufacturers shall include the following:
   1. APG-Neuros, Inc. of Quebec, Canada, (514) 249-2724.
   2. Aerzen, Coatesville, PA 610-380-0244.
   3. ABS of Meriden, Connecticut, United States, (203) 238-2700.
   4. Or equal.

2.2 DESIGN CONDITIONS

A. Basis of Design:
   1. The blowers have been designed based on the first named manufacturer, APG-Neuros, Inc.

B. Performance Tests:
   1. All the conditions specified herein shall be as defined in ASME PTC 10 - 1997 Performance Test Code on Compressors and Exhausters (re affirmed in 2003) or equivalent standard.
   2. All the pressures and temperatures specified herein refer to stagnation conditions as defined in ASME PTC-10 or equivalent standard.
   3. Inlet conditions are defined as the conditions that exist at the inlet of the air filter.
   4. The discharge conditions are defined as the conditions that exist at the upstream flange of the discharge isolation butterfly valve.
   5. The blower shall be designed to handle filtered air for the following rated conditions:
      a. Barometric pressure: 14.7 psia.
      b. Maximum pressure loss in clean inlet filter/silencer: 0.12 psig.
      c. Maximum total system volumetric flow-rate of air required: 4,000 scfm (corrected to 14.7 psia, 68 DegF, and 36 percent RH).

C. The blower shall not exceed the nameplate motor rating over the entire range of operation. When the blower is operating at or between any of the combinations of the following conditions, the electrical power draw (stated as horsepower) of the motor shall not exceed 200 HP and the blowers shall not surge.
   1. Barometric pressure: 14.7 psia.
   2. Site elevation: 8 FT.
   3. Inlet conditions:
      a. Pressure: 14.7 psia.
      b. Temperature: 30 to 100 DegF.
      c. RH: 10 to 100 percent.
   4. Inlet capacity: 2,000 to 4,000 scfm per blower.
   5. Discharge pressure: 8.5 psig.
   6. Blowers shall be capable of a minimum turndown to 50 percent of maximum design flow.

D. The blower shall maintain a minimum of 3.0 psig away from surge at any operating point in the capacity range above. The blowers shall be capable of operating continuously and satisfactorily at any point between the minimum and the maximum flows without surge, vibration, hunting, overload of motor or AFD or excessive heating of the bearings.

E. The vibration of the blower shall not exceed 1.4 mils as measured at the volute flanges. Refer to Section 11005 for vibration testing procedure.

2.3 ENCLOSURES

A. The standard enclosure:
   1. Act as a sound enclosure and air intake for the blowers.
   2. The enclosures must be designed for easy inspection and maintenance of all blower package components.
   3. Hinged doors shall provide easy and quick access for routine maintenance of the blower and the package components.
   4. Doors shall use a frame, reinforcements and supporting elements as required.

B. Blower electrical components, instrumentation and instrument connections shall all be mounted inside the blower enclosure.
   1. Install fish eyes on the high voltage side of all enclosures for infrared testing.

C. Motors shall be located inside the blower enclosures. Requirements for motor cooling air for each Manufacturer shall meet the following requirements:
   1. Forced motor cooling air from the blower room is required. Motor cooling air is exhausted to the blower room; or
   2. Motor cooling air and inlet process air are common sources. All motor cooling air is exhausted with the process air.

D. Power feed shall be at top of blower cabinet.

2.4 BLOWERS

A. Blowers shall be air foil bearing or magnetic bearing type turbo blowers and shall not require oils or lubricants for adequate operation. Blowers shall be capable of variable speed and output operation.

B. Blowers shall have been NRTL certified, to meet UL standards, with certification label shown on nameplate. Field evaluation for certification approval shall not be permitted.

C. Blower casing shall have a maximum continuous duty design temperature of 400 DegF, and a design pressure of 50 psig.

D. Blower impellers:
   1. To be of the backswept three dimensional high efficiency configuration, designed using Computational Fluid Dynamics (CFD) with two stages in one (axial and centrifugal) disk.
   2. Milled from forged aluminum alloy or stainless steel
   3. First lateral critical speed to be at least 120 percent of the maximum allowable operating speed.
   4. The impeller shall be a single wheel mounted directly to the motor shaft and shall be statically and dynamically balanced.
   5. Designed to achieve maximum aerodynamic efficiency.
   6. The axial gap between the impeller and blower casing shall be adjusted by shims as needed.

E. Blower to provide a minimum rise to surge margin of 3.0 psig above the design discharge pressure and the head-capacity curve shall slope downward continuously (but not necessarily at the same slope) with increasing capacity and decreasing head. Blowers with curves that reflect two possible capacities for a given pressure (head) will not be acceptable.

F. Regardless of theoretical bearing life calculations, the bearings shall be designed for a minimum of expected twenty (20) years between major overhauls.

G. Manufacturer shall be responsible for attenuating noise and vibration in the blower package so that no vibration from the blower shall be transmitted to the floor, intake or discharge piping.

2.5 MOTORS

A. Each blower shall be supplied with a permanent magnet synchronous motor.
   1. The maximum allowable motor horsepower shall be 200 HP.

2.6 BEARINGS

A. Blowers shall be provided with either a magnetic or air bearing system as follows:
   1. Magnetic Bearing System:
      a. The motor rotor shaft shall be continuously levitated in a magnetic field by the magnetic bearing system. This system shall consist of:
         1) Four radial bearings at each end of motor.
         2) Two axial magnetic bearings.
         3) Multiple rotor position sensors.

4) A magnetic bearing controller (MBC).

b. The position sensors shall continuously measure the shaft position and send a signal to the MBC controlling the energy in the active magnetic bearings keeping the motor rotor shaft levitated and centered.

c. There shall be no mechanical contact between any moving surfaces at any time during the turbo compressor operation eliminating friction and wearing of all moving parts.

d. The magnetic bearing system shall not require any oil lubrication.

e. The magnetic bearing controller shall be an MBC-12 or equal having a maximum input power of 1.3 HP (1 kW) and be powered by a 3 phase, 60 Hz, 460V power supply from the blower source.

2. Air Foil Bearing System:

a. Composed of corrugated bump foil and an inner high temperature alloy core.

b. Bearing manufactured from synthetic media.

c. Bearing clearance of 1/30,000 IN.

d. The air bearing system shall not require any oil lubrication.

B. Provide bearing temperature sensors, as determined by manufacturer. High bearing temperature shall signal an alarm at the LCP.

2.7 INLET FILTER

A. The filter media shall have an efficiency of 90 percent by weight per ASHRE 52.2-1999 of 3 micron or larger particles, MERV 14 and UL Class 2 rating.

B. Maximum clean pressure loss across the filter shall be less than 0.12 psig, able to withstand a maximum 0.18 psig differential pressure.

C. Provide instrumentation to measure pressure across filter. Values to be recorded by the Blower PLC and made available to the SCADA system over the Ethernet communication system.

D. Filter (and silencer) performance losses to be included in the blower performance calculation.

E. Inlet filter enclosures (if required):

1. Galvanized sheet metal with stiffeners.
2. Hinged access door with door handle and gasket.
3. Rectangular to round pipe adaptor for remote mounted filter.
   a. Flanged connection with nuts and bolts.
4. If inlet filter and inlet piping is remote from the blower, manufacturer shall be responsible for ensuring inlet filter configuration will fit inside existing building and maintain minimum clearances as shown on Drawings.

2.8 INLET SILENCER (IF REQURIED)

A. Provide inlet silencer on remote mounted filter and inlet pipe for units that do not have integral filters in blower cabinet.

1. 28 IN galvanized steel flanges.
2. Galvanized steel body.
3. Nominal 2 IN thick mineral wool within annular space.
4. Maximum operating pressure of 0.29 psig and maximum pressure drop of 0.02 psig.
5. Noise attenuation:

Octave band, Hz	63	125	250	500	1000	2000	4000	8000
Insertion Loss, dBA	1	2	8	14	33	16	14	11

2.9 FLEXIBLE CONNECTOR

A. Provide each blower with an EPDM or stainless steel bellows style discharge expansion joint capable of withstanding the vacuum, pressure, and temperature under all operating conditions.

B. The expansion joint shall be included with control rods and galvanized steel flanges drilled for ASME/ANSI B16, Class 150 bolt pattern, size as recommended by blower manufacturer.

C. Provide flexible connector on inlet to blower where remote filter/silencer is installed.

2.10 BLOW OFF (BYPASS) VALVES

A. Provide manufacturer's standard automatic, pneumatic actuated or electro-pneumatic actuated blow-off valve.
   1. Provide valve with open-close position switches, if required by blower controls.

B. Power and controls for the valve shall be provided from each blower LCP.

C. Valves shall be rated for the maximum discharge air temperature.

2.11 DISCHARGE SILENCER

A. Provide discharge silencer, if required, to meet noise attenuation requirements described in Section 2.12 F.

B. Type 304 stainless steel flanges, size as recommended by blower manufacturer.

C. Type 304 stainless steel body.

D. Nominal 2 IN thick mineral wool within annular space.

E. Maximum operating pressure of 17.4 psig and maximum pressure loss of 0.02 psig at 8870 scfm, 185 DegF air.

F. Noise attenuation:

Octave band, Hz	63	125	250	500	1000	2000	4000	8000
Insertion Loss, dBA	2	6	15	24	35	27	21	12

2.12 DISCHARGE VALVES

A. Contractor shall provide blower with a flange type discharge butterfly valve meeting Section 15103 of the Specifications.
   1. Provide valve with open-close limit switches.
   2. Valves shall be rated for maximum discharge air temperature.

B. Size and actuator speed shall be as required by blower system and determined by the blower manufacturer. Valve operation shall be controlled by the blower LCP.

2.13 CHECK VALVES

A. Provide each blower with a high performance wafer type non-slam discharge check valve of the dual, flat-plate type with 316 stainless steel center hinge, spring closure, cast 316 stainless steel body and plate, Viton-B seal and aluminum-bronze plates, Inkonel or Approved Equal springs, and rated for temperature of 400 DegF.

2.14 BLOW OFF SILENCER

A. A galvanized steel blow off silencer shall be provided for the blow-off (bypass) valve internal baffles, packed with nominal 2 IN fiberglass or mineral wool sound absorbent material.

B. The blow off silencer shall be an integral unit, fitted with one flange for direct bolting to the blow off valve or connected to the blow off valve discharge pipe via a slip fit connection and set screws.

C. Noise sound attenuation:

Octave band, Hz	63	125	250	500	1000	2000	4000	8000
Insertion Loss, dBA	1	4	8	15	34	22	15	11

2.15 INSTRUMENTATION

A. The blower manufacturer shall provide the blower instrumentation described in this section. Instruments shall be as specified in this section and the corresponding instrument section in Division 17. These components shall be mounted within the enclosure except as noted.

B. The controls shall be designed such that the blower cannot operate unless the controls are energized and functional. All controls and instruments shall fail into a safe condition.

C. Each Blower shall be supplied with an integral AFD inverter for motor speed control.
   1. 97 percent efficiency at full rated motor speed and power.
   2. Each blower shall be supplied with an integral local control panel (LCP).
   3. Each blower LCP shall communicate to the MCP using Ethernet data link.
   4. All LCP controls, alarms and monitoring shall be accessible through a touch screen control panel.
   5. Ethernet communication port shall be provided for all status information to the plant SCADA system over fiber optic cable.

D. Instrumentation for each blower shall include, as a minimum:
   1. Inlet air temperature gauge field supplied or within blower enclosure.
   2. Inlet air temperature transmitter 4-20 mA.
   3. Inlet air filter differential pressure transmitter 4-20 mA.
   4. Discharge temperature transmitter, 4-20 mA
   5. Surge switch to shut down blower if blower infringes on surge point.
   6. Blower air flow rate reading.
   7. Blow off valve switches for position indication (open/closed).
   8. Discharge butterfly valve limit switches for position indication (open/closed), if required by manufacturer.
   9. Butterfly valve position indication for each DO controlled zone at the blower MCP.
   10. A high temperature (as determined by the blower manufacturer) shuts down the blower and generates an alarm. The alarm/shutdown shall be displayed until reset.
   11. Provide necessary hardware for direct communication between thermocouples, PLC, and Operator Interface.
   12. Amperage monitoring system:
      a. Monitor amperage at the AFD.
      b. High amperage signal shall shutdown the blower and generate an alarm.
   13. Vibration monitoring system:
      a. Monitor and display vibration (as determined by blower manufacturer).
      b. High vibration (as determined by the blower manufacturer) shuts down the blower and generates an alarm.

E. Local Control Panel (LCP):
   1. Each blower shall be equipped with an integral micro processor LCP control system.
   2. The LCP shall contain controls for blower start-up operation and shutdown.
   3. All LCP controls, alarms and monitoring shall be accessible through a touch screen control panel or a keypad/display screen combination.
   4. Ethernet/IP communication shall be provided for communication with the blower MCP.
   5. LCPs shall have UPS power for at least 15 minutes operation.

F. Main Control Panel (MCP):
   1. Blower supplier to furnish a custom MCP which will include the following:
      a. Implement the blower and aeration control strategy in Section 13441, including blower sequencing, blower speed control, header pressure control and four D.P. control loops.
      b. Coordinate the operation of the blowers through the blower LCP's.
      c. Gather blower information from the blower LCP's.
      d. Communicate data to the plant SCADA through a fiber optic Ethernet data link. Ethernet switches to be unmanaged, N-Tron, or approved equal. Provide facilities for terminating a 12 fiber, fiber optic cable in the MCP.
      e. Select Aeration Basin 1 or 2 or both in service.
      f. Selection of manual or automatic system operation.
      g. Selection of lead, lag and standby blower.
      h. Setpoint selections and control loop tuning constants.
      i. Other required functions for complete control system.
   2. The MCP shall be wall or floor mounted NEMA 12 with an operator interface and other required controls on the front of the control panel and other required equipment inside the panel including PLC.
      a. Programmable Logic Controller (PLC) to be Allen Bradley or Modicon Quantum.
      b. Operator interface to be Allen Bradley HMI Model 2711P-T15CAD1 Panelview Plus 1500 color, touch screen, 15 IN with Ethernet and RS-232 ports, 64 MB and 24 VDC or approved equal.
   3. MCP shall have panel supplier's standard UPS power for at least 15 minute operation.
   4. MCP shall meet the construction requirements of Section 13448.
   5. Panel power connection will be 120 VAC, 20 ampere circuit.
   6. The following information shall be made available to the plant SCADA system over the Ethernet data link.
      a. Air filter differential pressure.
      b. Air filter differential high alarm.
      c. Inlet air temperature.
      d. Discharge air temperature.
      e. High vibration alarm.
      f. Blowoff valve open/closed.
      g. Discharge air pressure.
      h. Blower AFD speed.
      i. Blower air flow.
      j. Discharge valve open/closed.
      k. D.O. in each zone.
      l. Blowers in operation.
      m. Blower fail.
      n. System in automatic.
      o. All system alarms.
      p. Aeration Basins in operation.
      q. Motorized valve position and position command for each of 6 DO control motorized valves.

G. Ethernet communication shall be provided between the MCP and the plant SCADA. The PLC in the MCP shall be able to communicate all blower and system data and alarms. The blower manufacturer shall coordinate with the system integrator to ensure proper configuration and setting up a tag database according to the Owner standards.

2.16 HARMONIC PROTECTION REQUIREMENTS

A. Each blower unit shall be designed and provided with all necessary equipment to protect the blower system from voltage and current distortion as follows:
   1. In accordance with and as defined by IEEE 519:

a. Each blower shall be designed to operate from a power bus that may contain up to 5 percent voltage distortion.
b. Each single or multiple set of AFDs powered from the same bus shall be designed to limit percent distortion factor to a maximum of 5 percent voltage distortion.
c. Current distortion limits shall not exceed the values listed in Table 10.3 of IEEE 519.
d. Line-to-line notching at the input to the drive shall have a maximum notch depth of 20 percent and a maximum notch area of 22,800 volt-microseconds reflected back to the power source.

2. The Point of Common Coupling (PCC) for all harmonic calculations and field measurements for both the voltage and current distortion shall be defined as the primary (line side) connection at the MCC for each AFD.

B. Harmonic filters may be separately mounted from the blower. Where filters are separately mounted, provide NEMA Type 1 enclosures with automatic isolating contact. The filter capacitors shall not be connected to the distribution system when the associated blower is not in operation. The filter dimensions are restricted to be not greater than the space allocated on the Drawings. Provide custom enclosures to meet the space restrictions. Contractor shall verify final cable and conduit sizing for the equipment supplied and provide the cable and conduit.

C. Coordinate manufacturer's requirements and connect at recommended location if different than shown at no additional cost to the Owner.

D. The Point of Common Coupling (PCC) for all harmonic calculations and field measurements for both the voltage and current distortion shall be defined as the primary (line side) connection of each blower.

2.17 UNINTERRUPTIBLE POWER SUPPLY (UPS) FOR MAGNETIC BEARINGS

A. Each blower using magnetic bearings shall be provided with an uninterruptible power supply (UPS) system that provides a secondary source of power for the magnetic bearings and magnetic bearing controller.

B. This system is a backup to the power generation mode feature that is the first line of safety if a power outage occurs assuring that the turbo compressor will spin down without damaging the high speed unit.

C. The UPS shall have batteries sufficiently sized to provide a safe spin down and a monitoring panel that will indicate the condition of the batteries.

2.18 BLOWER VENTILATION REQUIREMENTS

A. Each blower enclosure shall be ventilated in accordance with the manufacturer's recommended standards and Section 11081 to ensure proper operation of the mechanical equipment, controllers, AFD and motors.

B. Each manufacturer has differing ventilation requirements. The Contactor shall provide all ancillary ventilation equipment, ductwork and electrical components as needed to provide ventilation in accordance with the manufactures recommend standard.

C. Blower supplier shall indicate any special blower ventilation requirements. Coordinated shop drawing submittals with calculations shall support the ventilation equipment and systems selected for the blower enclosures.

D. The existing blower room is not air conditioned.

2.19 SURFACE PREPARATION AND SHOP PRIMING

A. All carbon steel or iron surfaces shall be prepared, shop primed, and finish painted with two finish coats of Manufacturer's standard paint system per Section 09905.

B. Machine surfaces that are not painted shall be protected by a coating with a Manufacturer's standard corrosive protective compound per Section 09905.

2.20 SOURCE QUALITY CONTROL

A. Upon completion of assembly, the blower package, shall be functionally tested at the place of assembly and may be witnessed by representatives of Owner and a Witnessing Engineer (provided by, but independent of the blower manufacturer) as specified in this section.

B. At a minimum, the blower system shall be factory tested for a duration of not less than 8 hours at maximum load and maximum temperature.

C. The entire blower system, blow-off valve, check valve, and LCPs shall be tested as an operational system before shipment. The LCP shall be connected to all enclosure instruments, electric valves, and appurtenances. All start/stop and running sequences and all safety and alarm systems shall be tested. The Witnessing Engineer, if present will sign the test procedure and results, indicating that the assembled blowers, auxiliaries, blow off valves, discharge valves, and LCP were tested together, as a system, in the blower manufacturer's shop. If a witnessing Engineer is not present, the factory test personnel shall certify the test results.

D. Each blower shall be performance tested in accordance with the ASME PTC 10 - 1997 Performance Test Code on Compressors and Exhausters (re affirmed in 2003). The test shall verify compliance with the performance and design criteria in paragraph 2.3 of this specification, as well as the power guarantee points stated in the Contractor's Annotated Bid and in the Agreement.

E. Net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance. There shall be no tolerances or measuring uncertainties used in reporting test results (i.e., the tests shall be reported with ± zero percent tolerance using the measured values).

F. The sound pressure level shall be measured to verify compliance with these specifications.

G. The Witnessing Engineer or factory test personnel 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 Codes or equivalent standard, modified to permit zero tolerance for flow and power.
   1. The capacity of the blower shall be defined as per Paragraph 4.26 of the ASME PTC 10 Power Test Code, including Air flow measurement with zero (0) tolerances.
   2. 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 one year per ISO 9001, Paragraph 4.11.
   3. Velocity vibration versus frequency levels shall be recorded within 10-1,000 and 10-10,000 Hz frequency range. Report vibration in velocity versus frequency.

H. The blower test report shall present computations in exact accordance with Section 5, 6, and 7 of ASME PTC 10 Code or equivalent standard with performance curves showing capacity, pressure, and horsepower inputs.

I. Test results of the motors and blowers shall be included in the Operations & Maintenance Manual.

J. If test is conducted in a country other than the Untied States, manufacturer to include two (2) business class air line tickets to the test site plus arrange for hotel accommodations and transport from the airport to the hotel.

K. Motor/blower assembly shall be given complete tests at 100, 75, 50, and 25 percent full load, power factors at 100, 75, 50, and 25 percent of full load, winding resistances, high potential, and bearing inspection. Certified motor test data sheets shall be submitted for review and acceptance. Data sheets shall give the observed and nameplate temperature and results of dielectric tests in addition to the above data. The sheets shall be marked to indicate motor application, manufacturer, type, frame size, bearing type, and enclosure type, and motor serial number.

2.21 MAINTENANCE AND SPARE PARTS

A. Furnish all special tools and appliances necessary to disassemble, service, repair, and adjust the blower equipment and appurtenances. The following spare parts shall be furnished:
   1. One (1) set of instrumentations for a blower/motor package.
   2. Six (6) complete sets of air filters for each blower furnished.
   3. One (1) spare of blow-off solenoid valve.
   4. One (1) Maintenance Tools Box.
   5. One (1) I/O module (PLC) for each type used.
   6. One (1) pump for cooling system, if required.

B. All spare parts shall be suitably packaged and clearly identified with indelible marking on the containers. Tools and spare parts (except for the air filters) shall be supplied in a tool chest for long-term storage and marked with manufacturer's name, along with a complete description on contents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The blowers, motors, LCP's and MCP, and appurtenances shall be installed in accordance with the instructions of the Manufacturer, as shown on the Drawings, and in compliance with Section 11005. 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 (± 1/4 IN) in accordance with the recommendations of the Manufacturer and contract documents, whichever is more stringent.

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.

C. Provide one 480V, 3 phase connection point for electrical power to each blower skid and pre-wire all equipment on each skid and blow-off valve.

3.2 FIELD QUALITY CONTROL

A. General Requirements:
   1. All Operation and Maintenance Manuals shall be in USA English and contain USA English units.
   2. All field service, online service, and/or phone service shall be provided in English.
   3. All nameplates for blower enclosures, motors, AFDs, etc., shall be in English and contain USA English units.

B. At a minimum, each blower package shall be field tested for duration of not less than 24 hours at maximum load and maximum temperature.

C. The Contractor shall provide third party electrical harmonic mitigation testing of each blower system. The third party testing shall:
   1. Demonstrate to the Owner that the harmonic distortion to the electrical supply system meets IEEE 519.
   2. Be performed for each blower package for a duration of not less than one hour.
   3. Be repeated if necessary at no cost to the Owner.

D. Noise Level:
   1. The blower manufacturer shall include all necessary provisions for reducing noise to meet the maximum sound pressure level requirements of this section.
   2. The maximum sound pressure level at any point at a distance of 3 feet or more from any blower/motor surface shall not exceed 81 dBA with the blower running at any speed.

a. The specified maximum sound pressure level of 81 dBA includes the noise emitted from any possible source in the Blower Room related to delivery of air, including but not limited to, the noise from the motor; the blower; inlet and discharge piping, fittings, valves and silencers; and any reflected noise.

3. The Contractor shall provide sound testing for the blowers.
   a. Submit testing plan prior to test.
   b. The sound pressure level shall be measured during the preliminary equipment tests of field testing after installation in the Blower Room and with one blower running.
   c. If it is found that the actual sound pressure level 3 feet away from the blower exceeds the maximum specified sound pressure level, the blower manufacturer shall make such modifications and additions as approved by Engineer as are necessary to limit the noise to 81 dBA.

3.3 BLOWER MANUFACTURER'S FIELD SERVICES

A. The blower manufacturer must provide onsite technical personnel to inspect the final installation and supervise the field start-up tests of the equipment and software. The services of the representative shall be provided for a minimum of three (3), 8-hour days for the blower system. If there are difficulties in operation of the equipment due to the blower manufacturer's fabrication and programming or Contractor's installation, additional service shall be provided at no extra cost to Owner.
   1. Provide, as a minimum, the following field services: Provide written documentation for check out including who performed the work, when performed, the final settings or tolerance and who witnessed the final settings.
      a. Verify proper connection of piping and installation of accessories.
      b. Check leveling of blower enclosure.
      c. Confirm proper wiring of all instruments and field wired items.
   2. A minimum 4 hours, for each blower, 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. Have no mechanical defects.
      d. Has fully functional instrumentation that 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.
   3. Field acceptance testing shall be conducted after the installation of all equipment has been completed and all instrumentation calibrated and working as intended and the equipment has operated for a sufficient period to make all desirable corrections and adjustments. Contractor shall schedule testing with the full knowledge and consent of Owner.

B. The blower manufacturer shall furnish the services of the designer/startup representative responsible for the blower LCP's and MCP. The services of the designer/startup representative shall be provided for a minimum of 5, 8-hour days (2 trips) to assist with startup and troubleshooting of aeration system controls and blower software programs as well as coordinate with monitoring for the plant SCADA system. The designer must have complete knowledge of proper blower operation and of the blower and aeration system software programs supplied in this section. The blower manufacturer shall deliver to the Owner a copy of the PLC program for coordination with the plant SCADA system. The manufacturer's system programmer shall be available by phone and e-mail to answer questions concerning the PLC program for the entire startup period.

C. The blower manufacturer shall include an allowance to provide an experienced start up/service factory representative to be present during the phases of start-up and testing as required in this specification.

3.4 FIELD PERFORMANCE

A. Performance Test:
   1. Test performed by representative of manufacturer in presence of Engineer and/or Owner.
   2. Run test over continuous 4 HR period.
   3. Results from test will be used to verify compliance with requirements in PART 2 of this Section and shall be submitted to Owner.
   4. Air flow rate, CFM, shall be measured and recorded every 15 minutes.
   5. Power feed to blower shall be measured and recorded with a recording watt meter.
   6. Test shall be run at same conditions as defined in Articles 1.5 B.9. and 2.2.
      a. Measured values will be averaged for each condition specified in Article 2.2 and the results compared to the guaranteed values.
      b. Power input shall be measured by calibrated watt meter.
      c. Air flow shall be measured by mass air flow meter.

B. Referee Test:
   1. In the event that performance requirements are not met, supplier may request referee test to verify that requirements are achievable.
   2. Request must be made within 10 days after completion of performance test.
   3. Test to be arranged and paid for by Supplier/Manufacturer.
   4. Owner may select any portable measuring devices meeting basic design requirements of this Project Manual.
   5. Test to be performed according to procedure outlined for performance test.
   6. Results will be used to establish new performance requirements, to be no more stringent that those specified herein.
   7. If results of referee test meet or exceed listed performance requirements, supplier shall submit to Owner a certified copy of the test report with positive results.
   8. If results of referee test do not meet the performance test requirements, supplier/manufacturer shall modify blower so that it meets the performance test requirements.
   9. Provide a field services engineer to work with the Instrumentation Subcontractor during startup and commissioning to verify control and data transfer, test all input and output points, and verify correspondence at points between MCP/LCP and the Control Center.

C. Training:
   1. Instruct Owner's personnel informal training sessions at jobsite with minimum service as follows:
      a. Jobsite over two (2) days: 16 HRS.
      b. Instruction time shall be separate from the field services time.
      c. Training shall include specific session on electrical and instrumentation, HMI and PLC programming and AFD configuration.

END OF SECTION

SECTION 11084
SUBMERSIBLE PROPELLER PUMPS

PART 1 - GENERAL

1.1 REQUIREMENTS

A. The Contractor shall furnish a total of three (3) submersible pumps for Mixed Liquor Return pumping in the aeration basins. For two (2) of these pumps, furnish all labor, materials, tools and equipment necessary for complete installation of submersible propeller pumps in the aeration basins as shown on the drawings and specified herein. Box and tag the remaining pump as an uninstalled spare.

B. The Contractor shall furnish and install two submersible propeller pumps complete with submersible power cable, guide rail system, hoist base, lifting cable, power cable, support cable, controls, wall pipes, flap gates, and all appurtenant equipment, complete and operable, in accordance with the requirements of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Except as otherwise indicated, the current editions of the Specifications and Standards listed in Section 11060 Pumping and Mixing Equipment: Basic Requirements and the following apply to the work of this Section:

ASTM A48	Standard Specification for Gray Iron Castings
ASTMA53	Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
ASTM A283	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 Section 01340 and Section 11005.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340, 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 with mounting details for pump mast assembly and davit crane.
   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.

8. Davit Crane Assembly:
    a. Boom mast, base, wire rope and winch details and specifications.
    b. Materials of construction.
    c. Dimensioned drawing.
    d. Capacity curves or tables.
9. Wall Pipe:
    a. Dimensioned drawings.
    b. Material of construction.
10. Flap Gate:
    a. Dimensioned drawing.
    b. Materials of construction.
    c. Certification of opening pressure differential specified.
11. Engineering Calculations:
    a. Provide equipment anchorage calculations as specified in Section 11005 demonstrating compliance with the applicable requirements of Section 11005.
    b. Include:
        1) Sizing of all anchors for securing davit crane base.
        2) Sizing of all anchors for securing pump mast assembly wall and base brackets.
        3) Sizing of pump support mast.

C. O&M Manuals: The Contractor shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01340.

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.

1.5 WARRANTIES

A. The equipment furnished under this Section shall be provided with warranties to meet the requirements in the General Conditions.

PART 2 - PRODUCTS

2.1 GENERAL

Number of Propeller Pumps: 3 (2 installed, 1 packaged as shelf spare).
Liquid Pumped: Mixed Liquor Activated Sludge.
Design Liquid Suspended Solids Concentration Range (mg/l): 1,500 to 3,500.
Duty: Continuous.
Maximum Liquid Depth (FT): 15.

2.2 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 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.

B. Unit Responsibility:
   1. 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.
   2. To ensure the integrity of the mounting system the propeller pump Manufacturer shall supply the support guide brackets, and mast, as specified above.

C. Manufacturers:
   1. Wilo-EMU USA.
   2. Landia.
   3. Flygt Horizontal Propeller Pump.
   4. Or approved equal.

2.3 SUBMERSIBLE PROPELLER PUMPS

Mixed Liquor Return Pump 1, 31PMP103
Mixed Liquor Return Pump 2, 31PMP203
Uninstalled Mixed Liquor Return Pump 3

A. General:
   1. Type: The motor shall drive the submersible pump propeller through a planetary gear reduction drive system that locates the motor shaft in line with the propeller shaft. 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. In addition, all components of the propeller pump, including motor, shall be capable of continuous operation in air, completely un-submerged, for 15 minutes minimum.
   3. Mounting:
      a. 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.
      b. A sliding guide bracket shall be an integral part of each propeller pump.
      c. 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.
      d. 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 65 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:
      a. Propeller shall be non-clogging backward curved design, capable of handling solids, fibrous materials, heavy sludges, and other matter normally found in wastewater treatment applications.
      b. Propeller shall be dynamically balanced so the propeller imbalance does not exceed ISO 1940 G6.3 tolerances to prevent excessive vibrations.
      c. Propeller vanes, diameter, blade angle, (in degrees), shall be as indicated.
      d. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced.

6. Bearings:
   a. Shaft shall rotate on two or three permanently lubricated bearings.
   b. Outboard propeller end bearing shall be an angular contact or deep groove bearing.
   c. Inboard, motor end, bearings shall be an angular contact or deep groove to take up the axial loads and a radial bearing to take up the radial loads.
   d. 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.
   e. All bearings shall have a minimum L-10 rated life of 100,000 hours.
7. Shaft:
   a. Wall pump shafts shall be Series 420 stainless steel. Carbon steel shafts with or without shaft sleeves are not acceptable or equal to stainless steel.
   b. Shafts shall be supported by single or double row outer bearings for radial thrust and a single or double row inner bearing for axial thrust.
   c. All shafts shall be dynamically balanced and shall be amply sized to minimize shaft deflection. Shaft overhang shall not exceed 2.5 times the shaft diameter. The diameter shall be the diameter of the shaft as it passes though the mechanical seal area. The overhang shall be the length of shaft from the propeller side of the last bearing closest to the propeller to the hub of the propeller. Certified dimensions and measurements shall be submitted to verify compliance to the specifications. The engineer reserves the right to require submission of a sample output shaft and detail drawing to independently verify submittal calculations.
   d. Minimum motor shaft diameter shall be: 1.97 IN.
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 face 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, and shall be capable of running in either direction without damage. Shaft seals that rely on the tank fluid as a lubricant will not be considered acceptable or equal.
9. Shroud: Each propeller pump assembly shall be provided with a shroud a full 360 degrees around the propeller. A maximum clearance of 1-1/2 IN 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:

Condition 1	Full Speed Operation
Pump Capacity (gpm)	Approx. 6,000 ± 250
TDH (FT)	Approx. 1.2
Maximum Propeller Speed (rpm)	280
Maximum Motor Speed (rpm)	1700
Maximum Motor Rating (hp)	10
Motor Efficiency (percent)	90
Condition 2	Reduced Speed Operation
Pump Capacity (gpm)	4200 ± 250
TDH (FT)	0.5

Motor Speed (percent)	50 ± 3
Condition 3	Minimum Speed Operation
Pump Capacity (gpm)	1000 ± 250
TDH (FT)	0.5
Motor Speed (percent)	25 ± 3
Propeller	
Number of Vanes	3
Diameter (IN)	29.6 ± 1
Nominal Wall Pipe Diameter (IN)	18
Blade Angle (degrees)	17
Motor Electrical	
Voltage, Phase, Hertz	480/3/60
Drive Type	VFD
Maximum Power Input (kw)	7
Number of Poles	4
Maximum Full Load Current (amps)	10
Maximum Seating Current (amps)	90
Maximum Power Consumption (hp)	10
Wall Pipe Diameter, inches	18 (nominal)

C. Materials of Construction:
   1. Except as noted below, pump 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 and shroud shall be of Type 316 stainless steel.
   3. The propeller shaft shall be of Type 316 or Type 420 stainless steel.
   4. The mechanical seals shall contain a stationary face ring of silicon carbide and a rotating face ring of silicon carbide.
   5. All anchor bolts, nuts, and washers shall be Type 316 stainless steel.
   6. Wall pipe: Type 316 stainless steel.
   7. Motor housing and gear casing: cast iron, ASTM A48 40B, with two component ceramic-based coating, minimum 16 mils DFT, or equal.

D. Controls:
   1. Each motor shall be provided with temperature and moisture monitoring system meeting the requirements below:
      a. Provide each motor with integral temperature sensors, one on each leg, which opens on high temperature.
      b. Each pump 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.
   2. Furnish monitoring relay equal to Flygt Mini CAS 120 for field mounting in motor control center.

E. Motor and Power Cable:
   1. General: The motor shall be a squirrel cage, induction, shell type design, housed in an air filled, sealed, watertight chamber. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least ten evenly spaced starts per hour and have a minimum 1.15 service factor. The motor shall be suitable for service in a Class 1, Division 2 environment and bear UL or FM approval. The stator winding shall be insulated with

moisture resistant Class H insulation which will resist a temperature of 180 DegC (356 DegF). The stator shall be dipped and baked three times in Class F varnish. The rotor bars and short circuit rings shall be made of aluminum.

2. Cable: Provide pump cable of sufficient length to connect to terminal junction box where indicated. Pump cable shall be sized according to the NEC and ICEA Standards, suitable for submersible service. The cable shall be rated for 600-volt and 90 DegC with a 40 DegC ambient temperature and shall be FM approved.
3. Cable Entry: Cable entry seal design shall provide a watertight submersible seal. The cable entry housing shall be an integral part of the back plate or upper lid. The cable entry shall have a double set elastomer grommets or a single grommet with cable strain. The cable entry shall be comprised of one or two cylindrical elastomer grommets, each flanked by washers designed with a close tolerance fit against the cable outside diameter and the entry inside diameter. The assembly shall bear against a shoulder and be compressed to from a watertight seal. The cable entry shall be designed to insure a watertight seal between the electrical junction chamber and the motor, preventing fluid leakage into the motor.

F. Mounting and Support System:
1. Each propeller pump (except uninstalled pumps) 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, and at 10 FT vertical intervals along the basin wall.
2. Pipe Flange Mounted Discharge Connection (If necessary): Each propeller pump (except uninstalled pumps) 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 4-IN by 4-IN by 3/16 IN if square or 4 IN 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 1/4-IN diameter 316 stainless steel power cable support cable with each propeller pump 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 clamps at 5 FT intervals.
6. Lifting Cable: Provide a minimum 1/4 IN diameter 316 stainless steel lifting cable and securely attach 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. Wall Pipes:
1. Provide minimum schedule 40 Type 316 stainless steel wall pipe for each installed pump (2 total). Furnish two wall pipes without weep rings and with the discharge end flanges shipped loose for field welding; these wall pipes are for installation in existing walls.
2. Nominal diameter: Coordinate with requirements for attachment of pump.
3. Flanged ends.
4. Furnish with integral Type 316 stainless steel pipe support (on pump side) and Type 316 stainless steel anchor bolts to secure pipe support to basin floor.

H. Accessories:
1. Adjustable hoists:
   a. Provide two (2) hoists.
      1) Minimum 28-81 IN reach range.

2) Primary lifting capacity equal to but not greater than 2,000 pounds with the boom fully lowered and retracted.
3) Secondary lifting capacity equal to but not greater than 1,000 pounds with boom fully lowered and fully extended to the maximum hook reach of 81 IN.
4) One hoist system for each ML return pump, as shown on the Drawings.

b. Provide a wall mount socket base for the mast. The hoist shall be easily removed from the hoist base to facilitate moving to another location or for storage.
c. The boom, mast, base, and wire rope, shall be of 304 or 316 stainless steel construction.
d. The boom shall telescope to four different lengths and shall be adjustable in height under load by means of a jack screw.
e. Hand winch:
1) Worm gear design, hand-operated, with capability to be operated by hand drill motor (do not furnish drill motor).
2) Provide an anchor hole in the flange of the drum for easy attachment and removal of the lifting cable to allow the cable assembly to be attached to a cleat if the hoist is moved.
3) Provide an automatic friction brake to prevent the winch load from freewheeling.
4) Make the winch handle an integral part of the braking mechanism.
5) Material: carbon steel with three part epoxy coating.

f. Capable of rotating 360 degrees under load enabling the pump to be removed from the tank in a single lifting and rotating motion.
g. Wire rope:
1) Provide one wire rope assembly with swaged ball fitting and load hook for each mL return pump (6 total).
2) Minimum cable length: 45 FT.
3) Minimum cable diameter: ¼ IN.

2. Lifting Lugs: Equipment weighing over 100 pounds shall be provided with lifting lugs.
3. Identification Plate: An identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4 IN die-stamped equipment identification number and equipment data.
4. Anchors: Concrete anchors shall be in conformance with Section 05505, minimum 5/8 IN diameter Type 316 stainless steel. Coordinate required size and location with Shop Drawings. The mixer shall determine the size and proper location for anchors and shall furnish the anchors.
5. Flap Gate:
a. Provide on discharge of each wall pipe.
b. Material: FRP and Neoprene.
c. Size: Nominal 18 IN diameter, match wall pipe.
d. End: Flanged, match size and drilling pattern of wall pipe flange.
e. Fasteners and clamping bar: Type 316 stainless steel.
f. Hinge/Seal: Neoprene.
g. Configuration: See Drawings.
h. Opening pressure differential: 4 inches water column maximum.
i. Maximum submerged weight of flap (moving part): 16 pounds.
j. Manufacturer: Plasti-Fab Inc., Model 18” FRP Flap Gate or equal.

I. Spare Parts:
1. Each size and type of propeller pump shall be supplied with the following parts:
a. Two (2) sets motor shaft bearings.
b. Two (2) sets seals, gaskets, and O-rings.

J. Protective Coating:
1. Shop and field painting shall be in accordance with requirements specified in Section 09905.

PART 3 - EXECUTION

3.1 GENERAL

A. Execution shall be in accordance with Section 11060.

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. Comply with Section 01650.

B. Factory Testing: Pumps shall be tested at the factory. The Owner may, at Owner’s discretion, witness the factory test. 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 pump dry to verify proper rotation and alignment.
   4. Run pump submerged at least 30 minutes under at least 6 FT 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.

C. Functional Testing: A functional wet test shall be conducted at plant startup. The functional wet test should verify operation without excessive noise, vibration, cavitation, or overheating and document motor voltage and current draw.

D. Performance Testing:
   1. A factory trained representative shall inspect the installation of the pumps before the tank is filled and before start up to assure the installation has been completed in accordance with the Manufacturer’s recommendations.
   2. Start up of the pumps shall be in accordance with the Manufacturer’s recommended start up procedures.
   3. An installation start up form shall be completed for each pump and supplied with the final documents.
   4. Provide on site startup by factory certified startup representative.
   5. A functional wet test shall be conducted at plant startup.
   6. Verify operation without excessive noise, vibration, cavitation, or overheating. Document motor voltage and current draw.

3.5 TRAINING

A. Provide a minimum of 4 hours of training by startup representative.

END OF SECTION

SECTION 11088

AERATION EQUIPMENT: FINE BUBBLE TYPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for the design, fabrication and installation of fine bubble aeration equipment to form a complete aeration system within new aeration basins to satisfy process oxygen requirements and maintain solids suspension shall include, but not limited to:
      a. Fixed header fine-bubble membrane diffusers.
      b. All distribution and manifold piping including drop pipes as indicated on the Drawings.
      c. Adjustable pipe supports.
      d. Moisture blow-offs.
      e. Air piping expansion provisions.
      f. Anchor bolts, and expansion anchors.

B. As shown on the Drawings, the aeration basins are arranged in two (2) process trains.
   1. Each process train begins with two (2) anoxic cells.
   2. Process train basin flow sequences are as follows:
      a. 1A – anoxic; 1B – swing; 1C – 1D – 1E – aerobic.
      b. 2A – anoxic; 2B – swing; 2C – 2D – 2E – aerobic.

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 05505 - Metal Fabrications.
   4. Section 11005 - Equipment: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Civil Engineers (ASCE):
      a. 18-96, Standard Guidelines for In-Process Oxygen Transfer Testing.
   2. American Society of Civil Engineers/Environmental and Water Resources Institute (ASCE/EWRI):
      a. 2-06, Measurement of Oxygen Transfer in Clean Water.
   3. American Society for Testing and Materials (ASTM):
      a. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      b. A380, Standard Practice of Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
      c. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
      d. D573, Standard Test Method for Rubber-Deterioration in an Air Oven.
      e. D1171, Standard Test Method for Rubber Deterioration-Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
      f. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
      g. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

B. Qualifications:
   1. All equipment shall be supplied by a single Manufacturer or Supplier.
   2. Manufacturer of fine bubble membrane disc diffusers shall have a minimum of 10 installations in operation for more than three (3) years.

3. Supplier to provide with first submittal a list of 10 membrane disk installations that have operated for a minimum of three (3) years continuously.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Fabrication and/or layout drawings.
      a. Diffusers:
         1) Manufacturer.
         2) Type and model.
         3) Dimensional information.
         4) Stable airflow rate range and corresponding headloss.
         5) Oxygen transfer efficiency (clear water) for design conditions.
         6) Mounting arrangement.
         7) Mounting instructions.
         8) Number and distribution per basin.
         9) Acceptable air flow range per diffuser.
         10) Engineering calculations.
            a) Documenting number of diffusers.
            b) Document SOTR achieved.
            c) Document mixing achieved.
            d) Document uniform distribution of air throughout each drop leg basin grid so that the air flow per diffuser does not vary by more than 5 percent at any specified air flow rate.
      b. Air distribution system:
         1) Dimensional information including size and spacing of all piping, Drawings to scale showing installation in existing or new aeration basins.
         2) Materials.
         3) Joint restraint.
         4) Expansion compensation.
         5) Moisture blow-off details.
         6) Pipe support details including layout for laterals, manifolds and headers.
         7) Installation instructions.
         8) Engineering calculations.
            a) Thrusts due to pressurized pipes.
            b) Forces due to expansion of pipes.
            c) Forces on pressurized pipe due to sudden loss of air pressure.
            d) Temperature of pipe walls for site conditions in air distribution piping.
            e) Headloss calculations. (Diffusers to top of drop leg over the air flow range specified.)
            f) Performance curves. (Headloss versus diffuser air flow over the air flow range specified.)
            g) Forces due to submersible mixer velocities in Zones 1B and 2B.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

2. Performance test data (results and reports):
   a. Including but not limited to:
      1) Certified oxygen transfer tests.
      2) Quality control tests.
      3) Permeability tests.
      4) Uniformity test.
      5) Strength testing.
      6) Chemical resistance data.
   b. Reports signed by registered professional engineer.
   c. Reports to include:
      1) Description of test facility.
      2) Description of sampling procedures.
      3) Engineering calculations.
      4) Summary of test results.
3. Warranty.
4. Certificate of Proper Installation:
   a. Include benchmark pressure at the connection drop leg to the airflow control butterfly valve.
   b. Determine benchmark pressure as specified in the FIELD TESTING Article in PART 3 of this Specification Section.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect the diffusers when exposed to the elements before being placed into operation per manufacturer's recommendations.

1.5 WARRANTY

A. All aeration equipment components and accessories to be free of defects in materials, workmanship, and installation for a period of one (1) year from date of Final Acceptance in writing and signed jointly by Manufacturer and Contractor.

B. In addition, the Manufacturer shall warrant the following:
   1. The membrane diffuser elements shall not fail for a period of seven (7) years after delivery or six and one-half (6.5) years from Substantial Completion, whichever occurs first.
      a. Failure is defined as one or more of the following measured or observed changes on diffusers in a cleaned condition:
         1) Any rupture or tear of the membrane.
         2) Any measured durometer exceeding 80 Shore A.
         3) If one or both of the above changes occurs, the manufacturer shall provide replacement membranes for the failed membranes to the Owner for replacement by the Owner.
            a) If more than 60 percent of the membranes in a tank fail, all membranes in the tank shall be provided with replacement membranes.
   2. Additionally the manufacturer shall warranty the aeration system and components as follows:
      a. Manufacturer shall warrant that membranes will operate continuously for seven (7) years after start-up, and pressure drop increase across membranes in a cleaned condition as compared to benchmark pressure drop test specified in the FIELD TESTING Article in PART 3 of this Specification Section shall not exceed 0.7 psig during that period.
      b. If the pressure drop increase exceeds 0.7 psig, as determined by Owner, pressure drop testing on clean membranes within seven (7) years after start-up, the manufacturer shall furnish new membranes for all diffusers within the affected tank(s) to the Owner for replacement by the Owner.
      c. Manufacturer will be compensated for providing replacement membranes according to the following formula:

$$\text{Replacement Membrane Compensation} = \frac{(P)\,(Y)\,(N)}{7}$$

P = Purchase price per new membrane delivered to site
Y = Years of operation prior to failing pressure drop test by Owner
(Partial years will be rounded to nearest 0.1 year)
N = Total No. of Replacement Membranes

1.6 EXTRA MATERIALS

A. Furnish, tag and box for shipment and storage the following spare parts:
   1. Diffusers:
      a. 10 percent extra diffusers, including gaskets.
      b. 10 percent extra diffuser assemblies.
      c. 10 percent extra diffuser tap plugs.
   2. One (1) set of special tools required to assemble/disassemble the diffusers and grid piping.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Sanitaire- Silver Series.
   2. EDI- Flex Air SSM.
   3. Aquarius.
   4. Stamford Scientific, Inc. (SSI).
   5. Or approved equal.

2.2 MATERIALS

A. Membrane Diffusers:
   1. Circular membrane diffuser discs of 9 IN DIA with integral O-ring of EPDM synthetic rubber compound with precision die formed slits.
      a. Thermoplastic materials (i.e., plasticized PVC or polyurethane) are not acceptable.
   2. Add carbon black to the material for resistance to ultraviolet light.
   3. Design diffuser as one-piece injection molded part with a minimum thickness of 0.080 IN.
   4. Limit the maximum tensile strength of the diffuser to 10 psi when operating at 2.4 SCFM/FT2 of material.
      a. Furnish proportionately thicker material for larger diameter disc diffusers to limit the maximum tensile stress and to resist stretching.
   5. Produce diffusers free of tears, voids, bubbles, creases or other structural defects.
   6. Furnish diffuser material to meet the following:
      a. Base polymer: EPDM, ASTM D573.
      b. UV resistance: Carbon black.
      c. Specific gravity: 1.25 or less.
      d. Durometer: Minimum 58 durometer, +5 percent, ASTM D2240.
      e. Modulus of elasticity: 500 psi, ASTM D412.
      f. Ozone resistance (72 HRS: 104 DegF, 50 pphm): No cracks at 2X magnification, ASTM D1171, Test A.
      g. Tensile strength: 1200 psi, ASTM D412.
      h. Elongation percentage:
         1) Retained 70 HRS at 212 DegF: 75 percent maximum, ASTM D573.
         2) Minimum at break: 350 percent, ASTM D412.

B. Diffuser Assemblies:
   1. Furnish diffuser assemblies including diffuser, diffuser gasket, holder, retaining ring and air flow control orifice.
   2. Membrane diffuser:

a. Incorporate an integral check valve into the membrane diffuser.
b. Design and test diffusers for a dynamic wet pressure (DWP) of 6 IN +/-20 percent water column at 1.0 SCFM/diffuser and 2 IN submergence.

3. Diffuser support plate: Provide a PVC or glass filled polypropylene support plate to form an air plenum under the diffuser and support for the membrane when the air is off.
4. Diffuser assembly to be fusion welded to air distribution piping.
   a. Mechanical attachment of diffuser assembly to air distribution piping is not allowed.

C. Air Piping and Supports:
1. Drop leg:
   a. Provide each basin with the number and size of drop legs shown in Drawings.
   b. Fabricate drop leg from header to manifold from Schedule 10 or 12 gage type 304L stainless steel, ASTM A240; full immersion passivate per ASTM A380.
   c. Extend drop leg from the manifold to the stainless steel air header connection as shown on the Drawings.
   d. Provide stainless steel flanged joint at the elevation shown on the Drawings and support drop leg from its upper connection.
2. Manifold:
   a. Connect drop leg to manifold with a stainless steel band coupling.
   b. Furnish manifolds having the same nominal pipe diameter as the drop leg.
   c. Fabricate manifold from Schedule 10 or 12 gage type 304L stainless steel, ASTM A240; full immersion passivate per ASTM A380.
   d. Join manifold sections with 125 LB flanges and gaskets.
   e. Fabricate manifolds with 4 IN DIA flanged or factory solvent welded stub connections to each air distribution header.
   f. Provide stainless steel supports for each diffuser manifold with a maximum spacing of 17.5 FT between supports.
   g. Design manifold, connections and supports to resist thrust generated by expansion or contraction of the piping system.
   h. Ensure supports are adjustable vertically and horizontally for alignment of piping on sloped basin floor.
   i. Design manifold connections and supports in Zone 1B and 2B to resist thrust forces from operaton of submersible mixers in these zones, as indicated in Drawings.
3. Air distribution piping:
   a. Furnish distribution piping having a nominal diameter of 4 IN minimum.
   b. Fabricate distribution piping from unplasticized PVC conforming to ASTM D3034, SDR-33.5.
   c. All piping and diffuser assemblies: Contain 2 percent titanium dioxide (TiO_2) to protect against UV degradation.
   d. Supply factory solvent welded holders on maximum 4 FT spacing.
      1) Field welding will not be permitted.
   e. Join sections of distribution piping with 125 LB flanges and gaskets or non-rotational fixed union-type joints and gaskets.
   f. Use interlocking spines or equivalent to prevent rotation of union style joints.
   g. All joints, regardless of type: Resist 80 FT-LBS minimum without rotation.
   h. Provide stainless steel supports for each distribution header with a maximum spacing of 6.5 FT between supports.
   i. Ensure supports are adjustable vertically and horizontally for field alignment of piping on sloped basin floor.

D. Supports:
1. Manifold supports:
   a. Provide manifold supports, of 316 stainless steel.
   b. Manifold supports: Include manifold hold downstrap (U-bolt or equal), cross-tree and supporting structure.

c. Supports to be adjustable to allow the diffuser grid to be installed at the same level throughout the basins.

2. Distribution piping supports:
   a. Provide one (1) fixed anchor support of 316 stainless steel for each distribution header section to prevent longitudinal and rotational movement of the distribution header at the support.
   b. Furnish guide supports which allow longitudinal movement of the distribution header to allow for thermal expansion and contraction of the header.
   c. Provide a PVC expansion joint, when required, between each distribution header section restrained by a fixed anchor support to allow for thermal expansion and contraction of the header between fixed supports.
   d. Supports to be adjustable to allow the diffuser grid to be installed at the same level throughout the basins.
   e. Air distribution piping supports: 1/2 IN DIA threaded rods, minimum to meet seismic requirements.
   f. Use single anchor bolt design for supports.
3. Anchor bolts:
   a. Provide 316 stainless steel epoxy adhesive anchor bolts.
   b. Adhesive anchors to meet requirements in Specification Section 05505.
   c. Design anchors for grid piping for at least 10 times the normal buoyancy uplift forces.
4. Grind all fasteners and supports to minimize sharp protruding edges.
5. Provide each aeration grid with a continuous air purge system for removing liquid within the distribution grid:
   a. Air purge system to consist of:
      1) Sch 80 PVC piping and fittings.
      2) Ball valve and discharge point: Location shown on Drawings. Ball valve easily accessible. Ball valve horizontal.
      3) Support from vertical walls at 4 FT – 0 IN with stainless steel pipe clamps and stainless steel expansion anchors.
      4) System complete with all pipes, valves, fittings and accessories.
      5) Ball valves: 3/4 IN type 316 stainless steel or PVC.
      6) Provide flexible pipe connections and all other allowances for expansion and contraction.
      7) Design: Manufacturer's standard except as indicated herein.
      8) Air purge piping shall have minimum diameter of 3/4-IN.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design Criteria:
   1. Provide aeration for each train, in aeration zones as shown on the Drawings and per the following criteria:

CRITERIA	BASIN ZONE			
Aeration Basin Elevation, FT, MSL	B	C	D	E
Water surface, minimum	110.75	110.7	110.67	110.4
Water surface, maximum	112.2	111.2	111.5	110.8
Floor slab, maximum	96.5	96.5	96.5	96.5

B. Provide aeration grids for each of the aeration basins as shown in the table below:

ZONE	GRIDS REQ'D	LENGTH (FT)	WIDTH (FT)	ACTIVE VOLUME (GAL)
Aeration Basin 1B/2B	1	50	20	100,250
Aeration Basin 1C/2C	1	90	20	181,030
Aeration Basin 1D/2D	1	90	20	181,030
Aeration Basin 1E/2E	1	100	20	200,500

C. Diffusers:
1. Membrane disc.
2. Diameter: 9 IN.
3. Install sufficient diffusers to meet the minimum oxygen demand at the low flow condition, while maintaining 0.5 scfm per diffuser.
   a. Install additional diffusers to meet the maximum flow, plus an additional 20 percent blank diffusers.
   b. Space diffuser "blanks" such that uniform aeration and additional mixing of the basin contents is maintained when additional diffusers are added.
   c. For each diffuser blank, furnish diffuser element holder mounted on air distribution header but with PVC, stainless steel or rubber plug in place of diffuser.

D. Standard Oxygen Transfer Rate Distribution Summary (lbs/hr/train):

Condition	No. of Trains Online	Zone B (Swing)	Zone C	Zone D	Zone E	Total per Train	Total
Current ADWF	2	-	250	175	100	525	1050
Current MM	2	-	300	210	120	630	1260
Minimum Hour	1	-	100	70	40	210	210
Design ADWF – 1 basin online	1	250	630	420	250	1550	1550
Design ADWF – 2 basins online	2	-	350	230	140	720	1440
Design MM	2	-	440	290	175	905	1810
Design MD	2	-	530	300	200	1030	2060
Design Peak Hour	2	250	851	567	338	2005	4010

E. Airflow (SCFM) Distribution Summary – per Aeration Train:

Condition	No. of Trains Online	Zone B (Swing)	Zone C	Zone D	Zone E	Total per Train	Total
Current ADWF	2	-	960	680	385	2025	4050
Current MM	2	-	1150	810	460	2420	4840
Minimum Hour	1	-	540	336	208	1084	1084

Condition	No. of Trains Online	Zone B (Swing)	Zone C	Zone D	Zone E	Total per Train	Total
Design ADWF – 1 basin online	1	950	2430	1600	970	5950	5950
Design ADWF – 2 basins online	2	-	1340	880	530	2750	5500
Design MM	2	-	1700	1100	675	3475	6950
Design MD	2	-	2000	1250	750	4000	8000
Design Peak Hour	1	950	3281	2160	1310	7700	7700

F. Maximum pressure at top of drop leg all basins: 7.5 psig.

G. Mixing Requirements:
   1. Ensure mixing over the air flow range specified prevents deposition of solids in or near basin corners behind columns, supports and incidental structural components.
   2. Ensure no progressive buildup of solids exists or is such that process can be adversely affected.

H. Holders Installed:
   1. Number to meet maximum air flow rates, headloss and oxygen demand requirements above plus additional 20 percent.
   2. Diffuser "blanks" spacing to achieve uniform aeration and mixing.
   3. For each blank, furnish diffuser element holder mounted on air distribution header but with PVC, EPDM or threaded stainless steel plug in place of diffuser.

I. Air Distribution System:
   1. Header pipe diameter in aeration basin: As shown on Drawings.
   2. Drop leg pipe diameter: As shown on Drawings.
   3. Air distribution manifold diameter: As shown on Drawings.
   4. Diffuser distribution header (diffuser lateral) pipe diameter: 4 IN minimum or as required.
   5. Pipe support spacing main pipes, headers, and manifolds: 8 FT-0 IN maximum.
   6. Pipe support spacing 4 IN pipes: 7 FT-6 IN maximum.
   7. 4 IN PVC and CPVC wall thickness: 0.125 IN minimum.
   8. Maximum spacing between diffuser distribution header (diffuser lateral): 4 FT-0 IN.
   9. Air distribution piping system capable of withstanding a minimum lateral force of 10 LB/SQ FT.
   10. Provide sufficient diffuser laterals so that the distance between diffusers along the lateral.
   11. Space diffuser laterals equally unless resulting spacing results in clearance (diffuser edges of adjacent laterals) of less than 12 IN.
      a. In this case, stagger the lateral spacing so that a pair of laterals will be placed closer together to permit a clearance greater than 12 IN on remaining laterals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 11005.

B. Assemble aeration system equipment in factory to ensure proper fit.
   1. Mark parts with erection marks, disassemble for shipment.

C. Install in compliance with manufacturer's instructions:
   1. Do not use power tools to secure orifice bolts, clamps, or retaining rings.
   2. Use calibrated torque wrenches that slip when set torque is exceeded.

D. Pipe Supports and Tie Downs:
   1. Sliding support: As required to compensate for expansion/contraction.

E. Diffuser Leveling:
   1. Installed within +/-1/4 IN of common horizontal plane.
   2. Check installation elevation by filling basin to top of diffusers.
   3. Adjust diffuser elevations as required to achieve horizontal plane.

F. Cleaning:
   1. Clean all piping to remove visible dirt, dust, and other matter before starting system or installing diffusers.
   2. Do not use process air compressors for air cleaning.
   3. Air furnished by Contractor.

3.2 FIELD QUALITY CONTROL

A. Provide manufacturer's field services in accordance with Specification Section 01650.
   1. Provide Owner with a written Certificate of Proper Installation that manufacturer's equipment has been installed properly, has been started up, and is ready for operation by Owner's personnel.
   2. Include results of benchmark pressure test.

3.3 TRAINING

A. Provide on-site training in accordance with Specification Section 01650 as specified below:
   1. One (1), 8 hr training session, excluding travel time to the job site.

3.4 FIELD TESTING

A. Contractor is to pay for all testing and remedial action.

B. Quality Control Tests:
   1. Perform the quality control tests described below by the equipment supplier.
      a. Submit detailed reports on all test results to the Engineer for acceptance prior to shipment.
   2. Unless otherwise specified, perform each test on a minimum total sample size of 40 diffusers selected at random from the total number of diffusers to be supplied.
      a. If diffuser production requires multiple batches, select, at random, an equal number of diffusers from each batch so that the total number of diffusers tested is not less than 40.
   3. For each quality control test, 95 percent of the diffusers tested shall comply with the requirements of the test.
      a. If more than 5 percent of the test sample fails to meet the requirements of the specific test, then the entire batch of diffusers shall be tested to ensure that 95 percent of all diffusers meet the test requirements.

C. Uniformity Testing:
   1. Perform a uniformity test to demonstrate an even distribution of air bubbles when the diffusers are submerged.
      a. For the number of diffusers selected for the test, submerge the diffusers to a depth of 1 IN of clean tap water.
      b. Apply an initial air flow of 2.5 SCFM per diffuser for a period of five (5) minutes and then reduce the air flow per diffuser in increments of 0.5 SCFM for a period of five (5) minutes at each air flow rate to a minimum of 0.5 SCFM per diffuser.
      c. Visually observe and photograph the water surface to assure uniformity of air distribution.
   2. Conduct the uniformity test with diffusers arranged and spaced in a pattern similar to that proposed for the installation.
      a. 95 percent of the diffusers tested shall show a substantially even distribution of air at air flows from 0.5 to 2.0 SCFM per diffuser.

D. Benchmark Pressure Test.
   1. Perform following benchmark pressure test for each basin.

a. Temporarily provide and install calibrated 0-15 psi pressure reading device with 0.05 psi graduations located at connection of air line to butterfly valve.
b. Adjust airflow to basin drop leg to equal 2.5 SCFM per installed diffuser as measured by flowmeter installed at drop leg.
c. Measure and record:
1) Drop leg pressure in psig.
2) Airflow in SCFM using flowmeter port installed in air line.
3) Ambient air temperature.
4) Relative humidity.
5) Barometric pressure.
6) Basin liquid elevation.

2. Submit test results attesting in writing that values provided represent aeration system benchmark pressures.
a. Benchmark pressures will be compared with subsequent like testing results by the Owner, at its discretion, with diffusers in a cleaned condition to determine compliance with warranty requirements.

E. Shop Oxygen Transfer Test:
1. Conduct a performance test to demonstrate capability of the aeration equipment to meet the specified oxygen transfer requirements.
a. The test will be witnessed by a representative of the Owner.
2. Base all tests on the following criteria:
a. A minimum of three (3) tests for the average and peak conditions in complete accordance with ASCE/EWRI 2-06 normalized to 1000 mg/l TDS for each aerobic zone.
b. Conduct tests by an aeration testing firm in a full scale aeration test tank (minimum of 200 SQ FT) at the specified submergence and water depth with a diffuser density equivalent to the specified tank configuration.
1) Diffuser density is defined as the ratio of the total tank surface area to the total active diffuser surface area.
c. Conduct shop test with air rate and mass rate of oxygen transfer directly proportional to the ratio of the shop test tank volume and the design tank volume.
d. Plot of standard condition pounds of oxygen transferred per day per 1000 CU FT of tank volume versus standard condition cubic feet of air per minute per 1000 CU FT of tank volume: (LBS-O_2/day/1000 CU FT-tank) vs. (SCFM/1000 CU FT-tank).
1) Standard conditions of oxygen transfer are defined as 68 DegF, 1 atmosphere ambient pressure, clean water.
2) Standard air is defined as 68 DegF, 1 atmosphere, 36 percent R.H., containing 23 percent oxygen by weight.
3. Certify and stamp all tests by a Professional Engineer.
4. Include all costs for testing (exclusive of witnesses' expenses) in the equipment price.
a. All tests may be witnessed at Owner/Engineer option.
b. Cost of travel and living expenses for Owner/Engineer to be paid by the Owner.
5. Submit all test data from oxygen transfer tests for approval by the Engineer prior to manufacturing equipment.

F. Off-gas Testing:
1. Standard off-gas testing:
a. Conduct clean water test on first basin converted to diffused air system.
b. Conduct off-gas test on same basin after at least one (1) month of continuous operation.
1) Coordinate date with the Owner.
2. According to ASCE 18-96.
3. The following basin coverage will be followed:
a. Test at least one of the two trains.
b. Hoods will cover at least 4 percent of the test basin.
c. Use a minimum of six (6) hood positions per train.

4. Administered by:
    a. Dr. Michael Stenstrom (UCLA).
    b. Redmon Rubicon.
    c. An approved independent tester.

END OF SECTION

SECTION 11089
AERATION EQUIPMENT: COARSE BUBBLE TYPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coarse bubble type aeration equipment.
   2. All piping, fittings, supports, mixing diffusers and appurtenances as indicated on Drawings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A554-72, Welded Stainless Steel Mechanical Tubing.
      b. A530-72, General Requirements for Specialized Carbon and Allow Steel Pipe.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide details of diffuser assembly indicated. Include designation of diffuser type, number of diffusers, cfm range, attachment to header, support of header, expansion provisions and other associated appurtenances.

1.4 SPARE PARTS

A. Furnish the following extra materials.
   1. 2 extra diffuser elements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Sanitaire.
   2. Aquarius Technologies, Inc.
   3. Stamford Scientific, Inc.
   4. Or approved equal.

2.2 MATERIALS

A. Diffuser Body: 304L stainless steel, 20 gauge.

B. Piping system Components: 304L stainless steel, 12 gauge.

C. Air Header Manifold and Distribution Supports: Stainless steel, type 316.

D. Non Welded Parts: 304 stainless steel.

2.3 EQUIPMENT

A. Basic Configuration:
   1. Lay out air diffusion system in mixed liquor channels as shown on Drawings:

a. Furnish the coarse air aeration equipment beginning with a stainless steel flanged connection at the upstream side of the dropleg and include the dropleg, slip joint connection to the air distribution header, air distribution header, diffuser connectors, diffusers, supports, gaskets, header joints, bolts, nuts and washers, all to form the complete mixing systems within the mixed liquor channels as shown on the Drawings and herein specified.

2. Space diffusers evenly along the sir headers to provide mixing in the channels and to prevent settling of solids.

2.4 OPERATING REQIREMENTS

A. Design equipment for the aeration basins for operation at the following conditions:

	MIXED LIQUOR CHANNEL
Minimum air flow rate, scfm	100
Number of diffusers (minimum)	5
Maximum head over diffusers, FT	7.5
Drop Piping Diameter, IN	0.75
Note: Maximum diffusion system head loss (at maximum water depth) from drop pipe through diffuser exclusive of static head, 0.50 psi, at maximum air flow rate.	

2.5 FABRICATION

A. Air Header:
1. Bottom elevation of the air distribution header should be the same throughout the tank.
   a. Removable end cap at header ends.
2. Furnish a dropleg from the air main connection at the top of the tank.
   a. Provide a slip joint connection between the drop leg and distribution header.
   b. Provide a loose follower flange top connection.
   c. Support the dropleg from the connection at the air header.
3. Design connections between sections of the air distribution header to allow individual header sections to rotate independently of adjacent header sections.
4. Header dimensions as shown on the drawings with dimensional tolerances conforming to ASTM A554-72 and ASTM A530-72.
5. Factory welding only; field welding not allowed.
6. Wire brushed outside weld area.
7. All discoloration and deposits left by welding remove by pickling.
8. Factory welded diffuser connections, located in accordance with the contract drawings.
   a. Diffuser connectors located on a common horizontal plane.
9. Stiffen diffuser connectors and headers to withstand a vertical load that results in a moment of 500 IN LBS at the diffuser connector without any permanent deformation.
10. Install diffusers to within +/- 3/8 IN of a common horizontal plane.
11. After fabrication passivate all stainless steel assemblies and parts by immersion in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid at 140 DegF for a minimum of 15 minutes.

B. Supports:
1. Provide stainless steel supports for manifold and droplegs with a maximum spacing of 8 FT between supports.
2. Design manifold, dropleg, connections and supports to resist thrust generated by thermal expansion or contraction of the piping system.

3. Manifold supports shall include manifold hold downstrap (U-bolt or equal), cross-tree and supporting structure.
4. Manifold supports to be adjustable to allow diffusers to be installed as the same level through the two trains.

C. Diffusers:
1. Sanitaire stainless steel Model D-24, or Aquarius stainless steel Mode WBD24, or Approved Equal.
2. 3/4 IN Sch. 80 nipple, no insert.

D. Dropleg pipe butterfly valves:
1. See Section 15114.

PART 3 - EXECUTION

3.1 ERECTION / INSTALLATION / APPLICATION

A. Install per manufacturer recommendations.

B. See Section 11005.

3.2 FIELD QUALITY CONTROL

A. Leveling tests:
1. Introduce clear water into each channel to the top of the diffuser elements.
2. Check the level of the diffusers to document that all element horizontal surfaces are within 1/4 IN of a common horizontal plane and at the specified elevation.

B. Leakage and distribution of flow tests:
1. After successful completion of the leveling tests, raise the water level to 2 IN above the manifold.
2. Visually inspect the water surface to ensure that the airflow is uniformly distributed across the tank.
3. Repair any leaks in the elements holders, elements, pipes or the like.
4. Repeat the test until the installation is essentially void of air leaks.

END OF SECTION

SECTION 11093
PERFORATED PLATE SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:
   1. Mechanically cleaned influent perforated plate screens, motor, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

B. The equipment specifications, installation, and startup support requirements for wastewater screens designed to remove debris from raw wastewater. The screens will deliver the screenings to a shaftless screw conveyor which will convey to the screenings to a washer-compactor.

1.2 QUALITY ASSURANCE

A. General:
   1. This Section incorporates by reference the latest revision of the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall govern.

B. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturer Association (AGMA).
   3. American National Standards Institute (ANSI).
   4. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Screw Threads - Pipe Threads, General Purpose (Inch).
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250).
   5. ASTM International (ASTM):
   6. National Electrical Manufacturers Association (NEMA).
   7. National Fire Protection Association (NFPA):
      a. 70, National Electric Code (NEC).
      b. 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   8. Occupational Safety and Health Administration (OSHA).
   9. Underwriters Laboratories, Inc. (UL)
   10. Factory Mutual (FM)

C. Miscellaneous:
   1. Area Classifications:
      a. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification.
      b. All equipment and control panels supplied shall be suitable for operation in a Class I, Division 2 area classification, except for control panels to be located in unclassified areas as specified.

D. Unit Responsibility
   1. Screens and related appurtenances shall be furnished by one manufacturer.
   2. The responsible manufacturer shall be responsible for the entire unit. The responsible manufacturer shall select all components of the system to assure compatibility, ease of construction and efficient maintenance.

a. The responsible manufacturer shall coordinate selection and design of all system components such that all equipment furnished under the specification for the equipment, including equipment specified elsewhere but referenced in the specification, is compatible and operates properly to achieve the specified performance requirements.

3. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. Agents, representatives or other entities who are not a direct component of the manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in meeting this requirement.
4. This requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all work associated with the Contract.

E. Responsibilities and Qualifications:
1. All equipment provided under this Specification Section shall be obtained from a single manufacturer who, with the Contractor, shall assume full responsibility for designing, furnishing and installing a complete and operational influent screening system.
   a. The manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.
2. Manufacturer’s qualifications:
   a. Manufacturer shall have experience in manufacturing in-channel, perforated plate traveling belt screen equipment of similar size and configuration to the equipment specified herein in service in USA.
   b. For a manufacturer to be determined acceptable for providing the influent screening system on this Project, they must show evidence of a minimum of 15 installations in the United States of America and five (5) years experience in the design and manufacturer of perforated-plate fine screening equipment and systems of similar size and type as specified herein.
      1) All manufacturers must provide an installation list with contact names and valid phone numbers to verify in-channel perforated plate screen installations meet the above requirements.
3. The Contract Documents represent the minimum acceptable standards for equipment for this Project.
   a. All equipment will conform fully in every respect to the requirements of the respective parts and sections of the Drawings and Specifications.

F. Coordination:
1. Manufacturer shall coordinate discharge hopper dimensions, materials, and connections to sluice with sluice fabricator.
2. Coordinate with washer/compactor manufacturer to ensure that the screens and washer/compactors work together.

1.3 SUBMITTALS

A. Shop Drawings:
1. Information required under Section 11005.
2. Drawings showing the size of the screen unit, including:
   a. Motors.
   b. Piping connections.
   c. Construction details of equipment.
   d. Wiring diagrams.
3. Product information, calculations, charts or graphs to verify that the screen unit provided meet the requirements set forth in these Specification.
4. Certified Drawings showing the equipment in plan and section installed in the Plant, at a scale of not less than 1/4 IN equals 1 FT:
   a. Label all components.
   b. Show dimensions and total weight of the each screen unit component
   c. Fabrication and installation details, including access doors and supports.
   d. Dimensional relationship between screen and sluice.

5. A recommended list of spare parts for each component item (indicate if for each, or for both units furnished under this Section).
6. Flow rate and pressure requirements of wash water system for each screen unit
7. Detailed Specifications including a complete description of equipment materials (type, thickness, load rating, etc.).
8. Field panel data, including Manufacturer's catalog information, complete dimensional data, and component data.
9. Catalog cuts of all components.
10. Electric motor operator data including Manufacturer's catalog information, complete dimensional data, wiring diagrams, and calculations substantiating selection.
11. Factory testing procedure and setup as specified in paragraph 3.1.
12. Provide equipment anchorage calculations as specified in paragraph 1.4 A.1.p. of Section 11005 demonstrating compliance with the applicable requirements of paragraph 1.5 of Section 11005.

B. Reports and Forms:
1. Installation certification.
2. Factory test report.
3. Field test report.

C. Operation and Maintenance Manuals:
1. All operation and maintenance information specified in Section 01342.

1.4 ENVIRONMENTAL CONDITIONS

A. The screens will be installed in enclosed channels and outdoors at the headworks of the Pinole Wastewater Treatment Plant in Pinole, CA.

B. Screenings will consist of rags, plastics, and large debris, including rocks, cans, sticks, branches, and lumber.

C. Equipment shall be rated for installation in a Class I Division 2 Group D location.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Huber Technology, Inc., EscaMax.
2. Waste-Tech, Inc.
3. Or approved equal.

2.2 DESIGN REQUIREMENTS

A. General:
1. The design of all components shall be balanced so that jamming at any point will not cause structural failure but will result in stalling of the drive motor.
2. All components, including gear reducer, shall be able to withstand, without damage or permanent distortion, the full stall torque of the drive motor.

B. Performance and Configuration Requirements:
1. Service: Raw wastewater influent.
2. Number of screens: 2.
3. Type: Perforated curved plate. (enclosed)
4. Opening size (circular): 6 mm diameter.
5. Angle of screen installation: 70 degrees from horizontal.
6. Flow conditions:
   a. Average dry weather flow: 4.1 mgd.
   b. Maximum day: 12.0 mgd.

c. Pear hour: 20.0 mgd.
7. Channel width: 3 FT.
8. Channel depth: 5 FT (from channel bottom to operating floor).
9. Maximum upstream water depth: 4.5 FT (at 12 mgd).
10. Minimum down stream water depth: FT (at 4.1 mgd and lower).
11. Maximum headloss allowable at maximum flow:
    a. For clean water: 1.83 FT (at 12 mgd).
    b. At 30 percent blinding factor (when submitting clean water head loss calculations): 2.11 FT (at 12 mgd).

C. Basis of Design:
1. The influent screens have been designed based on the first named manufacturer Huber Technology, Inc.
2. The Drawings show the general location of the equipment and the orientation, service connections and relationship between the components.
3. These items may vary depending on the equipment provided.
4. Any changes shall be coordinated and provided by the manufacturer and Contractor to ensure a complete and functional system.
5. Contractor shall pay the costs for all modifications and/or redesign of the system illustrated on contract plans and any modifications to structural, mechanical, or electrical/instrumentation control areas of work, including the cost for the Engineer to verify the layout, sizing and any re-design to accommodate the proposed equipment.

D. Equipment Environment Application Rating:
1. Facility open to atmosphere: Envelope from top of channel to elevation 18 IN above top of channel and 10 FT wide.
2. NEC area electrical classification shall be as per NFPA 820, Chapter 5.

2.3 SCREEN UNIT

A. Equipment List:

EQUIPMENT NAME	EQUIPMENT NUMBER
Influent Screen No. 1	12 PRS
Influent Screen No. 2	12 PPS

B. Materials and Equipment:
1. General:
    a. The influent screens shall be designed to remove screenings from raw wastewater influent flow and typical in-plant recycle flow streams.
    b. The equipment shall include all safety devices, machinery guards and similar items as required by OSHA.
    c. Flanges on equipment shall comply with ASME B16.1, Class 125 unless otherwise indicated.
        1) Threaded flanges and fittings shall have standard tapered pipe threads complying with ASME B1.20.1.
    d. Bearings shall conform to the standards of ABMA.
    e. Speed reducer gearbox shall be of the enclosed type, oil lubricated and fully sealed with a breather to allow air to escape but keep dust and dirt out.
        1) The casing shall be of cast iron or heavy duty steel construction with lifting lugs and an inspection cover for each gear grain.
        2) An oil level sight glass shall be provided and installed for easy reading.
        3) For lubricated equipment, where shafting protrudes from oil reservoir, provide bearing and oil contamination control to all oil lubricated gearboxes by installing rotating labyrinth or magnetically activated face seals at all shaft protrusions. “Lip Seals” are not allowed.

f. Gears and gear drives shall be shipped fully assembled for field installation.

C. Perforated Plate Screens:

1. The influent screens shall generally consist of punched-plate curved screen segments, frame, roller chain (or box link drive), sprockets and guides, screen cleaning system, screen cover, discharge hopper, drive motors and appurtenances.
2. The drive unit shall be a dual or variable speed, 230/460 volt motor direct coupled to a hollow shaft type gear reducer equipped with anti-friction bearings and designed in accordance with AGMA recommendations for 24 HR, Class II service.
   a. The design operating single or dual speed range of the screen panels shall be a minimum of 10 FT per minute up to a maximum of 20 to 30 FT per minute.
3. The standard frame will be constructed of minimum 5 mm 316 stainless steel.
   a. Side channel seals will be a continuous stainless steel strip with 316 stainless steel brackets and non metallic wear resistant material insert.
   b. Discharge hopper shall be of 14 GA 316 stainless steel construction and shall cover the full width of the screen.
   c. The hopper shall fully enclose the discharge of the machine and shall be provided with inspection hatches. The hopper shall be provided with seismic supports.
   d. The hopper shall bolt to the sluice trough.
4. The curved screen plates will be constructed of 316 stainless steel with a minimum plate thickness of 3 mm.
   a. The distance between the perforated panels (gaps) shall be no greater than one-half the diameter of the perforated openings to prevent solids from bypassing between the screen plates.
   b. The screens shall have a curved surface, with curvature facing out.
   c. Positive lifting devices shall be provided on the plates for removing solids from the channel floor.
   d. The lifting devices shall be lifting fingers on every fourth screen panel.
   e. The screen segments will be attached to the drive links via ANSI 316 stainless steel bolts with lock washers.
5. The screen will be a stationary type and shall anchor to the top of the channel walls at the operating level.
   a. No mounting or fastening of the unit to the side walls or the bottom of the channel will be allowed.
   b. Routine service shall be capable of being performed with the screen in the channel.
   c. The screen shall also be removable from the channel without entering the channel.
6. The portion of the screen located above the channel shall be fitted with gasketed 14 GA 316 stainless steel covers.
   a. The covers shall not be hinged for access to the screening panels. Bolted and hinged stainless steel covers will prevent access to the screen segments and chain extending above the channel during operation.
   b. The covers will be provided with hinged inspection hatches.
   c. The side and bottom seal shall be DELRIN polyacetal or polyurethane or Neoprene.
   d. A hinged inspection door giving access to the full width of the brush shall be provided.
   e. Brush seals may be used for additional protection of screenings passage, but not as primary sealing.
7. All welding in the factory will use shielded arc, inert gas, MIG or TIG method.
   a. Add filler 304 wire to all welds to provide for a cross section equal to or greater than the parent metal.
   b. Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of the joint.
   c. Remove all pointed protrusions from underside and face of welds and remove all weld spatter.
   d. Field welding of stainless steel will not be permitted, except to connect customer piping to frame influent and effluent connections.
8. Bolts, nuts and washers shall be ANSI 316 stainless steel.

9. The screen chains shall be constructed of 316 stainless steel, have a breaking load of not less than 24,000 LBS(f) and screen size shall be as per manufacturer recommendations.
    a. The minimum total chain load service factor on any chain selection should be 2.5.
10. Chain tensioning is accomplished by adjustable screws on the main drive shaft.
11. For screens equipped with a grease lubrication system.
    a. The lubrication system will consist of a series of small-diameter 316 stainless steel tubes running to all grease points located on the screen.
    b. The grease lines will be mounted on each side of the frame at a central point on each side of the screen.
    c. All grease lines shall be equipped with fittings for easy access.
    d. All grease lines shall be filled prior to delivery.
12. The screen shall be automatically self-cleaning through the interaction of the screening panel, spray bar and rotating bristle brush.
    a. The drive mechanism shall be protected from the trash stream in order to insure that the screen runs smoothly without jamming.
        1) The driving force must be transmitted to provide clean, trash free components to avoid misalignment or binding which render the screen inoperable.
    b. The rotating brush shall have nylon or polypropylene bristles.
        1) Bristles must be long enough to allow passage of the solids 1.5 times the size the perforated plate can carry up, out of the flow.
    c. The brush motor shall be equipped with a single-speed, dual voltage motor and rated for Class I, Division 1 Group D service.
    d. The ratio between the perforated panel traveling speed and the peripheral speed of the brush must be 50:1, when the screen is traveling at standard speed.
        1) The brush must be suitable for high speed operation.
13. The inner surface of the screen shall be cleaned using a water spray system.
    a. The water spray system shall consist of a series of spray nozzles spaced and staggered as required to properly clean the plate.
    b. The total flow required for the water spray system shall be based on a minimum flow rate of 4 gpm per linear feet of screen width.
    c. Spray wash assembly shall be supplied with a solenoid valve provided by the manufacturer.
        1) Failed position: Closed.
        2) Provide with ability to adjust the valve closing speed between 5 seconds and 60 seconds.
    d. Valve operation for spray wash cycle shall be as recommended by the screen manufacturer and control shall be from the screen main control panel.
14. Cleaning system shall transport all material from screen into screw conveyor.

D. Control Panels:
1. Local Control Panel:
    a. All screen equipment shall be rated for installation in a Class I Division 2 Group D location. Control panel shall be designed so the panel can be mounted with the bottom of the panel more than 1-1/2 FT above the concrete slab so the panel is not in a hazardous area.
    b. Each perforated plate screen shall be provided with a separate control panel.
        1) Design local control panel to be delivered to jobsite as individual, prewired ready for installation and field wiring.
        2) Each panel to be designed for single 480 V, 3 phase feeder and have a main breaker disconnect with cover mounted handle.
    c. Contractor shall coordinate the function of the control panel with all related equipment.
        1) Contractor shall provide all wiring, conduit and accessory items between the control panel and the screen.
    d. Provide motor starters for all motors provided.
        1) Provide NEMA rated starter size 1 minimum.
        2) Dual rated starters are not acceptable.
        3) All components shall meet requirements of Division 16 Specifications.

e. Control enclosures shall be pedestal mounted stainless steel with NEMA 4X rating and bottom of panel shall be a minimum of 18 IN from the floor.
f. The panel fabrication shop shall be certified by UL as being a UL 508 listed systems control shop, certified to install a serialized label on the finished product.
g. Contractor shall coordinate the function of the control panel with all related equipment.
h. The screen shall be operable by each of the following methods:
    1) Automatic: Intermittent operation based on timer and head loss (differential head).
    2) Manual:
        a) Continuous operation.
        b) Screen will be raised by pushbuttons at the control panel.
i. Provide fully adjustable recycle timer capable of automatically cycling the screen on and off.
j. When provided with a pivot or a home switch, the screen shall be factory-equipped with a NEMA 7 junction terminal box containing terminals for connection of 3 PH power from the motor starter, control power supply, and if applicable “home position” proximity switch.
    1) In case the proximity switch is provided, the screen shall return to its home position by means of a proximity switch.
    2) The screen will continue to rotate until the home position limit switch stops the screen in the rest position.
    3) The switch will have an appropriate length integral cable.
k. The current (torque) overload protection device shall be mounted in the control panel to cause the motor starter to be automatically de-energized upon current overload.
    1) If a blockage occurs, causing motor overload, the screen shall automatically shut down and illuminate a red alarm light at the control panel.
    2) The control panel shall be equipped with a manual reset button.
l. A red mushroom head emergency stop button shall be mounted in a NEMA 7 enclosure on one (1) of the support legs of the perforated plate screen.
m. Provide a main thermal-magnetic breaker disconnect to remove all power, and separate disconnecting means to remove power from each motor controller.
n. Provide wire tags on every conductor.
    1) Provide slip-on or heat shrink sleeve markers.
    2) Tags using adhesives are unacceptable.

2. Provide solid-state air conditioning units in all panels containing electronic components such as programmable logic controllers, and remote I/O.
    a. Panels that utilize timer and relay logic do not require air conditioning.
        1) All stainless steel panels require a sun shield on top, front and back of panel unless it is mounted in the shade per the Contract Drawings.
    b. When required, provide air conditioning units with thermostatic control as necessary for internal air circulation to maintain internal temperature ratings of 90 DegF or below.
        1) Provide filters on intake and exhaust openings.
3. The panel shall comply with Specification Section 13448 and at a minimum, be complete with the following:
    a. Selector switch: HAND, OFF, AUTO.
    b. Event timer: For selection of time duration between starts (from 1 to 24 HR).
    c. Duration timer: To ensure that the screen will continue to operate for at least one and one-third (1-1/3) revolutions after the high differential level signal is removed.
    d. High-high differential level (HHDL): Overrides all other start signals. This HHDL signal shall make all motors of the screen run continuously. The spray wash solenoid valve shall open and remain open while the screen is running. This circuit shall also switch the main drive motor on high speed during the full HHDL condition duration. As the water level drops below the high-high differential level, the screen motors shall change to standard speed, and the plates shall make a complete travel trajectory around the two axes as cleaning cycle before stopping. (Levels set to suit site conditions).

e. Provide dry isolated contacts for AUTO, FAIL and RUN and a contact closure to call for washer/compactor to start.
f. See control descriptions in specification Section 13441 for screen control.

E. Components:
1. Nuts, bolts, and other fasteners, Type 316 stainless steel.
2. Equipment identification plates as provided in Specification Section 10400.
3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Specification Section 05505.

F. Coatings:
1. For non-stainless steel and non-aluminum metal surfaces, prepare, and prime, and finish coat in accordance with Specification Section 09905.
2. Stainless steel shall be cleaned and passivated following fabrication in accordance with ASTM A380.
a. Sand or bead blasting, sanding, grinding, or hand passivation with acid is not acceptable.

2.4 SPARE PARTS

A. The items listed in this paragraph are representative of the spare parts required for each screen unit. Manufacturer shall add or modify items from the list as appropriate for each Manufacturer's equipment.

B. In addition, provide the following spare parts:
1. Screens:
a. Perforated curved plate sections: Five (5) per unit.
b. Side plate seals:Five (5) per unit.
c. Rotating cleaning brush: One (1) per unit.
d. Main drive motor and gear reducer: One (1).
e. Brush motor and gear reducer: One (1).

C. All parts are to be suitably marked by part number referenced to the Manufacturer's O & M Manual.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The Manufacturer shall submit a description of the proposed testing procedure to the Engineer at least 10 weeks in advance of the proposed testing date. In addition, the Manufacturer shall provide the Engineer with at least 4 weeks advance written notice of the date and location of the factory tests.

B. The Engineer reserves the right to witness the factory tests. The Manufacturer shall not be responsible for the Engineer's travel expenses.

C. The test results shall be signed and certified by an officer of the Manufacturer.

D. Factory tests shall be conducted on each unit. Factory testing shall address the following items as a minimum:
1. Running test with minimum of four hours of continuous operation.
2. Functional test of the control panel operation.
3. All equipment shall be capable of continuous operation without mechanical or electrical defects or operational difficulties.
4. If necessary, repeat tasks until satisfactory results are obtained.
5. Produce a test report containing quantitative results in the form of data or charts.

E. Payment may be withheld on equipment delivered without a Engineer-accepted factory test report, until the test report is received, reviewed and accepted by the Engineer.

3.2 STORAGE, SHIPPING, AND DELIVERY

A. Storage:
   1. Store equipment per manufacturer's instructions.

B. Shipping:
   1. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.
   2. Field panels and other electrical components shall have all openings plugged to prevent moisture accumulation and corrosion.
   3. Ship rack or plug-in components separately to prevent damage.

3.3 INSTALLATION

A. Experienced, competent, and authorized factory-employed service technician of the equipment Manufacturer shall visit the site of work and inspect, check, adjust and approve the installation of equipment specified in this Section. The Manufacturer shall witness the installation and the Manufacturer and Contractor shall certify the installation.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
   1. After completion of the installation, each unit and associated field panels shall be field tested by the Contractor to ensure compliance with the performance requirements and operation with a factory-employed service technician, on-site to witness and assist in the testing.
   2. The Contractor shall provide labor, equipment, and materials to perform testing. Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage. Screen designs which do not lift screenings off the bottom of the channel floor will not be accepted until they have been modified and re-tested and shown to meet the criteria.
   3. Field testing shall address the following items as a minimum:
      a. The design requirements specified in Paragraph 2.2 B.
      b. Screens operation with representative debris found in combined sewer systems (stones, wood, soda cans, plastics, rags, etc.).
   4. A complete test report shall be delivered to the Project Representative after testing is complete.
   5. The Contractor shall rectify installation deficiencies identified by the service technician.

B. A representative of the Contractor shall be present during all visits by the service technician.

C. The Contractor shall notify the Project Representative in accordance with materials testing when Manufacturer's services are required:
   1. The Contractor shall coordinate with the Manufacturer's service technician for operator and maintenance training.

D. Manufacturer's Services:
   1. Provide the following Manufacturer's Services for the minimum number of person days shown (does not include travel time). Provide the following separate trips:
      a. Installation check for each screen including: (one day per screen)
         1) Confirm the equipment has been installed in accordance with Manufacturer's requirements and is ready for operation.
         2) Initial lubrication.
         3) Alignment.
      b. Start up including: (1 day per screen.)
         1) Unattended trouble free operation.
         2) Process stabilization.
         3) Balancing and proper control system operation.

3.5 TRAINING

A. Provide training as specified elsewhere.

END OF SECTION

SECTION 11094
SCREENINGS WASHER/COMPACTOR

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes equipment specifications, installation, and startup support requirements for screenings washer-compactors designed to clean debris removed, dewater and compact the debris and convey the debris to an Owner-furnished dumpster bins. This Section includes:
   1. Washer-Compactor (12WC006).
   2. Associated motors, controls and appurtenances.

1.2 QUALITY ASSURANCE

A. General:
   1. This Section incorporates by reference the latest revision of the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and that of the listed document, the requirements of this Section shall govern.

B. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturer Association (AGMA).
   3. American National Standards Institute (ANSI).
   4. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Screw Threads - Pipe Threads, General Purpose (Inch).
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250).
   5. ASTM International (ASTM):
   6. National Electrical Manufacturers Association (NEMA).
   7. National Fire Protection Association (NFPA):
      a. 70, National Electric Code (NEC).
      b. 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   8. Occupational Safety and Health Administration (OSHA).
   9. Underwriters Laboratories, Inc. (UL).
   10. Factory Mutual (FM).

C. Miscellaneous:
   1. Area Classifications:
      a. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification.

D. Unit Responsibility:
   1. Washer-compactors and related appurtenances shall be furnished by one manufacturer.
   2. The responsible manufacturer shall be responsible for the entire unit. The responsible manufacturer shall select all components of the system to assure compatibility, ease of construction and efficient maintenance.
      a. The responsible manufacturer shall coordinate selection and design of all system components such that all equipment furnished under the specification for the equipment, including equipment specified elsewhere but referenced in the specification, is compatible and operates properly to achieve the specified performance requirements.
   3. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. Agents, representatives or other entities who are not a direct component of the manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in meeting this requirement.

4. This requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all work associated with the Contract.
5. The Contractor shall assure that all equipment provided for the project are products for which unit responsibility has been accepted by the responsible manufacturer. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the work.

E. Responsibilities and Qualifications:
1. All equipment provided under this Specification Section shall be obtained from a single manufacturer who, with the Contractor, shall assume full responsibility for designing, furnishing and installing a complete and operational washer/compactor system.
   a. The manufacturer shall be the source of information on all equipment furnished regardless of the manufacturing source of that equipment.
2. Manufacturer's qualifications:
   a. Manufacturer shall have experience in manufacturing screenings washer-compactor equipment of similar size and configuration to the equipment specified herein in service in USA.
   b. For a manufacturer to be determined acceptable for providing the screenings washer/compactor system on this Project, they must show evidence of a minimum of 15 installations in the United States of America and five (5) years experience in the design and manufacturer of systems of similar size and type as specified herein.
      1) All manufacturers must provide an installation list with contact names and valid phone numbers to that the installations meet the above requirements.
3. The Contract Documents represent the minimum acceptable standards for equipment for this Project.
   a. All equipment will conform fully in every respect to the requirements of the respective parts and sections of the Drawings and Specifications.

F. Coordination:
1. Manufacturer shall coordinate with inlet chute fabricator on dimensions, materials and connections.
2. Coordinate with screen manufacturer to ensure that the screens and washer/compactors work together.

1.3 SUBMITTALS

A. Per Section 01340.

B. Shop Drawings:
1. Information required under Section 11005.
2. Drawings showing the size of the washer-compactor, including:
   a. Inlet hoppers.
   b. Motors.
   c. Piping connections.
   d. Construction details of equipment.
   e. Wiring diagrams.
3. Product information, calculations, charts or graphs to verify that the washer-compactors provided meet the requirements set forth in this Specification.
4. Certified Drawings showing the equipment in plan and section installed at the WPCP, at a scale of not less than 1/4 IN equals 1 FT:
   a. Label all components.
   b. Show dimensions and total weight of the each component of the washer-compactor compactor.
   c. Fabrication and installation details, including details of supports, washer-compactor access door in the inlet hopper.
5. A recommended list of spare parts for each component item.
6. Flow rate and pressure requirements of wash water system for the washer-compactor.

7. Detailed Specifications including a complete description of equipment materials (type, thickness, load rating, etc.).
8. Field panel data, including Manufacturer's catalog information, complete dimensional data, and component data.
9. Catalog cuts of all components including the screw, housing, etc.
10. Electric motor operator data including Manufacturer's catalog information, complete dimensional data, wiring diagrams, and calculations substantiating selection.
11. Factory testing procedure and setup as specified in paragraph 3.1.
12. Provide equipment anchorage calculations as specified in Section 11005 demonstrating compliance with the applicable requirements of Section 11005.

C. Reports and Forms:
1. Installation certification.
2. Factory test report.
3. Field test report.

D. Operation and Maintenance Manuals:
1. All operation and maintenance information specified in Section 01342.

1.4 ENVIRONMENTAL CONDITIONS

A. The washer-compactors will be installed indoors in the headworks of the Pinole-Hercules Water Pollution Control Plant in Pinole, California.

B. Screenings will consist of rags, plastics, and large debris, including rocks, cans, sticks, branches, and lumber.

1.5 WARRANTIES

A. The equipment Manufacturer shall provide a two-year unconditional guarantee from commissioning of the equipment.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Huber Technology, Inc..
2. Andritz Separation, Inc.
3. John Meunier, Inc.
4. Orivo, Jones & Attwood Washpactor.
5. Or approved equal.

2.2 DESIGN REQUIREMENTS

A. General:
1. The design of all components shall be balanced so that jamming at any point will not cause structural failure but will result in stalling of the drive motor.
2. All components, including gear reducer, shall be able to withstand, without damage or permanent distortion, the full stall torque of the drive motor.
3. The equipment shall produce a clean, dry, low odor screenings material conforming to the following parameters and design requirements.
4. Washed screenings appearance:
   a. Light gray to white in color.
   b. No visible fecal matter.
   c. No free water.
   d. No putrescible organic matter.

B. Performance and Configuration Requirements:

1. Design screenings volume at peak wet weather flow: 70 cf/hr.
2. Minimum screenings volume reduction: 70 percent.
3. Minimum removal of organic constituents: 90 percent.
4. Minimum screenings weight reduction: 40 percent.
5. Minimum solid concentration: 50 percent.
6. Influent water flow: 150 to 200 gpm.
7. Motor size (maximum): 7.5 HP.
8. Minimum vertical travel discharge requirement: As indicated on drawings.
9. Minimum horizontal travel discharge requirement: 15 FT.
10. Access door: 2 FT x 0.5 FT.
11. Wash water demand: 95 gpm at 60 psi.

C. Basis of Design:
1. The permanent installation of the washer/compactor has been designed based on the first named manufacturer Huber Technology, Inc.
2. The Drawings show the general location of the equipment and the orientation, service connections and relationship between the components.
3. These items may vary depending on the equipment provided.
4. Any changes shall be coordinated and provided by the manufacturer and Contractor to ensure a complete and functional system.
5. Contractor shall pay the costs for all modifications and/or redesign of the system illustrated on contract plans and any modifications to structural, mechanical, or electrical/instrumentation control areas of work, including the cost for the Engineer to verify the layout, sizing and any re-design to accommodate the proposed equipment.

2.3 MATERIALS

A. Hopper, Screw Housing, Flights, Flanges: AISI Type 316 stainless steel.

B. Agitator Impeller: ASTM A48 Class 35B cast iron.

C. Screw Flights: Type 316 stainless steel.

D. Screw Shaft: Hollow shaft Type 316 stainless steel. Hard facing applied to the end of the screw.

E. Compactor Body/Pressure Zone: Type 316 stainless steel pipe.

F. Inlet Hopper: 1/4 IN Minimum 10 GA 316 stainless steel.

G. Drainage Trough: Minimum 10 GA 316 stainless steel.

H. Screening Discharge Pipe: AISI Type 316 SS, Schedule 10.

I. Fasteners: AISI Type 316 SS.

J. Flight Brushes: Nylon with optional stainless steel reinforcement.

2.4 EQUIPMENT FEATURES

A. Operation Features:
1. Screening materials enter washer section; compaction takes place at the end of the press.
2. During normal flow conditions, the washing process is continuous in the press.
3. Mountings for motors, impellers or any appurtenance which is required from the bottom of the unit will not be acceptable. All penetrations into the washer-compactor shall be through the top.

B. Inlet Hopper/Washing Chamber:
1. House the agitator used for the washing cycle. Agitator motor and impeller mounted to inlet hopper with a flange connection.
2. Designed to direct screenings material into the screw housing.
3. Attached to the screw housing via a flanged connection.
4. Arranged to allow for the mounting of a position switch or pressure sensor.
5. Inlet hopper shall have a 24 IN x 8 IN access door, location as shown on Drawings.

6. Provide a minimum 6 IN overflow drain.
7. Provide flange connection for 10 IN SST inlet. Coordinate inlet height with chute fabricator.
8. Mount one hydrostatic level sensor or pressure sensor to the body of the hopper the level sensor shall measure continuously the water level (or pressure) inside of the hopper (4-20 mA signal output).

C. Washer-Compactor Screw:
1. A shaft mounted washer-compactor screw shall be provided.
2. Flights shall be concentric to within 1/16 IN of the casing.
3. The distance between flights shall be arranged to allow transportation into the washing zone and compaction in the dewatering zone.
4. Screw shall have minimum Brinnel hardness of 200 or Hardox 400.
5. Provide screw with water resistant nylon brush attached to the screw in the drainage area to prevent debris from blinding the drain:
   a. Brushes shall be held in place by stainless steel screws and shall be replaceable.

D. Drain Pan:
1. Mount drain pan on the bottom of the screw housing along the full length of the housing:
   a. Pan shall be provided with flushing nozzle and a drainpipe.
   b. Slope pan towards the drain.
2. Pan shall be held in place by a latching system to allow fast and easy removal.
3. Provide pan with a resilient seal along its top edge to form a watertight seal with the screw housing.
4. Drain pipe shall be 4 IN diameter minimum and equipped with a motorized valve provided by the manufacturer and controlled by the local control panel.
   a. Tag numbers: TBD.
   b. Failure position: Last position.
   c. 120V power.

E. Screw Housing:
1. Cylindrical shape.
2. Entire housing shall be supported on 306 or 304L stainless steel legs.
3. Interior to incorporate anti rotation bars in the dewatering zone to prevent rotation of screenings and bottom drainage openings below the inlet hopper:
   a. Bottom openings: 5 mm perforations.
4. Top of the unit shall incorporate inlets for wash water nozzles in the washing and dewatering zones.
5. The inlet to the dewatering zone shall include a removable cover:
   a. Cover shall be held in place by a latching system to allow fast and easy removal.
   b. A resilient seal shall be provided along the edge to form a water tight seal.

F. Screenings Discharge Pipe:
1. Discharge to elevation and location shown on the drawings:
   a. Provide overflow and drain.
   b. Two 45 degree bends in discharge, unless otherwise shown.
2. Additional supports, if any, shall be designed and supplied by Manufacturer.
3. Discharge Pipe:
   a. The discharge conveyance pipe shall be of sufficient length and slope to discharge the washed and compacted screenings into Owner supplied waste container. See Drawings for discharge height.
   b. All necessary flanges shall be provided on the tube to allow installation.
   c. Mount discharge pipe flange to the washer-compactor body.
   d. Thickness: 1/8 IN minimum.

G. Press Zone:
1. Perforated holes (to be smaller than 6 mm), 360 degrees, or imperforate designed to drain the pressate back to the drainage zone.
2. Drain jacket to return waste liquid from pressing operation to the drain pan.

3. Press Zone Spray System:
    a. Integral with unit:
        1) Minimum Output: 13 gpm at 60 psig.
        2) Spray Nozzles (if used):
            a) 0.14 IN orifice.
            b) Stainless steel.
        3) Pipe and Fittings:
            a) Schedule 40 Stainless Steel, or flexible hose and stainless steel fitting.
            b) 1/2 IN minimum.
        4) Wash Water:
            a) Solenoid valve manifold shall be designed to accept water from the facility's non-potable water system that is sourced from chlorinated final plant effluent:
                (1) Automatic strainers with mesh openings of 100 micron filter the plant effluent before it is delivered to the solenoid valve manifold portion of the rotary screw dewatering unit.
                (2) The spray water will have the following characteristics:
                (a) Total Suspended Solids concentration: Maximum of 15 mg/l.
                (b) Maximum spray water temperature: 72 DegF.
                (c) Minimum spray water temperature: 55 DegF.
                (3) Spray water delivery pressure at the solenoid valve ranges from 40 to 60 psig.
                (4) Water pressure required at the connection to the unit for proper unit operation shall be not more than 125 psig.
        5) Spray wash connections shall be sized and positioned by the Manufacturer.
        6) Solenoid valves: To be provided by manufacturer and controlled by the local control panel.
            a) 120V power.
            b) Fail open.
            c) Tag IDs TBD:

H. Access Points:
    1. Provide adequate access to the washer/compactor for maintenance.

I. Agitator Motor:
    1. Maximum horsepower: 7.5 HP.
    2. Service factor: 1.15 @ 40 DegC.
    3. Per Section 11005.
    4. TEFC.
    5. Voltage: 460V, 3 phase, 60 HZ.
    6. Single speed:
        a. 900 RPM nominal.

J. Drive System:
    1. Shaft mounted gear motor assembly.
    2. The gear drive and integral waste screenings conveyor shall have a close-coupled connection:
        a. An axial bearing shall be attached via a flanged connection to the drive and the press body and shall handle all loads created during compaction, screw reversal and the overhung load of the screw.
        b. The screw shall be cantilevered off the thrust bearing so that the screw does not rest inside the press body. The use of wear bars or wear strips to support the screw is not acceptable.
    3. The axial thrust bearings shall be sealed to the press body with an O-ring seal.
    4. Motors:
        a. Maximum Horsepower: 5 HP.
        b. Service factor: 1.15 @ 40 DegC.
        c. Per Section 11005.
        d. TEFC.

e. Voltage: 460V, 3 phase, 60 Hz.
f. Single speed:
1) 1800 RPM nominal.

5. Reversing drive:
a. Flender, helical gear reducer.
b. AGMA Class II.
c. Minimum Efficiency: 85 percent.
d. Minimum Torque Output: 11,800 IN-LB.
e. Minimum Output Speed: 17 RPM.
f. Provide motor current relay to monitor Hi-Torque alarm and shutdown.

2.5 CONTROL PANELS

A. Local Control Panel (12LCP006):
1. The washer/compactor shall be provided with a separate control panel.
a. Design local control panel to be delivered to jobsite as individual, prewired ready for installation and field wiring.
b. Panel suitable for floor mounting or wall mounting as indicated on the Drawings.
c. The pressure transducer level controller shall be mounted in the main control panel.
d. Panel shall be constructed in accordance with specification Section 13448.
e. Washer/compactor shall receive “enable” signal from plant PLC when associated knife gate is open. Enable signal shall allow washer/compactor to operate when in Auto.
f. Panel shall be designed for a single 480 volt, 3 phase feeder with main breaker disconnect and cover mounted operating handle.
2. Contractor shall coordinate the function of the control panel with all related equipment.
a. Contractor shall provide all wiring, conduit and accessory items between the control panel and the screen.
3. Provide motor starters for all motors provided.
a. Provide NEMA rated starter size 1 minimum.
b. Dual rated starters are not acceptable.
c. All components shall meet requirements of Division 16 Specifications.
4. Control enclosures shall be stainless steel with NEMA 4X rating. Bottom of panel shall be a minimum of 18 IN from the floor.
5. The control panel shop shall be certified by UL as being a UL 508 listed systems control shop, certified to install a serialized label on the finished product and shall be UL labeled as such.
6. Contractor shall coordinate the function of the control panel with all related equipment.
7. The washer/compactor shall be operable by each of the following methods:
a. Automatic: Intermittent operation based on timer and level.
b. Manual:
1) Continuous operation.
8. The current (torque) overload protection device shall be mounted in the control panel to cause the motor starter to be automatically de-energized upon current overload.
a. If a blockage occurs, causing motor overload, the screen shall automatically shut down and illuminate a red alarm light at the control panel.
b. The control panel shall be equipped with a manual reset button.
9. A red mushroom head emergency stop button shall be mounted in a NEMA 4X enclosure adjacent to the washer/compactor.
10. Provide a main thermal-magnetic breaker disconnect to remove all power, and separate disconnecting means to remove power from each motor controller.
11. Provide wire tags on every conductor.
a. Provide slip-on or heat shrink sleeve markers.
b. Tags using adhesives are unacceptable.

B. The panel shall comply with Specification Section 13448 and at a minimum, be complete with the following:
1. Selector switch: HAND, OFF, AUTO.
2. Selector switch: FORWARD, OFF, REVERSE.

3. Event timer: For selection of time duration between starts (from 1 to 24 HR).
4. Duration timer.
5. Programmable controller: Must be compatible with the Plant PLC.
6. Operator interface with HMI display: Must be compatible with the Plant PLC.

C. The panel shall have the following dry contact signals available for remote status:
1. Auto.
2. Fail.
3. Run.
4. Provisions for normally open isolated contact closure to signal unit to start and unit shall continue to run until an adjustable time has elapsed.

2.6 COMPONENTS

A. Nuts, bolts, and other fasteners, Type 316 stainless steel.

B. Equipment identification plates as provided in Specification Section 10400.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Specification Section 05505.

2.7 COATINGS

A. For non-stainless steel and non-aluminum metal surfaces, prepare, and prime, and finish coat in accordance with Specification Section 09905.

B. Stainless Steel:
1. Unless otherwise specified or permitted, all items fabricated from stainless steel shall be thoroughly cleaned, degreased, and treated in a fully immersed pickling bath, to protect the stainless steel against corrosion.
2. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. Pickled surfaces shall be subjected to a 24 HR water test or a ferroxyl test to detect the presence of residual embedded iron and shall be repickled as required to remove all traces of iron contamination.
3. Pickled surfaces shall be adequately protected during shipping, handling, and installation to prevent contact with iron or steel objects or surfaces.
4. Blast cleaning of stainless steel shall not be allowed.
5. Stainless steel components shall be provided with an ASTM 480, No.1 finish.

2.8 SPARE PARTS

A. The items listed in this paragraph are representative of the spare parts required for the washer-compactor. Manufacturer shall add or modify items from the list as appropriate for each Manufacturer's equipment.

B. In addition, provide the following spare parts as the total amount of spare parts:
1. Washer-compactor
   a. 2 solenoid valves of each size.
   b. 3 fuse sets for controls.
   c. 1 drive system.
   d. 2 sets flight brushes.
   e. 1 screw with flight brush.
   f. 1 dewatering zone inlet cover resilient seal.

C. All parts are to be suitably marked by part number referenced to the Manufacturer's O&M Manual.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The Manufacturer shall submit a description of the proposed testing procedure to the Engineer at least 10 weeks in advance of the proposed testing date. In addition, the Manufacturer shall provide the Engineer with at least 4 weeks advance written notice of the date and location of the factory tests.

B. The Engineer reserves the right to witness the factory tests. The Manufacturer shall not be responsible for the Engineer's travel expenses.

C. The test results shall be signed and certified by an officer of the Manufacturer.

D. Factory testing shall address the following items as a minimum:
   1. Running test with minimum of four hours of continuous operation.
   2. Functional test of the control panel operation.
   3. All equipment shall be capable of continuous operation without mechanical or electrical defects or operational difficulties.
   4. If necessary, repeat tasks until satisfactory results are obtained.
   5. Produce a test report containing quantitative results in the form of data or charts.

E. Payment may be withheld on equipment delivered without a Engineer-accepted factory test report, until the test report is received, reviewed and accepted by the Engineer.

3.2 STORAGE, SHIPPING, AND DELIVERY

A. Storage:
   1. Store per manufacturer's instructions.

B. Shipping:
   1. Ship items as complete assemblies except where partial disassembly is required by transportation regulations or for protection of components.
   2. Field panels and other electrical components shall have all openings plugged to prevent moisture accumulation and corrosion.
   3. Ship rack or plug-in components separately to prevent damage.

3.3 INSTALLATION

A. Experienced, competent, and authorized factory-employed service technician of the equipment Manufacturer shall visit the site of work and inspect, check, adjust and approve the installation of equipment specified in this Section. The Manufacturer shall witness the installation and the Manufacturer and Contractor shall certify the installation.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
   1. After installation, the unit and associated field panel(s) shall be field tested by the Contractor to ensure compliance with the performance requirements and operation with a factory-employed service technician, on-site to witness and assist in the testing.
   2. The Contractor shall provide labor, equipment, and materials to perform testing. Testing procedures shall duplicate as nearly as possible the conditions of operation and shall be selected to demonstrate that the equipment is operational and free from damage.
   3. Field testing shall address the following items as a minimum:
      a. The design requirements specified in paragraph 1.4 B.
      b. Washer-compactor operation with representative debris found in combined sewer systems (stones, wood, soda cans, plastics, rags, etc.).
   4. A complete test report shall be delivered to the Project Representative after testing is complete.
   5. The Contractor shall rectify installation deficiencies identified by the service technician.

B. A representative of the Contractor shall be present during all visits by the service technician.

C. The Contractor shall notify the Project Representative in accordance with materials testing when Manufacturer's services are required:
   1. The Contractor shall coordinate with the Manufacturer's service technician for operator and maintenance training.

D. Manufacturer's Services:
   1. Provide the following Manufacturer's Services in accordance with Section 01660 for the minimum number of person days shown (does not include travel time). Provide the following separate trips:
      a. Installation check for the washer-compactor including: (1 day).
         1) Confirm the equipment has been installed in accordance with Manufacturer's requirements and is ready for operation.
         2) Initial lubrication.
         3) Alignment.
      b. Start up including: (1 day).
         1) Unattended trouble free operation.
         2) Process stabilization.
         3) Balancing and proper control system operation.

3.5 TRAINING

A. Manufacturer's Services:
   1. The Manufacturer will provide the following Services for training with the City in accordance with Section 01650 for the minimum number of person days shown and at such times as requested by the Engineer:
      a. Number of trainings: Two (2).
      b. Staff training sessions: One 4 hour training session per training session.
      c. Video Recording Presentation: 1 hour per training session.
   2. The Manufacturer will provide training of Engineer personnel in the operation and maintenance of the equipment and in accordance with Section 01650.

END OF SECTION

SECTION 11095
AUTOMATIC SELF-CLEANING STRAINERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Automatic self-cleaning strainers.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American National Standards Institute (ANSI).
   2. American Society of Mechanical Engineers (ASME).
   3. National Electrical Manufacturer's Association (NEMA).

B. Manufacturer's Qualifications: Manufacturer shall be regularly engaged in the design and manufacture of similar automatic self-cleaning strainers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
   3. Manufacturer's descriptive literature, illustrations, specifications, identification of materials of construction and engineering data.
   4. Submit complete detailed Shop Drawings including physical layout of the strainer, drive unit and control equipment, piping diagrams and field wiring diagrams, control diagrams and a complete description of the control system, manufacturer's installation instructions, and equipment operating characteristics.
   5. All items required by Section 11005.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle all products and materials as specified in Specification Section 01600.

1.5 WARRANTY

A. Provide manufacturers standard one year warranty from the date of Substantial Completion as defined in Division 0.

1.6 SYSTEM DESCRIPTION

A. Automatic self-cleaning strainers specified herein shall be used to strain plant utility water from the chlorine contact basin as shown on the drawings.

B. Cleaning shall be initiated after a pre-set time has elapsed or the differential pressure across the strainers exceeds a pre-set value.

C. Ability to manually initiate cleaning shall also be provided.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Amiad.
   2. Boll.
   3. Eaton.
   4. Spiral Water.
   5. Or approved equal.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Self-Cleaning Strainers shall be designed for the following conditions of service:
   1. Number of strainers: 1.
   2. Equipment Tag No(s): 72STR008.
   3. Strainer filter mesh opening: 100 micron, minimum.
   4. Single strainer flow rate: 250 gpm.
   5. System source water: Chlorinated Secondary effluent, filtered thru 1/32 IN strainer.
   6. System operating pressure range: 50 - 95 psig
   7. Design pressure: 75 psig.
   8. Feed water temperature: 44 to 88 DegF.
   9. Drive Motor HP: 15 watt.
   10. Power supply: 120 VAC, 1 PH, 60 Hz.

B. Strainers shall provide continuous, uninterrupted flow during rotary drum thickener operation.

C. Each strainer shall have a clean-screen pressure drop of no greater than 3.0 PSI at maximum flow specified herein.

D. Strainers shall be designed to self-clean effectively at operating pressures as low as 20 psi. No external water source shall be required for cleaning.

2.3 EQUIPMENT

A. Strainer:
   1. Strainer unit shall be an automatic, self-cleaning type with internal rotating cleaning element, and containing replaceable screening element.
      a. Filter housing and lid:
         1) Polycarbonate or CPVC.
      b. Cover: Removable to facilitate maintenance.
   2. Inlet and outlet flange connections: 6-IN, 150 lb ANSI standard, raised face flanges.
   3. Provide 1-1/2 IN minimum drain and 1/4 IN minimum vent connections.
   4. All internal components shall be stainless steel or as specified herein. The use of uncoated carbon steel for any wetted strainer surfaces is not acceptable.
   5. Cleaning:
      a. Cleaning shall be initiated manually, or by utilizing the pressure differential across the screen and/or on a timer basis. The strainer drain valve shall open and the cleaning element shall rotate slowly, cleaning solids from the screening element.
      b. Cleaning element shall be driven using an electric motor. Cleaning element shall be made of PVC that simultaneously moves linearly as a result of a threaded-shaft/fixed-threaded-bearing mechanism.
         1) Motor drive for the rotating cleaning element shall:
            a) Be suitable for operation with power supply specified herein.
            b) TEFC.
            c) Meet the requirements of Section 11005.
            d) Be reversing type if required by the manufacturer.
   6. The motor actuated automatic drain valve for each strainer shall be a 1 IN diameter, minimum, and be controlled by the strainer control panel.

7. If required for proper operation, each strainer shall be provided with end of travel limit switches. Switches shall be manufacturer standard suitable for the intended service.

B. Strainer Control Panel:
   1. Construction:
      a. Rack mount on strainer.
      b. Mount differential pressure switch on outside of panel or on strainer and wire into panel.
      c. NEMA 4X.
   2. Front panel devices (may vary with suppliers standard).
      a. Nameplate mounted with stainless steel screws.
      b. White Control Power On light.
      c. Manual-Off-Auto switch.
      d. Manual cleaning initiate push button.
      e. Red Fail light.
   3. Inside panel devices.
      a. PLC or hard device based according to manufacturer's standard.
      b. Main power circuit breaker with front panel operating handle for 120 VAC, single phase feeder.
      c. Relays, terminals, starter and other control devices as required.
   4. Control: Suppliers standard.
      a. Provide following isolated contact outputs for plant SCADA.
         1) Fail.
         2) Auto.

2.4 ACCESSORIES

A. Equipment Anchor Bolts: Contractor shall provide anchor bolts as specified in Specification Section 11005. Anchor bolts shall be sized by the strainer manufacturer.

B. Equipment Identification Plates: Contractor shall provide identification plate(s) securely mounted on each separate equipment component in a readily visible location as specified in Specification Section 10400.

2.5 FINISH PAINTING

A. Interior of strainer body and other submerged ferrous metals shall be factory coated with the manufacturer's standard fusion bonded, NSF 61 approved, epoxy coating.

B. Exterior of strainer body shall be factory primed with manufacturer's standard red oxide epoxy primers. Final finish coating shall be applied by the Contractor as specified in Section 09905.

2.6 SOURCE QUALITY CONTROL

A. Each strainer shall be hydrostatically tested at the manufacturer's factory. Testing shall be performed at one one-half times the maximum system operating pressure.

B. Units shall also undergo manufacturer's standard quality assurance/quality control testing to demonstrate compliance with these specifications.

2.7 MAINTENACE MATERIALS

A. Furnish all special tools required for normal maintenance.

B. Furnish one set of all manufacturer recommended spare parts for each strainer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions. See Section 11005 for additional requirements.

3.2 FIELD QUALITY CONTROL

A. See Section 11005.

B. The service of a manufacturer's field service representative shall be provided at the site for 8 hours (1 day) to furnish installation oversight, inspection, start-up, and adjustment services to the Contractor as required in Section 01650.

C. The service of a manufacturer's field service representative shall be provided at the site for 2 hours to furnish operations and maintenance training as required in Section 01650.

END OF SECTION

SECTION 11096
FORCED VORTEX GRIT REMOVAL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Forced vortex type grit removal system (13VGR003).

1.2 SYSTEM DESCRIPTION

A. Scope:
   1. Grit removal equipment.
   2. Equipment includes:
      a. Gear motor.
      b. Gear head.
      c. Paddle drive tube.
      d. Paddle.
      e. Grit removal pump.
      f. Auxiliary equipment.
   3. Chamber configuration: Two specific structural designs (Type A and Type B) are shown on the Drawings to accommodate equipment from two manufacturers. Any changes to Contract Drawing design to accommodate other manufacturers shall be the responsibility of the Contractor.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI);
   2. American Society of Mechanical Engineers (ASME);
   3. American Gear Manufacturer's Association (AGMA);
   4. American Society of Testing and Materials (ASTM);
   5. National Electrical Manufacturers Association (NEMA).

B. Qualifications:
   1. All equipment supplied by a single manufacturer or supplier.
   2. Manufacturer shall have a minimum of ten similar size and configuration units in operation.
      a. Submit five (5) references.
   3. Contract Drawings are based on the two listed manufacturers. Any changes to the Contract Document design shall be designed by a civil or structural engineer registered in the State of California.

1.4 DEFINITIONS

A. Overall Removal efficiency: The fraction of grit settled in the grit chamber from a unit volume of wastewater influent flow expressed as a weight percentage of the corresponding weight of grit in the same volume of influent flow.

1.5 SUBMITTALS

A. Shop Drawings and Product Data:
   1. See Section 01340.
   2. Scaled floor plan and sections showing dimensions, weights, structural supports, embedments, openings, and clearances.
   3. Sufficient data to verify compliance with specifications and to illustrate construction or assembly of the components and materials.

4. Manufacturer, model, and type.
5. Detailed specifications and data describing materials, parts, and accessories used, which constitute the complete grit removal equipment.
6. Electrical wiring diagrams.
7. Submit design computations and stress diagrams for bearings, bearing life, center drive tube, paddles, AGMA rating of all driven components with calculations, and minimum gear reducer output torque.
8. Full scale test results from installations of similar size and peak design flow rates for each size unit tested in accordance with testing requirements included in Part 3 of this Section of specifications. At the least, the performance results shall equal that specified in Part 2 of this Section of specifications.
9. Installation and reference list.
10. Stamped and signed Drawings and calculations for Contract Drawing changes if alternative equipment is supplied.

B. Operation and Maintenance Manuals:
   1. See Section 01342.

C. Field Test Report:
   1. Results of full-scale tests performed in accordance with testing procedure included in Part 3 of this Section of specifications, and with both minimum and peak design flows applied to each size unit.

D. Certification of Proper Installation and Satisfactory Operation.

1.6 JOB CONDITIONS

A. Equipment designed to separate organics and remove grit from raw screened wastewater in the new headworks facility using forced vortex principle. In this design, the grit moving across the chamber is hydraulically scoured by propeller or impeller blades rotating within 6 IN of the grit chamber floor, but not directly in contact with it, to lift up the organics.

B. Drive equipment suitable for outdoor installation with exposure to wind, rain and sunlight.

C. Paddle and drive shaft suitable to resist corrosion caused by wastewater gases and acids biologically generated from such gases.

D. Any electrical equipment mounted less than 18 IN above the top of the concrete deck shall be rated for installation in a Class 1, Division 2 area.

1.7 WARRANTY

A. The manufacturer of the equipment shall warrant all equipment provided will be free from defects in material and workmanship for a period of one (1) year.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Type A grit removal equipment: Smith and Loveless (Pista).
   2. Type B grit removal equipment: OVIVO (Jones & Attwood Jeta).
   3. No others acceptable.

B. Note that Type A and type B Sections are provided on the Drawings. The 3D model that grit area plans and sections are cut from are based on type A grit removal equipment. Contractor will be responsible for any modifications to the structure if type B is provided.

2.2 DESIGN AND PERFORMANCE

A. Grit Removal Unit No. 1 (Tag number 13VGR003):
   1. Number of units: 1.
   2. Design flows:
      a. Peak hour flow: 20 mgd.
      b. Maximum day wet weather flow: 12 mgd.
      c. Average annual flow: 4.1 mgd.
      d. Average dry weather flow: 4.0 mgd.
      e. Minimum hour minimum flow: 1.0 mgd.
   3. Estimated water surface elevation in grit basin:
      a. At peak design flow: See drawings.
      b. At average design flow: See Drawings.
   4. Influent channel width: 4 FT – 0 IN.
   5. Effluent channel width: 4 FT – 0 IN.
   6. Inside diameter of chamber: 16 FT.
   7. Direction of flow rotation: As shown on Drawings.

B. Maximum Head Loss Across Grit Basin at Peak Design Flow: 1/4 IN.

C. The grit removal unit shall meet the following maximum surface overflow rates (SOR) at the given design flows:
   1. Average dry weather flow SOR: 14 gpm/ft^2.
   2. Maximum day wet weather flow SOR: 41 gpm/ft^2.
   3. Peak hour flow SOR: 69 gpm/ft^2.

D. The grit removal unit shall meet one of the following grit removal efficiencies:
   1. At average dry weather flow of 4 mgd – Removal efficiency shall be seventy (70) percent or greater of the 300-micron grit particles.
   2. At peak hour flow rate of 20 mgd – Removal efficiency shall be twenty three (23) percent or greater of the unit influent grit.

2.3 MATERIALS

A. Steel Plate: 316 stainless steel.

B. Housing: Cast iron, ASTM A48, Class 25 or better.

C. Propellers or Impellers: 316L stainless steel.

D. Gears and Pinions: Alloy steel, heat treated, machined, and hardened in accordance with AGMA standards.

E. Bolts and fasteners: 316 stainless steel.

F. Anchor bolts: 316 stainless steel.

G. Drive tube and air bell: 316L stainless steel.

H. Influent baffle plate assembly (If required): 316L stainless steel.

I. Two piece floor plate assembly: 316L stainless steel.

2.4 FABRICATION AND MANUFACTURE

A. General:
   1. Welds on submerged or partially submerged components to be continuous. Passivate all welds.
   2. Dull sharp corners of cut or sheared edges by at least 1 pass of a power grinder.
   3. Field connections to be bolted. No field welding will be allowed.
   4. No moving parts subject to wear or stoppage below the water surface.
   5. All components designed for continuous 24 hour per day service.

B. Gear Motor:
   1. Helical gear type motor, minimum 1.5 HP, 460V, 3 phase, 60 Hz, TEFC, 1.15 SF with normal starting torque and low starting current.
   2. Gear reducer to include anti-friction bearings with high overhung load properties, and double lip temperature oil seals riding on precision ground shafts.
   3. Gear motor designed for heavy duty 24 hour service and not overloaded under any normal operating conditions.
   4. Oil lubrication for helical gearing.
   5. B-10 bearing life: 100,000 hours, minimum.
   6. Service factor: 2.0 or greater.
   7. Motors shall be sized so that under maximum continuous loading the name plate horsepower is greater than the driven load.

C. Mechanical Drive:
   1. Combination spur gear and minimum 21 IN diameter turntable bearing, totally enclosed in heave cast iron case, and driven by pinion on output shaft of gear motor.
   2. Output speed: 21 RPM, maximum.
   3. Mechanical drive assembly specifically designed for this service and installation, including additional weight from the stainless steel drive tube and propeller or impeller assembly.
   4. Gear box to be sealed with bottom opening for drive tube protected by air bell, 1/8 IN thick minimum, to prevent water from entering the gearbox in the event of flooding.
   5. Gear box oil lubricated and provided with 4 IN sight glass on gear case to allow verification of proper lubrication.
   6. Service factor: 5.0, minimum, at standard operating speeds.
   7. B-10 bearing life for turntable assembly: 175,000 hours, minimum.
   8. B-10 bearing life for other drive assembly bearings: 100,000 hours, minimum.
   9. Provide monitoring of torque loading of grit drive. Provide two adjustable torque switches; one for torque warning and one for overtorque shutdown.

D. Propeller or Impeller:
   1. Propeller or impeller connected to drive tube driven by mechanical drive turntable bearing.
   2. Propeller or impeller blades, 4 per unit minimum, affixed to drive tube by means of a 2 piece collar allowing adjustment in either an upward or downward position to assure maximum grit removal and organics separation.
   3. Drive tube: 1/4 IN thick, minimum.
   4. Propeller or impeller blades: 1/4 IN thick, minimum, welded to Schedule 40 pipe.

E. Baffle Plate:
   1. If required by manufacturer, provide 3/8 IN minimum baffle at inlet channel to maximize hydraulic conditions.

F. Floor Plate:
   1. If required by manufacturer, provide removable floor plate assembly over grit storage chamber to minimize the possibility of organic capture.
   2. Provide 3 IN opening for grit to pass through to storage chamber.
   3. Design plate assembly in two sections with lifting loops to allow access to the grit storage chamber.
   4. Plate to be 3/8 IN minimum with stiffeners to support a 200 pound per square foot live load.
   5. Install anchor bolts per manufacturers recommendations.

G. Control Panel:
   1. Outdoor, NEMA 4X stainless steel sized such that bottom of panel can be at least 18 IN above concrete slab..
   2. Designed for single 480 volt feeder for entire vortex grit system with main breaker and cover mounted handle.
   3. Starters and controls for all drives.
   4. Control power transformer(s).
   5. HOA switch for each drive.

6. Provisions for isolated NO contacts to remotely start and stop the grit system.
7. Isolated contacts for following:
   a. Grit System Run.
   b. Grit System Fail.
   c. Grit System Auto.
8. Isolated NO contact input to start grit washer when grit pump runs and adjustable time delay stop of grit washer when grit pump stops.

H. Painting:
1. Provide surface preparation, shop prime, shop or field finish coatings, and field touch up coatings in accordance with Section 09905.
2. Shop prime and finish coatings for gear motor and mechanical drive assembly as specified for exterior non-submerged metal surfaces and equipment.
3. No additional coatings required for stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Shop assemble each gear motor, mechanical drive, and propeller or impeller assembly prior to shipment and test run to assure proper operation of all components.

B. Install equipment in strict accordance with the Manufacturer's instructions and recommendations in the location shown on the Drawings.

C. Furnish manufacturer's recommended grades of oil and grease required for operation.

D. Set anchor bolts in accordance with the Manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

A. Provide services of manufacturer's field representative for a minimum of 32 HRS in two trips (minimum).

B. Manufacturer's field representative to be thoroughly familiar and experienced to inspect, adjust, start-up, conduct full scale field tests, and to instruct and train the Owner's personnel regarding this specific type of equipment.

C. Installation and Preparation Check.
1. Manufacturer's representative to check installation and alignment of grit removal unit and advise Engineer of deficiencies.

D. Start-up and Operation Check:
1. Manufacturer's representative to check for proper operation and propeller or impeller blade adjustment of grit removal unit.
2. Check for motor overloads by measuring amperage and voltage on each phase.
3. Demonstrate operation of grit removal equipment and control system to Owner's personnel.

END OF SECTION

SECTION 11120

PRIMARY CLARIFIER AND GRAVITY THICKENER: CIRCULAR GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General requirements that apply to scrapper type sludge collection and thickening equipment specified in other sections of these Specifications.
      a. Primary Clarifiers (Three Each).
      b. Gravity Thickener (One Each).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA):
      a. ABMA 9, Load Ratings and Fatigue Life for Ball Bearings.
   2. American Gear Manufacturers Association (AGMA):
      a. 6010-E, Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives.
      b. 6034-B, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gear motors.
      c. 2001-D, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   3. American Institute of Steel Construction (AISC):
      a. Manual of Steel Construction.
   4. American Iron and Steel Association (AISI):
      a. Steel Products Manual.
      b. American Iron and Steel Institute Manual.
   5. American Welding Society (AWS).
   6. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
   7. US Department of Labor, Occupational Health and Safety Administration (OSHA).

B. Qualifications:
   1. Utilize only American Welding Society (AWS) certified welders.
   2. Manufacturer experience:
      a. Minimum five (5) similar clarifier mechanism installations with diameters greater than or equal to 90 percent of the diameter of this specified clarifier.
      b. Supplied similar equipment for the past 10 years.
      c. The mechanism shall be a standard production product of the manufacturer.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Submit complete erection, installation, operation and maintenance information provided by the manufacturer.
   3. Submit, as a minimum, complete construction details, materials of construction, drawings of sludge collection and skimmer mechanisms, gears, gear reducers, center column, diffuser and influent wells, platform, walkway, motor, electrical diagrams, and other pertinent information.
   4. Submit copy of torque test results to Engineer.
   5. Submit statement and supporting calculations signed by a registered professional Structural Engineer that all members have been designed to support the loadings as specified.
   6. Submit manufacturer, model and certification of compliance to ABMA 9 bearing life.

7. Submit copy of report verifying completion of start-up and related field services.
8. Submit any special instructions for unloading at the jobsite, handling, storage and routine maintenance prior to installation and startup.

B. Miscellaneous Submittals:
1. Main drive speeds.
2. Size, make and type of electric motors and drive systems.
3. AGMA rated alarm, stall and ultimate torque capabilities.
4. Details of any revision necessary to adapt the piping, structural, electrical and instrumentation design to the equipment proposed.
5. Manufacturer must submit center column calculations.
6. Manufacturer must submit calculations verifying the output torque rating of the drive selected. Calculation will include all spur gears and pinions in the drive train.
7. Calculations and details must bear the stamp of a professional engineer.
8. Calculations of uniform sludge withdrawal and sludge withdrawal system head loss.

C. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for the mechanics and administration of the submittal process.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

B. Factory Assembly:
1. Assemble each mechanism in factory to ensure proper fit of parts. Mark parts with erection marks.
2. Disassemble mechanism into largest sections allowed by carrier regulations for shipment.

1.5 PROJECT CONDITIONS

A. Equipment suitable for installation in raw sewage.

B. Wastewater Temperature: 60 to 80 DegF.

C. Ambient Temperature: 25 to 110 DegF.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Ovivo.
2. Westech.
3. Evoqua.
4. Or approved equal.

2.2 MATERIALS

A. General:
1. Materials to be considered for construction of the clarifier mechanisms will be stainless steel construction as specified herein.
   a. Stainless steel plate, pipe, rod and rolled structural shapes shall be of the austenitic stainless steel type, AISI Type 304L (UNSS30403).
   b. Dual-certified 304/304L type may be used if it complies with all requirements of 304L.
   c. The welding electrodes for welding Type 304L stainless steel shall be either AWS 5.4E308L covered welding electrode or AWS 5.9ER308L bare welding electrode type, or equivalent filler metal.
   d. Autogenous welding of stainless steel is not allowed.

2. Ensure structural members and connections are designed so that the unit stresses will not exceed 100 percent of AISC allowable stresses when subjected to cutout torque and/or field torque test, whichever is higher.
3. For any axis parallel to bending action, size compression members not to exceed a slenderness ratio of 200 and size tension members not to exceed a slenderness ratio of 240.

B. Structural Design:
1. Maximum ratio of unbraced length to least radius of gyration (slenderness ratio).
   a. Compression members: 200.
   b. Tension members: 240 (for angle about the Z-Z axis).

2.3 EQUIPMENT

A. Primary Clarifier No. 1, No. 2 and No. 3 Performance Requirements:
1. Tank dimensions: 45 FT - 0 IN DIA.
2. Side water depth of new clarifier: 14 FT - 0 IN.
3. Minimum freeboard at maximum flow of new clarifier = 1.5 FT.
4. Influent column inside diameter: 18 IN.
   a. Primary Clarifier No. 1: 14 IN.
   b. Primary Clarifier No. 2: 18 IN.
   c. Primary Clarifier No. 3: 18 IN.
   d. Outlets: 4 at minimum 16 IN wide by minimum 18 IN water depth and minimum 28 IN overall depth.
5. AGMA 20 year continuous rated running torque applied at output of drive unit: 16,000 FT-LBS minimum.
6. Stall or motor cut-out torque: 2 times continuous torque.
7. AGMA yield torque applied at output of drive unit: 2 times continuous torque.
8. Minimum turntable ball race diameter: 30 IN.
9. Minimum internal spur gear pitch diameter: 26 IN.
10. Minimum drive motor horsepower: 3/4 HP.
11. Maximum drive motor speed: 1,800 rpm.
12. Drive output speed: Maximum 0.04 rpm (maximum 12 fpm tip speed).
13. Drive pinion: Single.
14. Minimum spur gear face width: 2.5 IN.
15. Flocculating feed well:
    a. Size: 14 FT DIA.
    b. Depth below water surface: (New clarifier).
       1) Primary Clarifier No. 1: 3 FT.
       2) Primary Clarifier No. 2: 3 FT.
       3) Primary Clarifier No. 3: 6 FT
    c. Thickness: Minimum 3/16 IN.
16. Influent head loss at maximum flow: 3 IN.
17. Thickness of all submerged stainless steel members: 1/4 IN minimum.

B. Structural Design:
1. Maximum ratio of unbraced length to least radius of gyration (slenderness ratio):
   a. Compression members: 120.
   b. Tension members: 240 (for angle about the Z-Z axis).
2. Maximum unit stress: 1.333 times AISC allowable stresses at all structural members when subject to twice the drive torque.
3. Design shall account for flocculation baffles per Section 11151.

C. Process Parameters:
1. The following data to be used to calculate clarifier components (per clarifier):

	AVERAGE DRY WEATHER	PEAK WET WEATHER
Influent flow (w/o RAS), mgd	1.4	4.0
Return sludge flow, mgd	0.25	0.25
Influent total suspended solids, mg/L	80 – 400	80 - 400

2.4 COMPONENTS

A. Drive Unit:
   1. Provide TEFC motor, premium efficiency, 230/460 volt, 3 phase, 60 Hertz, 1.15 SF..
   2. Reducer designed for AGMA Class II service rating.
   3. Load shall not exceed the motor nameplate ampere rating at any operating condition at or below the stall torque of the mechanism.
   4. Provide motor with manufacturer's standard insulation, a 45 DegC ambient temperature rating and for continuous duty.
   5. Main drive AGMA yield torque: 2 times continuous torque.

B. Overload Device:
   1. Provide normally open contact which closes at 80 percent of the design running torque for alarm activation.
   2. Provide a normally closed contact which opens at 100 percent of the design running torque for motor shutdown.
   3. Provide a normally closed contact or slip clutch which activates at 120 percent of the design running torque.
   4. Provide visual torque indicating device mounted on drive calibrated from 0 to 160 percent of the design running torque to indicate loading at all times during operation.

C. Shear Pins:
   1. Provide shear pin device set for 125 percent of AGMA rated torque or third switch.
   2. For shear pin, provide straight or necked shear pins.

2.5 FABRICATION

A. Center Pier:
   1. Fabricate center pier of cylindrical stainless steel with a minimum 42 IN DIA by minimum 3/8 IN wall thickness.
   2. Provide flanged base for anchor bolting to concrete base of clarifier as shown on Drawings.
      a. Provide water tight connection seal.
      b. Minimum of twelve (8) anchor bolts of at least 1 IN DIA.
   3. Provide a flanged top and stiffeners for supporting the sludge collection mechanism, the drive mechanism, drive-mounting plate, access platform, and the access bridge.
   4. Provide a drive mechanism mounting plate set plumb with the centerline of the center pier.
   5. Provide center pier which serves as an influent pipe and has a minimum of 4 equally-spaced ports at the upper end to direct the flow into the EDI at a velocity less than 1 fps.
   6. Provide easily accessible and removable plate near the bottom of the center pier for draining center pier.
      a. Opening shall be large enough to insert a submersible pump to dewater the clarifier influent pipe.
      b. Removable plate shall provide a clear square opening not less than 18 IN by 18 IN.
      c. The opening shall be reinforced as needed to handle the imposed loads on the center pier.
   7. Provide sludge return manifold to mount to existing 16 IN sludge pipe, mounted inside of center pier as shown on Drawings.
      a. Minimum 3 sludge return branches extended to edge of pier. Sized per manufacturer.

B. Flocculating Feedwell:

1. Fabricate from 3/16 IN minimum stainless steel plates.
2. The feedwell shall be located outside the influent pipe to diffuse the liquid into the tank without disturbance or formation of velocity currents.
3. Support the feedwell from drive cage above water level.
    a. Locate feedwell structural members on the outside of the feedwell to provide smooth interior.
4. Feedwell shall project 6 IN above water surface minimum.
5. Flocculation baffles will be supported from the flocculation well (see Section 11150).
6. Provide baffled openings in well at liquid level to allow release of scum in a tangential direction.
    a. Minimum 6 openings.

C. Center Drive Cage:
1. All-welded steel construction.
2. Transmit torque from drive unit to rotating components by the drive cage. DO NOT transmit any torque to the access bridge.
3. Design drive cage to encompass center column and transmit and/or carry all torques without overstressing members.
4. Design adjustable connection between drive unit and drive cage to provide for proper alignment and allowance for structural tolerances.

D. Truss Arms:
1. All welded stainless steel construction.
2. Rigidly braced structural truss arms rigidly supported by the center drive cage.
3. Design truss arms to transmit all torques to the center cage without overstressing members.
4. Use of the rods/turn buckles not allowed.

E. Drive Mechanism:
1. Fabricate drive components in accordance with AGMA 6010-E and AGMA 6034-B and AGMA 2001-D, or AGMA 2001-C95 for 24 HR continuous duty and 20-year design life based on rated AGMA torque. Design bearing for an ABMA 9 life of 200,000 HRS.
2. Completely factory assembled.
3. Exposed gearing is not acceptable.
4. The design must allow for servicing without removing the bridge.
5. Wormgear drive:
    a. Provide drive mechanism consisting of a primary gear reduction unit, an intermediate reduction unit, plus a final reduction unit consisting of a pinion and internal gear enclosed in a turntable base.
    b. Enclose all gearing in a cast iron housing.
    c. Provide all bearings of anti-friction type and running in oil.
    d. Provide totally enclosed ball bearing motor of ample power for starting and continuously operating the mechanism without overloading.
    e. Primary reduction unit:
        1) Provide a primary reduction unit which drives the intermediate reduction unit through a chain and sprocket arrangement.
        2) Furnish drive chain of #80L self-lubricated roller chain.
        3) Provide an adjustable base mounted on the intermediate reduction unit for chain tension adjustments.
        4) Direct coupled cycloidal reducers are also acceptable.
    f. Intermediate reduction unit:
        1) Provide an intermediate reduction unit consisting of a cast iron housed worm gear speed reducer, with grease and oil lubricated, anti-friction type bearings and service factor of 1.25.
        2) Mount the unit on a machined face on the top of the final reduction unit and properly aligned to maintain accurate centers for the final reduction gearing.
        3) Worm assembly worm and shaft of a heat treated alloy and integral construction and the worm gear of cast manganese bronze, aluminum bronze or ductile iron.

4) Direct coupled cycloidal reducers are also acceptable.

g. Final reduction unit:
   1) Provide internal gear drive by a heat-treated pinion from the slow speed shaft of the primary gear reducer. Construct the main pinion of heat treated AISI series alloy steel, machined after heat treatment. Support pinion at both top and bottom by a taper roller bearing assembly. Use one-piece pinion shaft construction without an intermediate coupling.
   2) Provide ductile iron internal gear and pinion of AGMA quality 6 minimum.
   3) Provide internal gear design to support center cage and collector.

h. Turntable base:
   1) Provide turntable base with annular raceway to contain balls on which the internal gear rotates.
   2) Furnish ball race without guide shoes and steady bearings.
   3) Furnish ball bearings of alloy steel bearing vertically and horizontally on four removable liner strips pressed into annular raceways in turntable base and internal gear.
   4) Protect internal gear, pinion and ball race by a seal and dust shield.
   5) Internal gear, pinion and ball race is to run in oil bath.
   6) Furnish turntable base bolted to the center column and designed to support the internal gear with rotating mechanism and access platform.
   7) Provide a pipe attached to bottom of turntable base for condensate removal.
   8) Furnish oil piping which terminates within the center of the base.
   9) Fully contoured precision gear/bearing sets are also acceptable.

F. Platform and Walkway:
   1. Walkway:
      a. Provide minimum clear walkway width of 3 FT.
      b. Fabricate walkway of 1-1/2 IN deep serrated aluminum grating.
   2. Operating platform:
      a. Provide platform for access to and around the drive mechanism.
      b. Provide minimum clear space at least 2 FT wide around the drive unit.
      c. Fabricate platform of 3/8 IN aluminum checkered plate.
   3. Include lift-out sections where required for routine maintenance of equipment.
   4. Guardrail:
      a. Provide guardrail in compliance with Section 05522 or manufacturer's standard OSHA compliant mechanically fastened aluminum system.
      b. Provide a 3/16 IN thick by 4 IN high aluminum kickplate around platform and walkway.
   5. Support walkway and operating platform from the center column and the tank wall.
   6. Design walkway and platform to withstand a live load of 50 LBS/SQ FT.
      a. Deflection shall not exceed L/360 when the dead load and live load are applied.
      b. Brace against lateral movement using wind load of 50 LBS/SF.

G. Scum Skimming and Removal:
   1. Skimming equipment shall be of the radial trough type with full radius skimming arms to operate within the circumferential scum baffle and influent well baffle.
   2. Provide clarifier with two (2) rotating skimming arms and one (1) fixed radial scum trough extending from the scum baffle.
   3. The skimming arm and offset scum deflector shall collect floating scum the full distance between the scum baffle and the inlet well.
   4. Provide proper support and make allowance for 3 IN vertical adjustment of the skimming arm.
   5. Skimmer blade assembly arranged to trap the scum at the scum baffle and discharge into the scum trough.
   6. The blade's bottom edge shall be always in contact with the scum trough when passing over the trough.

7. Fabricate scum trough made of reinforced 304 stainless steel plate and supported from the tank wall.
8. Design the scum trough for all dead loads plus a 200 LB point load at the inner end of the cantilever trough with no more than 1/2 IN deflection.
9. Provide minimum 12 IN wide approach ramp.
10. Inner end of trough to be 6 IN deep sloping to 20 IN deep at the tank wall.
11. Provide a 6 IN schedule 40 plain end scum line pipe connection.
12. Provide a flush valve assembly for automatic flushing of scum box and scum pipe.
13. Flush valve system to consist of a pivoting assembly to lift a ball or flap plate to open the flush valve.
    a. After the flush cycle, a counterweight will return the valve assembly to its closed position.
14. Fasten neoprene blade to the arm with stainless steel fasteners and stainless steel back-up bar.

2.6 SOURCE QUALITY CONTROL

A. Assemble the complete drive in the manufacturer's shop and test to assure the drive is running properly and to calibrate the drive control.
   1. Send a completed test report to the Engineer verifying the drive meets the quality assurance of manufacturer and engineer.

B. Provide evidence of compliance with requirements for the following:
   1. Referenced standards.
   2. Welder certifications.
   3. List of similar scope and size projects.
   4. Provide evidence of compliance with PART 2 requirements for the following:
   5. Structural members and connections are designed so that unit stresses do not exceed the specified percent of AISC allowable stresses.
   6. Compression and tension member slenderness ratios do not exceed the specified ratios.

C. Provide evidence in the form of field test that the suction header design used by the manufacturer is capable of uniform sludge withdrawal from the entire tank bottom (based on floor area swept).

2.7 MAINTENANCE MATERIALS

A. Two sets shaft seals for drive unit.

B. One skimmer wiper for each skimmer arm.

C. Two sight glasses.

D. Six shear pins.

E. Two sets of manifold seals for the suction headers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install clarifier equipment according to manufacturer's recommendations.

B. Install as required by the weirs and baffles manufacturer and in accordance with the contract documents.

C. Where weir plates or scum baffle plates are non-standard length or non-standard mounting hole configuration, such machined or cut edges shall be resin sealed with manufacturer's seal mix.

D. Weirs and baffles shall be carefully aligned and leveled to the elevations shown on the Drawings. In the completed installation, no variation greater than 1/8 in shall exist between any two notches of the weir plate in any one tank. In addition, the average deviation from one quadrant of the weir to any other shall not exceed 1/16 IN. Weir elevation shall be verified once the tank is filled. Caulking compound shall be used to completely prevent flow of liquid up between the concrete weir and the weir plate.

E. For identification and tagging, comply with Section 10400.

3.2 PAINTING

A. Manufacturer shall prime paint the equipment in accordance with Section 09905.

B. Contractor to prepare (including field blasting) and paint clarifier mechanism in accordance with Section 09905.

C. The drive mechanism shall be shipped with a factory applied finish paint system in accordance with Section 09905. Fabricated steel housings shall be painted inside and out to prevent flake corrosion of the internal housing.

D. In the event of damage, make all repairs and replacements necessary to the approval of the Engineer at no additional cost to the Owner.

E. All aluminum in contact with dissimilar materials shall be coated with Koppers Hi-Guard, two coats, 2.0 - 3.0 dry mils per coat or 3M #21, 10 mil thick insulating tape.

3.3 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Provide test equipment, tools and instruments necessary to accomplish equipment testing.
   4. Conduct initial startup of equipment, perform operational checks and supervise acceptance testing.
   5. Provide through Contractor a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
   6. Provide Personnel Training for the specified minimum number of 8 hours at jobsite per Section 01650 on operation and maintenance of furnished equipment.
   7. Provide the following:
      a. For equipment inspection: 4 HRS minimum, or as needed, for each clarifier and thickener.
      b. For equipment start-up and testing: 4 HRS minimum for each clarifier and thickener.

B. Torque Test:
   1. Load test the entire collector mechanism by anchoring collector arms individually, one at a time.
      a. In successive tests, demonstrate the sludge collection mechanism's (including drive unit, cage, gears and structures) capability to withstand not less than 130 percent of the specified rated running torque.
   2. Field torque test the clarifier and thickener mechanisms under the supervision of the equipment manufacturer's representative before the mechanisms are approved and placed into operation.
   3. The 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 and the Engineer.
      a. Apply a torque load to the scraper arm by means of a ratchet lever and cylinder connected to the cable assembly.
   4. Measure the magnitude of the applied load by calculating the torque from the distance of the line of action of each cable to the centerline of the mechanism.
      a. Readings shall be taken at 100 percent and 120 percent of the AGMA rated torque.

b. The test load shall be applied and noted on the torque overload device.

5. The manufacturer's service representative shall certify that the alarm and motor cut-out torque of the drives as calibrated in the manufacturer's shop are in proper operation to shut down the units as specified.

C. Operation Test:

1. Fill clarifier to its operating level with clean water and operate mechanism continuously for a period of not less than 48 HRS.
   a. At no time during the operating tests shall the equipment exceed 100 percent the design running torque or exhibit indications of binding or uneven operation.
   b. Record torque values as registered on the drive mechanism torque indicator and motor amperage (all three (3) phases) at 3 HR intervals.
2. After successful completion of the fully submerged operating test, operate the mechanism with no more than 1.5 FT of water in the tank for a period of not less than 6 HRS.
   a. Record data as described above.
3. If the mechanism exceeds rated torque or, in the opinion of the Owner, the mechanism exhibits indications of binding or improper adjustment, then:
   a. Contractor shall immediately halt the tests and remedy the problem.
   b. Repeat the tests after completion of necessary repairs or adjustments.
   c. Failure to successfully complete the test in three (3) attempts is sufficient cause for rejection.

END OF SECTION

SECTION 11125
SLUDGE COLLECTION: CIRCULAR SUCTION-TYPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Design, fabrication, and installation and testing requirements for:
      a. Secondary clarifiers circular suction type sludge collection.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ASD 1, Aluminum Standards and Data.
   2. American Bearing Manufacturers Association (ABMA):
      a. ABMA 9, Load Ratings and Fatigue Life for Ball Bearings.
   3. American Gear Manufacturers Association (AGMA):
      a. 2001-D, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
      b. 6034-B, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
   4. American Institute of Steel Construction (AISC):
      a. 325, Manual of Steel Construction.
   5. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A48, Standard Specification for Gray Iron Castings.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A536, Standard Specification for Ductile Iron Castings.
      e. E18, Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials.
   6. American Welding Society (AWS):
      a. D1.1, Structural Welding Code – Steel.
   7. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   8. Occupational Safety and Health Administration (OSHA).
   9. Society of Automotive Engineers (SAE):
      a. AMS 6440M, Steel. Bars, Forgings, and Tubing 1.45Cr (0.98 1.10C) (SAE 52100) For Bearing Applications.

B. Qualifications:
   1. Comply with AWS D1.1 procedures and practices.
   2. Manufacturer experience:
      a. Minimum five (5) similar clarifier mechanism installations with diameters greater than or equal to 90 percent of the diameter of this specified clarifier.
      b. Supplied similar equipment for the past 10 years.
      c. The mechanism shall be a standard production product of the manufacturer.

C. Independent Design Evaluation of Drive:
   1. Clarifier manufacturer to submit the following information for the proposed drive unit to an independent AGMA member engineer for design evaluation:
      a. Complete drive assembly fabrication drawings.
      b. Drive component drawings and/or brochures for all drive components.
      c. Manufacturer and model of all drive components.
      d. Gear and pinion interval specifications, including all heat-treating procedures.

e. AGMA calculations for drive components.
f. Additional information needed to completely evaluate proposed drive assembly.

1.3 SYSTEM DESCRIPTION

A. Provide single source coordination responsibility through the manufacturer for the complete sludge collection system.

1.4 SUBMITTALS

A. Submit the following with the Proposal:
1. Proposal data sheets.
2. Clarifier mechanism drawings for column support, sludge withdrawal and scum collection.
3. Sufficient data to verify compliance with specifications and to illustrate construction or assembly of the product.

B. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer, model and type.
c. Complete erection, installation, operation and maintenance information provided by the manufacturer.
d. Complete construction details, materials of construction, drawings of mechanisms, gears, gear reducers, bridge, electrical wiring diagrams, control wiring diagrams, scum box and scum baffle supports, and other pertinent information.
e. Catalog cutsheets for purchase subcomponents.
f. Submit evidence of compliance with Article 2.7 requirements, including:
1) Reference standards.
2) Independent evaluation of drive.
3) Structural design requirements.
g. Main drive speed.
h. Size, make, and type of electric motor and drive system.
i. AGMA rated alarm, stall, and ultimate torque capabilities.
j. Details of any revision necessary to adapt the piping, structural, electrical and instrumentation design to the equipment proposed.
k. Manufacturer, model and certification of compliance to ABMA 9 bearing life.
l. Certification report from AGMA engineer confirming that equipment design meets referenced AGMA standards.
m. Statement signed by a California registered professional Structural Engineer that all members have been designed to support the loadings as specified.
n. For-information-only calculations as follows:
1) Center column and bridge support calculations.
2) Scum box support calculations.
3) Calculations showing withdrawal rates and head losses in the suction header.
4) Calculations showing equal withdrawal rates through the openings and head losses of the sludge withdrawal ring, if required by manufacturer.
o. Calculations and details must bear the stamp of a California registered professional Structural Engineer.

C. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.
2. Certified as-built drawings (general arrangement and general arrangement details).
3. Erection drawings.

4. Complete bill of materials for the equipment, including the weights of all structural steel components.
5. Installation and maintenance instructions for the specific equipment including:
   a. Erection sequence.
   b. Maintenance and trouble-shooting check points.
   c. Complete lubrication procedures with recommended grades of lubricants.
6. Cut sheets for all equipment items purchased from sub-vendors.
7. Clarifier manufacturer’s recommended spare parts, specifically denoting:
   a. Wear items.
   b. Long-delivery items.
   c. All items convenient for stock as optional replacement items.

D. Informational Submittals:
   1. Manufacturer's certification regarding installation and start-up.
   2. Submit copy of field-torque test results to Engineer.
   3. Submit copy of report verifying completion of start-up and related field services.
   4. NACE certification of surface preparation and paint application at factory.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

B. Factory Assembly:
   1. Assemble each mechanism in factory to ensure proper fit of parts.
   2. Mark parts with erection marks.
   3. Disassemble mechanisms including motors and drives into largest sections allowed by carrier regulations for shipment of all four clarifiers to the site for storage.

1.6 PROJECT CONDITIONS

A. Equipment suitable for installation in mixed liquor from an activated sludge process.

B. Wastewater temperature: 60 to 85 DegF.

C. Ambient temperature: 40 to 90 DegF.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ovivo.
   2. Westech.
   3. Evoqua.
   4. Or approved equal.

2.2 MATERIALS

A. General:
   1. Structural members and connections:
      a. Unit stresses not to exceed 130 percent of AISC allowable stresses when subjected to cutout torque and/or field test torque, whichever is higher.
   2. Compression members:
      a. Slenderness ratio not to exceed 120 for any axis parallel to bending action.
   3. Tension members:
      a. Slenderness ratio not to exceed 240 for any axis parallel to bending action.
   4. Stainless steel:
      a. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.

B. Bridge: Type 316 Stainless Steel.

C. Center Pier: Type 316 Stainless Steel.
   1. Sludge return manifold: Type 316 stainless steel.

D. Plate: Type 316 Stainless Steel, ASTM A666.

E. Structural Shapes: Type 316 Stainless Steel, ASTM A276.

F. Tube: Type 316 Stainless Steel, ASTM A269.

G. Main Spur Gear:
   1. Ductile iron: ASTM A536, 100-70-83 or 80-60-03.
   2. Cast iron: ASTM A48, Class 60 or 50A.

H. Main Bearings: SAE AMS 6440M, Rockwell C64, ASTM E18.

I. Worm Shaft (if used):
   1. Ductile iron: ASTM A536, 80-55-06.
   2. Cast alloy bronze, AISI 4140/42H.

J. Pinion and Pinion Shaft:
   1. Ductile iron: ASTM A536, 80-55-06.
   2. Alloy steel AISI 4150.

K. Gear Housing:
   1. Gray iron, ASTM A48.

L. Shear Pins: 2017-T4, AA ASD 1, aluminum screw machine stock.

M. Shear Pin Holes: Hardened steel, Rockwell "C" 62-64, ASTM E18.

N. Turntable Base:
   1. Gray iron, ASTM A48.

O. Liner Strips: Steel, Rockwell "C" 38-42, ASTM E18.

P. Plow Squeegees: 316 stainless steel, ASTM A666.

Q. Drive Dust Shield: Steel, ASTM A36.

R. Drive Seal: Felt or neoprene.

S. Lip Seals: Neoprene.

T. Submerged Fastening Hardware including Anchor Bolts: 316 stainless steel, ASTM F593.

U. Center Cage, Truss, Manifold: Type 316 Stainless Steel, ASTM A276.

V. Scum Skimmer Blade: 316 stainless steel, 16 GA, ASTM A666.

W. Scum Skimmer Wiper: Neoprene.

X. Wear Strips: Polyurethane.

Y. Scum Drop Box: 316 stainless steel, ASTM A666.

Z. Bolts, Nuts and Anchor Bolts: Stainless steel, Type 316, ASTM F593.

AA. Scum Box and Scum Baffle Supports: Type 316 stainless steel.

BB. Sludge Collection Manifold: Type 316 stainless steel.

2.3 EQUIPMENT

A. Clarifier Performance Requirements:
   1. Clarifier service category and tag number:
   2. Tank dimensions: 65 FT - 0 IN DIA.
   3. Side water depth: 18 FT - 0 IN.

4. Minimum freeboard at maximum flow = 1.5 FT.
5. Influent column inside diameter: 3 FT.
   a. Outlets: 4 at minimum 16 IN wide by minimum 18 IN water depth and minimum 28 IN overall depth.
6. AGMA 20 year continuous rated running torque applied at output of drive unit: 16,000 FT-LBS minimum.
7. Stall or motor cut-out torque: 2 times continuous torque.
8. AGMA yield torque applied at output of drive unit: 2 times continuous torque.
9. Minimum turntable ball race diameter: 30 IN.
10. Minimum internal spur gear pitch diameter: 26 IN.
11. Minimum drive motor horsepower: 3/4 HP, 230/460 volt, 3 phase, 60 Hertz, TEFC, premium efficiency, 1.15 SF.
12. Maximum drive motor speed: 1,800 rpm.
13. Drive output speed: Maximum 0.04 rpm (maximum 12 fpm tip speed).
14. Drive pinion: Single.
15. Minimum spur gear face width: 2.5 IN.
16. Flocculating feed well:
    a. Size: 22 FT DIA.
    b. Depth below water surface: to be coordinated with flocculation baffles fabricator - minimum of 6 FT (see Section 11150).
    c. Thickness: Minimum 3/16 IN.
17. Influent head loss at maximum flow: 3 IN.
18. Thickness of all submerged stainless steel members: 1/4 IN minimum.

B. Structural Design:
1. Maximum ratio of unbraced length to least radius of gyration (slenderness ratio):
   a. Compression members: 120.
   b. Tension members: 240 (for angle about the Z-Z axis).
2. Maximum unit stress: 1.333 times AISC allowable stresses at all structural members when subject to twice the drive torque.

C. Process Parameters:
1. The following data to be used to calculate clarifier components (per clarifier):

	AVERAGE DRY WEATHER	PEAK WET WEATHER
Influent flow (w/o RAS), mgd	1.2	6.0
RAS flow, mgd	0.6	4.0
Influent + RAS flow, mgd	1.8	12.0
MLSS, mg/L	1500 - 3500	1500 – 3500

2.4 COMPONENTS

A. Overload Monitoring and Protection System:
1. Furnish an electrical-mechanical overload sensing system for each clarifier drive mechanism, including:
   1) Factory calibrated torque switches, rated 5 amps at 120 Vac minimum.
   b. Field adjustable over the full torque range of the unit.
   c. Alarm switch set at 100 percent of AGMA rated drive torque capacity in case of an impending overload.
   d. Second alarm switch set at 120 percent of AGMA rated drive torque capacity to shut down drive motor.
   e. Amperage and current sensing devices shall not be acceptable for the overload sensing system.
2. Mechanism loading indicator:
   a. Separate device, suitable for outdoor mounting.

b. Mechanism loading indicated on a 0-130 percent graduated scale at all times during operation.
c. Oriented so that torque may be read from access bridge side.

B. Shear Pin (if used):
1. Shear pin device: Set for 140 percent of AGMA rated torque.
2. Provide straight, non-tapered shear pins with bushings.
3. Shear Pin Monitoring System:
a. Provide shear pin monitoring system to detect shear pin failure.
b. Shear pin failure sensor shall be mounted on clarifier drive to sense shear pin failure and shall be weatherproof with required cables to connect to monitoring panel depending on panel location.

2.5 FABRICATION

A. See Section 11005.

B. General:
1. Welds on submerged or partially submerged components shall be continuous.
2. Dull sharp corners of cut or sheared edges by at least two (2) passes of a power grinder.

C. Center Pier:
1. Fabricate center pier of cylindrical stainless steel with a minimum 42 IN DIA by minimum 3/8 IN wall thickness.
2. Provide flanged base for anchor bolting to concrete base of clarifier as shown on Drawings.
a. Provide water tight connection seal.
b. Minimum of twelve (8) anchor bolts of at least 1 IN DIA.
3. Provide a flanged top and stiffeners for supporting the sludge collection mechanism, the drive mechanism, drive-mounting plate, access platform, and the access bridge.
4. Provide a drive mechanism mounting plate set plumb with the centerline of the center pier.
5. Provide center pier which serves as an influent pipe and has a minimum of 4 equally-spaced ports at the upper end to direct the flow into the EDI at a velocity less than 1 fps.
6. Provide easily accessible and removable plate near the bottom of the center pier for draining center pier.
a. Opening shall be large enough to insert a submersible pump to dewater the clarifier influent pipe.
b. Removable plate shall provide a clear square opening not less than 18 IN by 18 IN.
c. The opening shall be reinforced as needed to handle the imposed loads on the center pier.
7. Provide sludge return manifold to mount to existing 16 IN sludge pipe, mounted inside of center pier as shown on Drawings.
a. Minimum 3 sludge return branches extended to edge of pier. Sized per manufacturer.

D. Flocculating Feedwell:
1. Fabricate from 3/16 IN minimum stainless steel plates.
2. The feedwell shall be located outside the influent pipe to diffuse the liquid into the tank without disturbance or formation of velocity currents.
3. Support the feedwell from drive cage above water level.
a. Locate feedwell structural members on the outside of the feedwell to provide smooth interior.
4. Feedwell shall project 6 IN above water surface minimum.
5. Flocculation baffles will be supported from the flocculation well (see section 11150)
6. Provide baffled openings in well at liquid level to allow release of scum in a tangential direction.
a. Minimum 6 openings.

E. Center Drive Cage:
1. All-welded stainless steel box truss construction: 4 FT by 4 FT minimum.

2. Drive cage shall transmit and/or carry all torques (including stall torque) without over stressing members.
    a. Do not transmit any torque to the access bridge.
3. Design drive cage to encompass center column.
    a. Design cage to withstand 200 percent of design torque.
4. Design adjustable connection between drive unit and drive cage to provide for proper alignment and allowance for structural tolerance.
5. Design to support and rotate suction header under maximum load with 1.5 safety factor.

F. Suction Header:
1. Provide rectangular-shaped, full tapered (two (2) directions) section varying in size from a maximum near the tank center to a minimum at the outer end.
2. Provide one (1) header per clarifier, extending from the center manifold to the tank periphery.
3. Provide a flanged end for bolting to the center outlet manifold.
4. Orient header to direct the sludge into the influence of the orifices.
5. Attach a neoprene squeegee with a stainless steel backing plate to the underside of the header.
    a. Provide slotted holes for a minimum 1 IN vertical adjustment of the squeegee.
6. Near the center manifold, provide the header with a 1/4 IN steel plate with neoprene blade to direct sludge from center area to the first orifice or provide first orifice minimum of 6 IN from center manifold.
7. Provide inlet orifices at regular intervals along header.
    a. Do not exceed 30 IN spacing along the header.
    b. Vary the orifice sizes to assure hydraulic balance in the tank and uniform sludge withdrawal from the entire tank bottom at all flows specified.
8. Sludge withdrawal by means of individual riser pipes is not acceptable.

G. Suction Header Support Arms:
1. Provide connections between the truss and header of 1/4 IN steel plate.
2. Fabricate truss arm capable of supporting the header and a surface scum skimming blade.

H. Suction Header Manifold:
1. Provide center manifold constructed of 1/4 IN minimum thickness stainless steel and fitted with two (2) sealing rings.
2. Provide manifold bottom plate securely anchored to the concrete floor and grouted in place after proper alignment.
3. Provide manifold seals:
    a. Secure in place using a minimum of two (2) stainless steel bands.
    b. Each stainless steel band shall have a minimum of two (2) screw clamps to allow for proper tightening of bands.

I. Scum Removal System:
1. Scum skimmers assembly:
    a. Include skimmers, wiper assembly, beaching assembly, and scum trough and discharge piping.
    b. Provide one (1) rotating scum skimmer arm per basin.
    c. Mount skimmers tangentially to influent well and support entire weight on sludge collector truss.
    d. Do not support the skimmer on the scum baffle.
    e. Design skimmer to collect and move scum the full distance between the flocculating center well and scum baffle.
    f. Provide wiper assembly with neoprene wiping edge attached to hinged steel blade, designed to sweep scum up beaching plate and into scum trough.
    g. Ramp crest of scum trough to be at same elevation as top of scum baffles.
    h. Support wiper assembly at its outer end while traveling across scum trough.
2. Scum box:

a. Size: 3 FT long by 6 FT wide.
b. Support from tank wall.
c. Connect to scum withdrawal pipe.
d. Assembly shall include:
   1) Scum trough.
   2) Vertical stainless steel sides.
   3) Sloping ramp.
   4) Supports and bracing.
e. Provide flexible connector for connection to scum withdrawal pipe.
f. Scum withdrawal piping as shown on Drawings.

J. Drive Mechanism:
1. Provide drive mechanism, completely factory assembled, consisting of a primary gear reduction unit, an intermediate reduction unit, plus a final reduction unit consisting of a pinion and internal gear enclosed in a turntable base.
2. Enclose all gearing in a cast iron ASTM A48, Class 40A housing.
   a. Exposed gearing is not acceptable.
3. Provide all oil lubricated bearings of anti-friction type.
4. Provide totally enclosed motor of ample power for starting and continuously operating the mechanism without overloading.
   a. The motor shall conform to NEMA standards and be 230/460 V, 3 PH, 60 Hz.
   b. Motor shall be a minimum of 3/4 HP.
   c. Motor shall comply with NEMA MG 1, Design B and shall be totally enclosed with Class B insulation designed for continuous duty outdoor service.
5. Primary reduction unit:
   a. Provide a primary reduction unit which drives the intermediate reduction unit through a chain and sprocket arrangement.
   b. Furnish drive chain of #80L self-lubricated roller chain and OSHA approved removable chain guard of molded polyethylene.
   c. Provide an adjustable steel base mounted on the intermediate reduction unit for chain tension adjustments.
6. Intermediate reduction unit:
   a. Provide an intermediate reduction unit consisting of a cast iron housed worm gear speed reducer, with oil lubricated, anti-friction type bearings and service factor of 2.0.
   b. Mount the unit on a machined face on the top of the final reduction unit and properly aligned to maintain accurate centers for the final reduction gearing.
   c. Worm assembly: Worm and shaft of heat treated alloy and integral construction and the worm gear of cast manganese bronze or aluminum bronze.
7. Fabricate drive components in accordance with AGMA 2001-D and AGMA 6034-B for 24 HRS continuous duty and 20 year design life based on rated AGMA torque.
   a. Design bearings for a L_{10} life of 200,000 HRS.
8. Final reduction unit:
   a. Provide internal gear drive by a heat-treated pinion from the slow speed shaft of the primary gear reducer.
      1) Construct the main pinion of heat treated alloy steel, machined after heat treatment.
      2) Support pinion at both top and bottom by a taper roller bearing assembly.
      3) Use one-piece pinion shaft construction without an intermediate coupling.
   b. Provide ductile iron internal gear of AGMA quality 7 minimum.
   c. Provide internal gear design to support center cage, collector and all other rotating components.
9. Turntable base:
   a. Provide turntable base with annular raceway to contain balls on which the internal gear rotates.
   b. Furnish ball race without guide shoes and steady bearings.
   c. Furnish ball bearings of alloy steel, bearing vertically and horizontally on four (4) removable liner strips pressed into annular raceways in turntable base and internal gear.

1) Liner strips shall be minimum 3/8 IN thickness.

d. Protect internal gear, pinion and ball race by a seal and dust shield.

e. Internal gear, pinion and ball race is to run in oil.

f. Furnish turntable base bolted to the center column and designed to support the internal gear with rotating mechanism, access platform, and one (1) end of the access bridge.

g. Provide a pipe attached to bottom of turntable base for condensate removal.

h. Furnish plugged or capped oil piping which terminates within the center of the base.

1) Provide oil level sight glass and oil drain.

i. Furnish condensate drain at a low point of base to drain off condensate and any contaminates.

j. Provide a turntable assembly designed so that the internal gear, balls and strip liners may be removed without raising the access bridge.

k. Underwater bearings carrying any part of the load are not acceptable.

K. Access Platforms:

1. Minimum 8 FT by 8 FT.

a. 3 FT minimum clearance around drive unit assembly for maintenance and service, and access from walkway.

2. Fabricate for uniform live load of 100 LBS per SQ FT.

3. Construct of 1-1/2 IN deep serrated aluminum grating attached to minimum 1/4 IN structural stainless steel frame, with any necessary stiffeners and supports.

4. Include lift-out sections where required for routine maintenance of equipment.

5. Provide walkway, access platform and handrail in full compliance of federal, state, and local safety standards.

L. Walkways:

1. Provide stainless steel beam-type or pont truss type access bridge setting on operating platform to support walkway and tipping scum trough.

a. Provide 3 FT wide walkways covered of 1-1/2 IN deep serrated aluminum grating.

2. Provide at locations and orientation shown on Drawings.

3. Walkway fabrication:

a. Fabricate walkway with uniform live load of 150 LBS per lineal foot with a maximum deflection of 1/360 of the span.

b. Walkway shall be braced against lateral movement using wind load of 30 LBS/SQ FT.

4. Provide handrail and toe plate on each side of walkway and around access platform.

a. Fabricate handrail of triple rail, 1-1/2 IN DIA Schedule 40 aluminum, 42 IN height.

b. Fabricate toe plate of 3/16 IN thick by 4 IN high aluminum.

c. Extend walkway to the center of the clarifier.

5. Support stainless steel beams on steel or ultra high molecular weight (UHMW) slide plates at the tank wall.

M. Anchorage:

1. Provide ASTM A276 316 stainless steel anchor bolts complete with nuts and washers for equipment installation.

2. Bolts shall be 1 IN DIA minimum.

N. Fasteners:

1. All fasteners shall be Type 316 stainless steel.

2. Bolts shall be 1/2 IN DIA minimum.

O. Sludge Collection Manifold:

1. Constructed to rotate around the inlet column, and attached to truss.

2. Neoprene seals with 316 stainless steel clamps.

3. Size per manufacturer.

P. Shop or Factory Finishing:

1. Surface preparation and shop painting is required for all non-316 stainless ferrous metals, equipment and accessories per the following:

a. Prime coat:
   1) P1 = 1 coat, 3.5 mils, Series 90-97 Tneme-Zinc or equal (Zinc-Rich Urethane).
b. Finish coat(s):
   1) F1 = 1 coat, 6 mils, Series L69 Epoxoline or equal (Polyamidoamine Epoxy).
   2) F2 = 1 coat, 2.5 mils, Series 1080 Endura-Shield W.B. or equal (Waterborne Acrylic Polyurethane).

2. Apply a heavy application of a rust-resistant coating to gears, bearing surfaces, and other unpainted surfaces.
   a. Maintain coating during storage and until the equipment is placed into operation.
3. All aluminum in contact with dissimilar materials shall be coated with Koppers Hi-guard, two (2) coats, 2.0-3.0 dry mils per coat.

2.6 SOURCE QUALITY CONTROL

A. Provide evidence of compliance with PART 1 requirements for the following:
   1. Referenced standards.
   2. Independent design evaluation of drive.

B. Provide evidence of compliance with PART 2 requirements, signed by a Registered Professional Structural Engineer, for the following:
   1. Structural members and connections are designed so that unit stresses do not exceed 130 percent of AISC allowable stresses.
   2. Compression and tension member slenderness ratios do not exceed 120 and 240, respectively.
   3. Statement that all members have been designed to support the loadings as specified.
   4. Center column and bridge support calculations.

2.7 SPARE PARTS

A. For each drive furnished, provide:
   1. One (1) set of all bearings and bearing seal rings for drive unit.
   2. Two (2) sets of all gaskets.
   3. Two (2) sets of spur gear felt seals and replaceable bearing races.
   4. Additional sprockets and chain links for tip speeds of 5, 10 and 15 fpm (if used).
   5. Two sets neoprene lip seals.
   6. Two (2) sets scum box seals for pipe trough connection.
   7. One (1) set of all bearings for skimmer system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install clarifier equipment according to manufacturer's recommendations.
   1. Manufacturer's service technician shall observe and direct equipment installation.
   2. Manufacturer's service technician shall certify that mechanism has been installed in accordance with manufacturer's recommendations.

B. Grout:
   1. Utilize clarifier mechanism to install a 2 IN finished grout floor in the tank floor.
      a. Use temporary screeds attached to the collector arms and the mechanism.
      b. Guide with mechanism under power from drive unit.
      c. See Section 03308 for additional grout installation requirements (similar to concrete).

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.

4. Conduct initial startup of equipment, perform operational checks, and supervise acceptance testing.
5. Provide through Contractor a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
6. Instruct Owner's personnel as specified in Section 01650 at jobsite on operation and maintenance of furnished equipment.
7. Provide the following:
    a. For equipment inspections: 8 HRS minimum, or as needed, for each clarifier.
    b. For equipment startup and testing: 24 HRS minimum for each clarifier.

B. Torque Test:
1. Load test the entire collector mechanism by anchoring collector arms individually, one (1) at a time.
    a. In successive tests, demonstrate the sludge collection mechanism's (including drive unit, cage, gears and structures) capability to withstand not less than 130 percent of the specified rated running torque.
2. Field torque test the clarifier mechanism under the supervision of the equipment manufacturer's representative before the mechanisms are approved and placed into operation.
3. The 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 and the Engineer.
    a. Apply a torque load to the scraper arm by means of a ratchet lever and cylinder connected to the cable assembly.
4. Measure the magnitude of the applied load by calculating the torque from the distance of the line of action of each cable to the center line of the mechanism.
    a. Readings shall be taken at 100 percent and 120 percent of the AGMA rated torque.
    b. The test load shall be applied and noted on the torque overload device.
5. The manufacturer's service representative shall certify that the alarm and motor cut-out torque of the drives as calibrated in the manufacturer's shop are in proper operation to shut down the units as specified.

C. Operation Test:
1. Fill clarifier with water to its operating level and operate mechanism continuously at its maximum speed for a period of not less than 48 HRS.
    a. At no time during the operating tests shall the equipment exceed the rated torque or exhibit indications of binding or uneven operation.
    b. Record torque values as registered on the drive mechanism torque indicator and motor amperage (all three (3) phases) at 3 HRS intervals.
2. After successful completion of the fully submerged operating test, operate the mechanism at full speed with no more than 1.5 FT of water at the sidewall in the tank for a period of not less than 6 HRS.
    a. Record data as described above.
3. If the mechanism exceeds rated torque or the mechanism exhibits indications of binding or improper adjustment:
    a. Contractor shall immediately halt the tests and remedy the problem.
    b. Repeat the tests after completion of necessary repairs or adjustments.
    c. Failure to successfully complete the test in three (3) attempts is sufficient cause for rejection.
    d. Failure to complete the testing program as outlined in the preceding paragraphs is sufficient cause for the Owner to require that the equipment be removed from the Project.

D. Mechanism Speed Setting:
   1. After completion of the specified field tests, fit the drive mechanism with a sprocket set which shall provide the rake arms with a tip speed of 15 fpm.

END OF SECTION

SECTION 11142
ROTARY DRUM THICKENING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rotary drum thickeners (61RDT001, 61RDT010) and flocculation tank with agitator (61MX002, 61MX012).

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. ASTM International (ASTM):
      a. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   3. American Welding Society (AWS).

B. Qualifications:
   1. Utilize only AWS certified welders.

C. Single Source Responsibility:
   1. All equipment described in this Specification shall be supplied by the manufacturer.
   2. The manufacturer shall be fully responsible for the design of the equipment and integration of all system components to meet all design and performance requirements specified herein.
   3. Coordinate placement of manually operated equipment and appurtenances to locations easily accessible to operator following installation of all systems and equipment included in this Contract.
      a. Manually operated equipment and appurtenances include but are not limited to valves, reservoirs, grease fittings and other lubricating devices, handwheels for wash tube assemblies, and electrical control devices.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Utility utilization rates and pressures.
      a. Plant water: required flow, pressure, and source.
      b. Plant power: required amperage of 480 VAC, 3 phase, 3 wire, single feeder.
   3. Provide complete manufacturer's installation instructions, construction details, materials of construction, electrical diagrams, and motor and drive details.
   4. Provide complete layout drawings showing locations of ancillary equipment, foundation requirements and supporting calculations, utility connections, location of thickener relative to equipment pad and discharge end enclosure.
   5. Certification of bearing life.
   6. Drum specifications including type and mesh size or opening size.
   7. Documentation necessary to verify that thickening unit complies with specified construction.
   8. Performance test protocol.
   9. Motor typical test report.
   10. Motor nameplate data.
   11. Control/power panel schematic drawings including field terminations.

B. Operation and Maintenance Manuals:
   1. See Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Miscellaneous Submittals:
   1. Manufacturer's certification of installation and start-up.
   2. Performance test report:
      a. Performance test report shall have at minimum the following:
         1) Summary of testing details.
         2) Testing results.
         3) Comparison of test results to minimum performance requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

1.5 PROJECT/SITE CONDITIONS

A. The rotary drum thickening equipment and supporting equipment shall be capable of gravity thickened primary and waste activated sludge.

B. Feed Sludge Characteristics:
   1. Sludge description: Primary sludge and waste activated sludge are co-thickened in a gravity sludge thickener. The co-thickened sludge is withdrawn from the bottom hopper of the gravity thickener and pumped to the rotary drum thickeners.
   2. Solids content: 0.7 to 1.5 percent.
   3. Volatile solids content: 65 to 80 percent.
   4. Temperature: 55 to 70 DegF.
   5. pH: neutral.

C. Washwater Supply:
   1. Source: Strained, 100 micron, 3W plant utility water.
   2. Pressure: 40 psi.
   3. Quantity: 25 gpm, maximum.

1.6 WARRANTY

A. Equipment Warranty
   1. Manufacturer to warrant the equipment specified herein to be free of defects in workmanship and materials for a period of:
      a. Twelve (12) months from date that equipment is put into full-scale operation or eighteen (18) months from delivery, whichever comes first. Specified test periods are not included for determining start date.
      b. Manufacturer to provide written guarantee to replace defective workmanship and/or materials as defined per the “Warranty” sub-section.
   2. Manufacturer to replace any parts that fail due to defects in workmanship and material and shall deliver the parts to the project site at no cost to the Owner.
      a. Manufacturer or manufacturer’s trained representative to be on site within 48 hours of receiving written notice (via fax or e-mail) of equipment failure.
      b. Manufacturer or Manufacturer’s trained representative to perform diagnostic work.
      c. Manufacturer or Manufacturer’s trained representative to order required replacement part(s) immediately.
      d. Replace defective parts within 30 calendar days, after written notification.

1.7 PERFORMANCE WARRANTY

A. The manufacturer shall guarantee the performance of the thickening system supplied based on minimum performance requirements described in this Specification.

B. If the thickener does not meet the minimum performance requirements described in this Specification, the manufacturer, at his expense, shall make modifications to the equipment until requirements are met.

C. A retainage equal to 20 percent of the equipment cost will be withheld by the Owner until after the performance testing.
   1. If the thickener meets the minimum performance requirements, the Owner will then pay the amount retained on the next partial payment request after successful performance testing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rotary drum thickener:
      a. Fokoku Koyogo Company, Ltd.
      b. Parkson Corporation, Hycor ThickTech.
      c. IPEC.
      d. Or approved equal.

2.2 MATERIALS

A. Rotary Drum Thickener:
   1. Drive shafts (if provided): Polyethylene coated carbon steel.
   2. Drums: 316 stainless steel.
   3. All other: 304 stainless steel.

B. Flocculation Tank with Variable Speed Agitator:
   1. Wetted parts: 316 stainless steel.

C. Frame: 304 stainless steel.

D. Control Panel: NEMA 4X.

2.3 EQUIPMENT

A. Rotary Drum Thickener:
   1. Number of Units: Two (2).
   2. Minimum Performance Requirements:
      a. Maximum hydraulic capacity: 150 gpm.
      b. Inlet consistency: 0.7 to 1.5 percent total solids.
      c. Outlet consistency: 6 percent total solids, minimum.
      d. Polymer usage rate: Less than 14 lb/dry ton.
      e. Minimum solids capture rate: 93 percent.
   3. Motor:
      a. 3 HP (minimum), TEFC, 1800 rpm, 480 VAC, 3 Phase, 60 Hertz, 1.15 service factor.
      b. Inverter duty and premium efficiency.
   4. Drive:
      a. Drive shall be mechanical gear reducer with drive chain or gear reducer with gear drive.
      b. Drive speed shall be controlled with VFD.
      c. Design bearing life based upon actual operating load conditions imposed by driven equipment.
      d. Permanently lubricated sealed bearings conforming to ABMA standards.

B. Flocculation Tank with Variable Speed Agitator:
   1. Number of Units: Two (2).
   2. Minimum Performance Requirements:
      a. Hydraulic retention time: 3 to 5 minutes under average conditions.

b. The inlet of the tank shall be located at the bottom of the tank and conditioned sludge shall overflow from the discharge pipe located near the top of the tank.
c. The tank shall be an open top design to allow for visual inspection of floc.

3. Agitator motor:
   a. 1 HP minimum, TEFC, 1800 rpm, 480 VAC, 3 Phase, 60 Hertz, 1.15 service factor.
   b. Drive shall be gear motor with VFD based speed control.
   c. Design bearing life based upon actual operating load conditions imposed by driven equipment.
   d. Permanently lubricated sealed bearings conforming to ABMA standards.

2.4 ACCESSORIES

A. Provide one (1) set of all special tools required for maintenance and operation of flocculation tank, agitator and rotary drum thickener.

B. Discharge End Enclosure:
   1. 14 GA stainless steel.
   2. Designed to prevent splashing sludge at discharge end of the thickener.

C. Guards:
   1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
   2. Interior applications:
      a. Construct from 16 GA stainless steel rolled to conform to shaft or coupling surface.
      b. Roll to conform to shaft or coupling surface.
      c. Connect to equipment frame with stainless steel bolts and wing nuts.

D. Name and Data Plates:
   1. Attach a stainless steel name plate to the following pieces of equipment with the equipment designation as shown in 1.1 A. permanently stamped on plate:
      a. Rotary Drum Thickener.
      b. Flocculation Tank.
      c. Solenoid or motor controlled valve for washwater.
      d. Local Control/Power Panel.
      e. Washwater booster pump, if required.
   2. Attached a stainless steel data plate to each motor with the following information permanently stamped:
      a. Manufacturer's name.
      b. Equipment operating parameters.
      c. Serial number.
      d. Speed.

E. Lifting Eye Bolts or Lugs:
   1. Provide on all equipment 50 LBS or greater.

2.5 FABRICATION

A. Rotary Drum Thickener:
   1. Frame:
      a. Welded and/or bolted structural shapes.
      b. Construct to allow removal of drum from other elements without disassembly of frame.
      c. Provide appropriate lifting lugs to permit ready removal of pieces for maintenance or access.
   2. Drum:
      a. Shall be constructed of stainless steel perforated metal.
         1) Porosity or percent opening determined by manufacturer.
      b. Shafts shall be supported by bearings mounted outside the wet environment.
      c. Delivery of output solids shall be by gravity.
      d. Cylinder diameter: 24 IN minimum, 60 IN maximum.

e. Cylinder length: 96 IN minimum, 120 IN maximum.

3. Drum Washing System:
   a. Completely enclosed spray system.
   b. External spray header with spray nozzles.
   c. Provide electric or motor actuated valve for washwater header.
   d. Provide washwater booster pump, if required.
4. Washwater and Filtrate Collection Pan:
   a. Minimum 14 GA stainless steel.
   b. All filtrate and washwater shall be collected and discharged by gravity to common drain through 4 IN NPT pipe stub.
5. Washwater Deflection Panels:
   a. Minimum 16 GA stainless steel.
   b. Design to contain spray from washwater.
   c. Panels shall be designed for easy removal.

B. Flocculation Tank with Variable Speed Agitator:
1. 10 GA stainless steel minimum.
2. Provide 6 IN flanged inlet/drain and 6 IN flanged overflow.
3. Agitator motor:
   a. Flange mounted to flocculation tank.
4. Impeller:
   a. Composed of stainless steel shaft and double vertical flat blade (or manufacturers recommended blades).
   b. Nylon steady bearing centrally located in the bottom of the tank (if provided).
5. Structurally sound and self supporting under operating conditions.

2.6 CONTROLS

A. Local Control/Power Panel:
1. General:
   a. Design for single 480 volt, 3 phase feeder with front panel circuit breaker disconnect with one panel for each thickener.
   b. Provide isolated control section and 480 volt power section with control power transformer and power supplies for other voltages needed.
   c. Provide internal circuit breakers for each power use.
   d. Provide interior panel light(s) and convenience outlet.
   e. See requirements in Section 13448 for panel construction.
2. Panel specifications:
   a. Free standing, NEMA 4X stainless steel enclosure with front padlockable door(s), back pan for internal devices and internal hinged panel if needed.
3. Control section:
   a. Shall be manufacturer’s standard controls with front panel mounted operator interface and AB Micrologix PLC or equal.
   b. Provide all data to plant SCADA through an Ethernet I/P or TCP/IP link and link all VFD’s so VFD data can be obtained through this same data link.
   c. Control section to include:
      1) All needed power supplies.
      2) PLC.
      3) Relays, timers and appurtenances.
      4) Terminal blocks for external connections.
      5) All programming and configuration for PLC and operator interface.
      6) Register identification for use in SCADA configuration for access to data over the data link.
      7) CD copy of the PLC and HMI configuration and programming with annotated notes.
      8) UPS or battery backup and charger for at least 15 minutes operation of the controls.
      9) All other items needed for a complete thickener control system.

10) Front panel HOA switches for each drive.

4. Power section:
   a. Main breaker and front panel operating handle.
   b. Interior breakers for all loads.
   c. VFD's for all thickener drives, pumps, and mixers as applicable and VFD and controls for TWAS pump.
   d. Data links to PLC for each VFD.
   e. Marked terminals for external connections.
   f. All other items needed for a complete power section.
5. Control descriptions:
   a. When being fed by the Gravity Thickened Sludge (GTSL) Pumps, flow enters the flocculation tank and then flows by gravity to the Rotary Drum Thickener.
   b. The GTSL Pumps are positive displacement pumps operating on variable speed drives.
   c. The flow rate to the flocculation tank and thickener is controlled by the speed of GTSL pumps running.
   d. The thickened sludge pump shall operate at variable speed to match the sludge pumping rate to the sludge discharge of the thickener based on level in the thickened sludge pump feed hopper.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:
   1. Manufacturer shall provide at least 2 site visits, at different times, each site visit shall be at least five (5) eight-hour day, plus travel time, at the Project Site for performing the following Special Services:
      a. Installation Check.
      b. Startup.
      c. Manufacturer's Field Service Report.
      d. Manufacture's Training Service.

B. Performance Testing (PT):
   1. Upon manufacturer's request, the Owner will provide a representative 4 GAL sample of sludge to the manufacturer for initial polymer selection.
      a. Manufacturer shall recommend a polymer dose rate to Owner for best thickening performance.
   2. The PT shall be conducted by the manufacturer to show compliance with minimum performance requirements described in this Specification.
   3. The manufacturer shall notify the Owner a minimum of two (2) weeks in advance of PT.
   4. Field samples will be taken by the Owner under supervision of the manufacturer.
   5. The manufacturer's technical representative and Owner's personnel shall be present for the PT testing.
   6. Performance testing procedures:
      a. The thickener shall be operated for seven (7) hours, with one (1) hour for start-up and shut-down.
      b. The thickener shall be operated at normal sludge feed rates ranging from 0 gpm to 200 gpm for the duration of the PT.
      c. Sampling and testing:
         1) Samples will be taken on an hourly basis during the PT.
            a) Samples shall be collected within five (5) minutes of the end of each operating hour (seven (7) samples total).

b) Samples will be analyzed for the following parameters:

SAMPLE	ANALYSIS
Sludge Feed	Volatile Solids (VS)
	Total Solids (TS)
Filtrate	Total Suspended Solids (TSS)
Thickened Waste Activated Sludge	Total Solids (TS)

2) In addition to the above listed samples and analysis, the manufacturer shall track polymer usage throughout the PT.
   a) Polymer usage shall be expressed as pounds active polymer/ton dry solids.
   b) Hourly polymer usage rates shall be determined, based on hourly solids throughput and cumulative polymer usage for each hour.
   c) The average hourly polymer usage rates will be averaged over the entire PT run to determine the overall polymer usage for the PT.
   d) Active polymer concentrations shall be determined based on polymer manufacturer's product data (i.e. assumes 100 percent activation).
   e) Manufacturer shall also record flowrates of washwater, polymer solution, polymer dilution water, and feed sludge at times of sampling for solids analysis.
3) Solids capture shall be calculated using the following equation, based on the hourly samples taken as specified above:

   Percentage solids capture = [(C x (F-E))/((F x (C-E))] x 100 percent
   Where: C = Percent Solids (TS)
   E = Percent Filtrate Solids (TSS)
   F = Corrected Percent Feed Solids (TS)
   = [Percent Sludge Solids Concentration (percent TS) x Feed Sludge Flowrate (gpm)] / [Feed Sludge Flowrate (gpm) + Washwater Flowrate (gpm) + Polymer Solution Flowrate (gpm)]

   a) The solids capture rate shall be calculated on an hourly basis.
   b) The seven (7) hourly results shall then be averaged to determine the overall average solids capture rate during the PT.
4) All sample analyses shall be performed by the Owner.
5) All sample analyses shall be performed in accordance with applicable Standard Methods procedures.

d. After completion of the PT, the manufacturer shall prepare a written report containing the following minimum items:
   1) Summary of testing details.
   2) Testing results.
   3) Comparison of test results with minimum performance requirements.

7. The PT for the thickener shall be considered failed if the average thickened sludge solids concentration is less than the minimum required, OR if the overall average polymer usage rate is greater than the manufacturer recommended rate.
8. If the thickener system fails the PT, the manufacturer shall have a minimum of 5 calendar days to perform, at no expense to the Owner, supplemental testing, equipment adjustments, repairs, etc., and request a retest of the thickener.
   a. The manufacturer shall notify the Owner a minimum of three (3) working days prior to the retest.
9. The manufacturer shall have a maximum of two (2) trials to meet the minimum performance requirements described in this Specification.

10. If, in the opinion of the Engineer, the thickener system has met the performance requirements during the PT, the Engineer will notify the Owner that the thickener system installation and testing has been completed by the manufacturer and is ready for final acceptance.
11. If, in the opinion of the Engineer and Owner, the thickener system has failed to meet the performance requirements, the Engineer shall notify the Owner and manufacturer in writing of the unacceptable performance.

3.2 IDENTIFICATION OF EQUIPMENT

A. Identify equipment in accordance with Section 10400.

3.3 TRAINING

A. Provide two (2), 8-hr training sessions. Schedule with Owner on separate days.

END OF SECTION

SECTION 11150

SECONDARY CLARIFIER FLOCCULATION BAFFLES, WEIR PLATES AND SCUM BAFFLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Installation of flocculation baffles in the new secondary clarifiers.
   2. Flocculation baffles to be designed to improve the performance of the secondary clarifiers by:
      a. Eliminating density currents and flow entrainment from the settling zone of the clarifiers.
      b. Distributing the flow evenly across the full diameter of the clarifier.
      c. Creating a flocculation chamber at the center of the tank.
      d. Improving the flow patterns by providing good vertical flow distribution through deflection of incoming flow upward through its curved parts.
      e. Reducing the energy of incoming flow through its perforated surface and eliminating the need for an energy dissipating inlet.
   3. Installation of weir plates and scum baffles in the new secondary clarifiers.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D-256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
      b. D-570, Standard Test Method for Water Absorption of Plastics
      c. D-638, Standard Test Method for Tensile Properties of Plastics
      d. D-790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

1.3 SUBMITTALS

A. See Specification section 01340 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Detailed drawings showing equipment fabrication, dimensions, and method of attachment including number, locations and size of bolts.

C. Hydraulic Analysis Report:
   1. Hydraulic analysis confirming flocculation baffles design concept, its surface curvature and structural support system. It should also confirm size and locations of proposed openings and the pressure drop through them.
   2. The hydraulic analysis should determine hydrodynamic forces on the flocculation baffle system under the extreme flow conditions. If needed, desktop or finite element structural analysis should be performed to determine operating stresses on the panels. If operating stresses are found to be high, a physical laboratory “failure” test of one of the panels will be required to confirm structural integrity of the panels.

D. Manufacture’s recommended baffle dimensions and installation details.

E. Operation and Maintenance (O&M) Manuals:
   1. See Specification Section 01342 for requirements for the mechanics and administration of the submittal process:

a. Manuals should include capacity analysis of the clarifiers with and without any missing panels of the flocculation baffles. Analysis should clearly identify the optimal sludge return rate to avoid blanket scouring under normal and peak wet weather flows.

F. Manufacturer's Certificate of Compliance.

G. Shipping, storage, protection, and handling instructions.

H. Manufacturer's written/printed installation instructions.

I. One project reference (minimum) to show successful performance of the proposed flocculation baffles. .

J. Certified test reports of the physical and mechanical properties of the product.

K. Statement of coordination with secondary clarifier equipment.

1.4 WARRANTY

A. Manufacturer shall provide a 5-year product warranty for the flocculation baffles, weir plates and scum baffles to be free of defects in materials and workmanship.

B. The Installer shall provide a 5-year installation warranty for the baffles to be free of defects related to installation such as defects in the fasteners (panel to clarifiers) and clips (from panels to panel).

C. Both product and installation warranties will begin after installation (date of substantial completion).

1.5 COORDINATION

A. Manufacturer shall coordinate the flocculation baffle design and installation requirements with the clarifier equipment:
   1. Sludge Collectors (Secondary Clarifiers).
   2. Secondary Clarifier Flocculating Center Well.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Flocculation baffles, weir plates and scum baffles shall be the products of the following suppliers:
   1. Performance Composite, Inc.
      1418 South Alameda Street
      Compton, CA 90221
      Tel: 310-328-6661
      Fax: 310-782-3578
      Attn: Mr. Francis Hu
      Email: sales@performancecomposites.com
   2. Moonlight Molds Inc.
      14920 S. San Pedro Street
      Gardena, CA 90248
      Tel: 310-538-9142
      Attn: Mr. Mike Barlow
      Email: sales@moonlightmolds.com
   3. Bafco-Systems Inc.
      723 Casino Center Blvd.
      Las Vegas, NV 89101
      Phone: 1-888-611-4426
      Email: Sales@bafco-systems.com

2.2 FLOCCULATION BAFFLES

A. Flocculation baffles to be installed in the locations shown on the Drawings.

B. The flocculation baffles should be designed to deflect incoming flows and protect sludge blanket under a range of flows and loads:
   1. Average dry weather flow/clarifier = 1.2 mgd.
   2. Maximum month flow rate /clarifier = 1.8 mgd
   3. Maximum week flow rate / clarifier= 2.7 mgd
   4. Maximum day flow rate /clarifier = 3.4 mgd
   5. Peak hour flow rate / clarifier = 6.0 mgd
   6. Maximum RAS flow rate = 1.7 mgd
   7. Mixed liquor sludge concentration range = 1500 - 3400 mg/L

C. The flocculation baffle assemblies consist of a series of baffle panels supported by the Flocculation Center Well (FCW). Each panel is to be molded of corrosion-resistant, UV-treated FRP. If flocculation center well is stationary, baffles should be deigned with provisions to minimize tangential velocities underneath the baffle system.

D. The dimensions for the flocculation baffles assemblies shall be:
   1. Number of panels: to be determined by fabricator (minimum of 33 panels per clarifier).
   2. Panel width: to be determined by fabricator (minimum of 20 IN).
   3. Panel height: to be determined by fabricator (minimum of 64 IN).
   4. Spacing between panels: maximum of one (1) IN.
   5. Minimum clearance between bottom of baffle and top of truss is one (1) FT.

E. Baffle Components:
   1. Each baffle panel shall be molded of glass fiber-reinforced polymer. The resins and glass fiber reinforcing material shall be consistent with the environmental conditions and structural requirements.
   2. Baffle panel material shall have the following properties:

TEST	METHOD	MINIMUM VALUE
Tensile Strength	ASTM D-638	20,000 psi
Flexural Strength	ASTM D-790	30,000 psi
Flexural Modulus	ASTM D-790	1.4×10^6 psi
Notched Izod	ASTM D-256	24 ft-lbs/in
Water Absorption	ASTM D-570	0.6 percent

   3. The resin:
      a. An isophthalic polyester resin with corrosion-resistant properties, 33-402 resin or equivalent.
      b. Suitable for use in submerged waste treatment applications.
      c. Shall not contain fillers except as required for viscosity control.
      d. For viscosity control, a thixotropic agent up to 5 percent by weight may be added to the resin.
      e. Treated to provide UV suppression.
   4. Glass reinforcement:
      a. Consist of chemically bonded surfacing mat and chopped strand roving.
      b. 357-211 PLN CTC chopped strand roving or equivalent.
      c. Glass content of the finished laminate shall not be less than 30 percent by weight.
      d. The nominal thickness of each baffle panel shall be 1/2 ± 1/16 IN thick with resin rich surfaces and edges to prevent migration of moisture and fiber “blooming.”
   5. Both surfaces of flocculation panels shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be “hot coated” with resin to prevent wicking.
   6. All panels shall be painted with UV resistant paint.
   7. All attachment clips shall be 316 stainless steel.

2.3 WEIR PLATES AND SCUM BAFFLES

A. Weir plates, weir washers, weir splice plates, scum baffle panels, scum baffle splice plates and baffle support brackets shall be molded of glass fiber-reinforced polymer. The resins and glass fiber reinforcing material shall be consistent with the environmental conditions and structural requirements. Both surfaces of weir plates and scum baffles shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking. All FRP components should satisfy the minimum requirements below

TEST	METHOD	MINIMUM VALUE
Tensile Strength	ASTM D-638	10,000 psi
Flexural Strength	ASTM D-790	20,000 psi
Flexural Modulus	ASTM D-790	1.0×10^6 psi
Notched Izod	ASTM D-256	20 ft-lbs/in
Water Absorption	ASTM D-570	0.6 percent

B. The weir plates, splice plates and weir washers shall have minimum thickness of 1/4 IN. Weir plates shall not exceed 8 FT in length. Mounting holes in the weir plates shall be provided for vertical and horizontal adjustment of 2 IN or more with 5 IN diameter FRP weir washers to cover the holes. The weirs shall be mounted to the launders with stainless steel expansion anchors.

C. Scum baffle panels and splice plates shall have a minimum thickness of 1/4 IN thickness. The scum baffle panels shall be 16 IN high and shall not exceed 8 FT in length. The scum baffle brackets shall be provided to secure the baffle.

D. Anchors, nuts, bolts, washers and other hardware shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation:
   1. Contractor shall field verify existing and new clarifier flocculation well dimensions and install the baffle in accordance with the contract drawings, approved shop drawings, and manufacturer's recommendations.
   2. Mounting holes shall be factory drilled. Field cutting of baffle panels will be allowed to complete the structure and accommodate in-tank obstructions per the manufacturer's instructions.
   3. All field cut or drilled edges shall be coated per the manufacturer's recommendations to prevent fiber blooming or fraying.
   4. All of the clips required for installation shall be supplied by the baffle manufacturer.
   5. All hardware used shall be 316 stainless steel.
   6. Weirs and scum baffles shall be carefully aligned and leveled to the elevations shown on the drawings. Maximum allowable variation is 1/8" in the finished product.

3.2 TRAINING

A. Comply with Section 01650.

END OF SECTION

SECTION 11151

PRIMARY CLARIFIER SLUDGE PROTECTOR BAFFLES, WEIR PLATES AND SCUM BAFFLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sludge protector canopy baffle system designed to improve the performance of the Primary Clarifiers by:
      a. Eliminating sludge blanket scour resulting from incoming water fall by allowing the water to flow on its top.
      b. Distributing the incoming flow uniformly above the sludge blanket and into the settling zone.
      c. Increasing the sludge hopper volume by creating a canopy above the hopper.
   2. Canopy baffle system assemblies for existing primary clarifiers No. 1 and No. 2 and new primary clarifier No. 3.

   3. Installation of weir plates and scum baffles in the existing primary clarifiers No. 1, No. 2 and new primary clarifier No. 3.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D-256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
      b. D-570, Standard Test Method for Water Absorption of Plastics
      c. D-638, Standard Test Method for Tensile Properties of Plastics
      d. D-790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

1.3 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Detailed drawings showing equipment fabrication, dimensions, and method of attachment including number, locations and size of bolts.

C. Hydraulic Analysis Report:
   1. Hydraulic analysis confirming canopy baffles design concept, its surface curvature and structural support system. It should also confirm size and locations of proposed openings and the pressure drop through them.
   2. The hydraulic analysis should determine hydrodynamic forces on the canopy baffle system under the extreme flow conditions. If needed, desktop or finite element structural analysis should be performed to determine operating stresses on the panels. If operating stresses are found to be high, a physical laboratory “failure” test of one of the panels will be required to confirm structural integrity of the panels.

D. Manufacture’s recommended baffle dimensions and installation details.

E. Operation and Maintenance (O&M) Manuals.
   1. See Specification Section 01342 for requirements for the mechanics and administration of the submittal process.

a. Manuals should include capacity analysis of the clarifiers with and without any missing panels of the canopy baffles.

F. Manufacturer's Certificate of Compliance.

G. Shipping, storage, protection, and handling instructions.

H. Manufacturer's written/printed installation instructions.

I. One project reference (minimum) to show successful performance of the proposed canopy baffles.

J. Certified test reports of the physical and mechanical properties of the product.

K. Statement of coordination with secondary clarifier equipment.

1.4 WARRANTY

A. Manufacturer shall provide a 5-year product warranty for the products to be free of defects in materials and workmanship.

B. The Installer shall provide a 5-year installation warranty for the products to be free of defects related to installation such as defects in the support structure.

C. Both product and installation warranties will begin after installation (date of substantial completion).

1.5 COORDINATION

A. Manufacturer shall coordinate the canopy baffle system design and installation requirements with the primary clarifier equipment:
1. Flocculation center well.
2. Sludge Collectors.
3. Center column (cage) support system

B. The stainless steel support members and the existing steel system shown in the drawings are provided for conceptual use by the canopy baffle system designer. Designer shall verify the member shapes and sizes and shall provide a final design that is compatible with the cage and flocculation center well support system proposed by the clarifier manufacture.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Canopy baffle system, weir plates and scum baffles shall be the products of the following suppliers:
1. Performance Composite, Inc.
   1418 South Alameda Street
   Compton, CA 90221
   Tel: 310-328-6661
   Fax: 310-782-3578
   Attn: Mr. Francis Hu
   Email: sales@performancecomposites.com
2. Moonlight Molds Inc.
   14920 S. San Pedro Street
   Gardena, CA 90248
   Tel: 310-538-9142
   Attn: Mr. Mike Barlow
   Email: sales@moonlightmolds.com

3. Bafco-Systems Inc.
   723 Casino Center Blvd.
   Las Vegas, NV 89101
   Phone: 1-888-611-4426
   Email: Sales@bafco-systems.com

2.2 CANOPY BAFFLES

A. The canopy baffles assemblies shall consist of a series of panels that are supported from the inlet column support structure and flocculation center well. Each panel shall be molded of corrosion-resistant, UV-treated FRP.

B. The panels should be designed to deflect incoming flows and protect sludge blanket under a range of flows and loads:
   1. Minimum flow per clarifier = 1 mgd.
   2. Maximum flow per clarifier = 4.5 mgd.
   3. Minimum influent TSS = 80 mg/L.
   4. Maximum influent TSS = 400 mg/L.
   5. Minimum sludge concentrations = 0.3 percent.
   6. Maximum sludge concentration = 4 percent.

C. The panels should be designed to withstand forces caused by water fall during filling up the clarifiers or during cleaning. Also, the panels should stand the uplift forces caused by wind when clarifiers are offline for maintenance.

D. The dimensions for the canopy baffles shall be:
   a. Number of panels per clarifier: to be determined by fabricator (minimum of 28).
   b. Inner Panel Width: to be determined by fabricator (minimum of 6 IN).
   c. Outer Panel Width: to be determined by fabricator (minimum of 18 IN).
   d. Panel Length: to be determined by fabricator (minimum of 60 IN).
   e. Inner Spacing between panels: to be determined by fabricator (minimum of 2.5 IN and maximum of 6 IN).
   f. Outer Spacing between panels: to be determined by fabricator (minimum of 2.5 IN and maximum of 10 IN).

E. Baffle Components:
   1. Each panel shall be molded of glass fiber-reinforced polymer. The resins and glass fiber reinforcing material shall be consistent with the environmental conditions and structural requirements.
   2. Baffle panel material shall have the following properties:

TEST	METHOD	MINIMUM VALUE
Tensile Strength	ASTM D-638	20,000 psi
Flexural Strength	ASTM D-790	30,000 psi
Flexural Modulus	ASTM D-790	1.4×10^6 psi
Notched Izod	ASTM D-256	24 ft-lbs/in
Water Absorption	ASTM D-570	0.6 percent

2.3 COMPONENTS FOR CANOPY BAFFLE SYSTEM

A. Canopy Baffles:
   1. Each panel shall be molded of fiberglass-reinforced plastic. The resins and fiberglass reinforcing material shall be consistent with the environmental conditions and structural requirements.

2. The resin shall be an isophthalic polyester resin with corrosion-resistant properties, 33-402 resin or equivalent, suitable for use in submerged waste treatment applications. The resin shall not contain fillers except as required for viscosity control. For viscosity control, a thixotropic agent up to 5 percent by weight may be added to the resin. The resin shall be treated to provide UV suppression.
3. Glass reinforcement shall consist of chemically bonded surfacing mat and chopped strand roving. The glass reinforcement shall be 357-211 PLN CTC chopped strand roving or equivalent. The glass content of the finished laminate shall not be less than 30 percent by weight. The nominal thickness of each baffle panel shall be 1/4 ± 1/16 IN thick with resin rich surfaces and edges to prevent migration of moisture and fiber "blooming."
4. Both surfaces of canopy panels shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking.
5. All panels shall be painted with UV resistant paint.

B. Support Elements:
1. To be determined and designed by the fabricator.
2. 316 stainless steel hardware shall be used at the connection of the panels to the clarifier components and should satisfy the following requirments.
   a. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.
      1) Bars, shapes: ASTM A276, Type 316, 316L.
      2) Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 316.
      3) Strip, plate and flat bars: ASTM A666, Type 316, 316L, Grade A.
      4) Bolts and nuts: ASTM F593, Type 316.
   b. Minimum yield strength of 25,000 psi and minimum tensile strength of 70,000 psi.
      1) Strip, plate and flat bar for welded connections, ASTM A666, Type 304L or 316L.
   c. Welding Electrodes: In accordance with AWS for metal alloy being welded.

2.4 WEIR PLATES AND SCUM BAFFLES

A. Weir plates, weir washers, weir splice plates, scum baffle panels, scum baffle splice plates and baffle support brackets shall be molded of glass fiber-reinforced polymer. The resins and glass fiber reinforcing material shall be consistent with the environmental conditions and structural requirements. Both surfaces of weir plates and scum baffles shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking. All FRP components should satisfy the minimum requirements below

TEST	METHOD	MINIMUM VALUE
Tensile Strength	ASTM D-638	10,000 psi
Flexural Strength	ASTM D-790	20,000 psi
Flexural Modulus	ASTM D-790	1.0×10^6 psi
Notched Izod	ASTM D-256	20 ft-lbs/in
Water Absorption	ASTM D-570	0.6 percent

B. The weir plates, splice plates and weir washers shall have minimum thickness of 1/4 IN. Weir plates shall not exceed 8 FT in length. Mounting holes in the weir plates shall be provided for vertical and horizontal adjustment of 2 IN or more with 5 IN diameter FRP weir washers to cover the holes. The weirs shall be mounted to the launders with stainless steel expansion anchors.

C. Scum baffle panels and splice plates shall have a minimum thickness of 1/4 IN thickness. The scum baffle panels shall be 16 IN high and shall not exceed 8 FT in length. The scum baffle brackets shall be provided to secure the baffle.

D. Anchors, nuts, bolts, washers and other hardware shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation contractor shall field verify existing dimensions and install the baffle in accordance with the contract drawings, approved shop drawings and manufacturer's recommendations. Mounting holes shall be factory drilled. Field cutting of baffle panels will be allowed to complete the structure and accommodate in-tank obstructions. All field cut or drilled edges shall be coated per the manufacturer's recommendations to prevent fiber blooming or fraying. All of the rods, supporting beams, bolts required for installation shall be supplied by the contractor manufacturer. All hardware used shall be 316 stainless steel.

END OF SECTION

SECTION 11152

GRAVITY THICKENER WEIR PLATES AND SCUM BAFFLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gravity thickener weir plates and scum baffles.
   2. Installation of weir plates and scum baffles in the new gravity thickener.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D-256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
      b. D-570, Standard Test Method for Water Absorption of Plastics
      c. D-638, Standard Test Method for Tensile Properties of Plastics
      d. D-790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

1.3 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Detailed drawings showing equipment fabrication, dimensions, and method of attachment including number, locations and size of bolts.

C. Manufacture's recommended baffle dimensions and installation details.

D. Manufacturer's Certificate of Compliance.

E. Shipping, storage, protection, and handling instructions.

F. Manufacturer's written/printed installation instructions.

G. Certified test reports of the physical and mechanical properties of the product.

H. Statement of coordination with secondary clarifier equipment.

1.4 WARRANTY

A. Manufacturer shall provide a 5-year product warranty for the product to be free of defects in materials and workmanship.

B. The Installer shall provide a 5-year installation warranty for the product to be free of defects related to installation such as defects in the support structure.

C. Both product and installation warranties will begin after installation (date of substantial completion).

1.5 COORDINATION

A. Manufacturer shall coordinate the product system design and installation requirements with the gravity thickener equipment:
   1. Scum collector .

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Weir plates and scum baffles shall be the products of the following suppliers:

1. Performance Composite, Inc.
   1418 South Alameda Street
   Compton, CA 90221
   Tel: 310-328-6661
   Fax: 310-782-3578
   Attn: Mr. Francis Hu
   Email: sales@performancecomposites.com
2. Moonlight Molds Inc.
   14920 S. San Pedro Street
   Gardena, CA 90248
   Tel: 310-538-9142
   Attn: Mr. Mike Barlow
   Email: sales@moonlightmolds.com
3. Bafco-Systems Inc.
   723 Casino Center Blvd.
   Las Vegas, NV 89101
   Phone: 1-888-611-4426
   Email: Sales@bafco-systems.com

2.2 WEIR PLATES AND SCUM BAFFLES

A. Weir plates, weir washers, weir splice plates, scum baffle panels, scum baffle splice plates and baffle support brackets shall be molded of glass fiber-reinforced polymer. The resins and glass fiber reinforcing material shall be consistent with the environmental conditions and structural requirements. Both surfaces of weir plates and scum baffles shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking. All FRP components should satisfy the minimum requirements below

TEST	METHOD	MINIMUM VALUE
Tensile Strength	ASTM D-638	10,000 psi
Flexural Strength	ASTM D-790	20,000 psi
Flexural Modulus	ASTM D-790	1.0×10^6 psi
Notched Izod	ASTM D-256	20 ft-lbs/in
Water Absorption	ASTM D-570	0.6 percent

B. The weir plates, splice plates and weir washers shall have minimum thickness of 1/4 IN. Weir plates shall not exceed 8 FT in length. Mounting holes in the weir plates shall be provided for vertical and horizontal adjustment of 2 IN or more with 5 IN diameter FRP weir washers to cover the holes. The weirs shall be mounted to the launders with stainless steel expansion anchors. Weir cut from flat sheets are not acceptable. Weirs will be green in color

C. Scum baffle panels and splice plates shall have a minimum thickness of 1/4 IN thickness. The scum baffle panels shall be 16 IN high and shall not exceed 8 FT in length. The scum baffle brackets shall be provided to secure the baffle. Scum baffles will be same color as weirs.

D. Anchors, nuts, bolts, washers and other hardware shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation contractor shall field verify existing dimensions and install the baffle in accordance with the contract drawings, approved shop drawings and manufacturer's recommendations. Mounting holes shall be factory drilled. Field cutting of baffle panels will be allowed to complete the structure and accommodate in-tank obstructions. All field cut or drilled edges shall be coated per the manufacturer's recommendations to prevent fiber blooming or fraying. All of the rods, supporting beams, bolts required for installation shall be supplied by the contractor manufacturer. All hardware used shall be 316 stainless steel.

END OF SECTION

SECTION 11153
FLOW SPLIT TARGET BAFFLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Installation of flow split target baffles downstream of the grit chamber and the aeration basin effluent channels.
   2. Flow split target baffles to be designed to improve the flow distribution and prevent short circuiting by:
      a. Reducing the momentum of the flow exiting the effluent channels.
      b. Distributing the flow evenly across the full width of the distribution channels.
      c. Reducing water surface turbulence in the distribution channels.
      d. Improving the mixing and minimizing settling of solids in the distribution channels.
      e. Improving flocculation of solids in the distribution channels.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D-256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
      b. D-570, Standard Test Method for Water Absorption of Plastics
      c. D-638, Standard Test Method for Tensile Properties of Plastics
      d. D-790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

1.3 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Detailed drawings showing equipment fabrication, dimensions, and method of attachment including number, locations and size of bolts.

C. Hydraulic Analysis Report:
   1. Hydraulic analysis confirming flow split target baffles design concept, its surface curvature and structural support system. The analysis should determine the turbulence induced by the baffles, and its effect of flocculation and water surface fluctuations.
   2. The hydraulic analysis should determine hydrodynamic forces on the flow split target baffles under the extreme flow conditions. If needed, desktop or finite element structural analysis should be performed to determine operating stresses on the panels. If operating stresses are found to be high, a physical laboratory “failure” test of one of the panels will be required to confirm structural integrity of the panels.

D. Manufacture’s recommended baffle dimensions and installation details.

E. Manufacturer’s Certificate of Compliance.

F. Shipping, storage, protection, and handling instructions.

G. Manufacturer’s written/printed installation instructions.

H. Certified test reports of the physical and mechanical properties of the product.

1.4 WARRANTY

A. Manufacturer shall provide a 5-year product warranty for the flow split target baffles to be free of defects in materials and workmanship.

B. The Installer shall provide a 5-year installation warranty for the baffles to be free of defects related to installation such as defects in the C channels and bolts.

C. Both product and installation warranties will begin after installation (date of substantial completion).

1.5 COORDINATION

A. Manufacturer shall coordinate the flow split target baffle design and installation requirements with the contractor

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Flow split target baffles shall be the products of the following suppliers:

1. Performance Composite, Inc.
   1418 South Alameda Street
   Compton, CA 90221
   Tel: 310-328-6661
   Fax: 310-782-3578
   Attn: Mr. Francis Hu
   Email: sales@performancecomposites.com
2. Moonlight Molds Inc.
   14920 S. San Pedro Street
   Gardena, CA 90248
   Tel: 310-538-9142
   Attn: Mr. Mike Barlow
   Email: sales@moonlightmolds.com
3. Bafco-Systems Inc.
   723 Casino Center Blvd.
   Las Vegas, NV 89101
   Phone: 1-888-611-4426
   Email: Sales@bafco-systems.com

2.2 FLOW SPLIT TARGET BAFFLES

A. Flow split target baffles to be installed in the locations shown on the Drawings.

B. The flow split target baffles should be designed to deflect incoming flows under the following conditions:

1. In the channel downstream of the grit removal effluent channel:
   a. Maximum flow rate: 20.0 mgd.
2. In the channel downstream of the aeration basin effluent channel:
   a. Maximum flow rate: 30.0 mgd.

C. The flow split target baffle assemblies consist of a series of baffle panels supported by an upper and lower beams extending across the width of the channel. Each panel is to be molded of corrosion-resistant, UV-treated FRP.

D. The dimensions for the flow split target baffle assemblies shall be:

1. Number of Panels : to be determined by fabricator depending on width of channel and proposed width of the panel.
2. Panel width: To be determined by fabricator (minimum of 24 IN).
3. Panel height: To be match the elevations shown on the drawings.
4. Panel curvature: To be determined by fabricator (minimum radial angle of 45 degrees)

5. Spacing between panels: Maximum of 1-1/2 IN.
6. Minimum clearance between bottom of baffle and bottom of the channel 1 FT.

E. Baffle Components:
1. Each baffle panel shall be molded of glass fiber-reinforced polymer. The resins and glass fiber reinforcing material shall be consistent with the environmental conditions and structural requirements.
2. Baffle panel material shall have the following properties:

TEST	METHOD	MINIMUM VALUE
Tensile Strength	ASTM D-638	20,000 psi
Flexural Strength	ASTM D-790	30,000 psi
Flexural Modulus	ASTM D-790	1.4×10^6 psi
Notched Izod	ASTM D-256	24 ft-lbs/in
Water Absorption	ASTM D-570	0.6 percent

3. The resin:
   a. An isophthalic polyester resin with corrosion-resistant properties, 33-402 resin or equivalent.
   b. Suitable for use in submerged waste treatment applications.
   c. Shall not contain fillers except as required for viscosity control.
   d. For viscosity control, a thixotropic agent up to 5 percent by weight may be added to the resin.
   e. Treated to provide UV suppression.
4. Glass reinforcement:
   a. Consist of chemically bonded surfacing mat and chopped strand roving.
   b. 357-211 PLN CTC chopped strand roving or equivalent.
   c. Glass content of the finished laminate shall not be less than 30 percent by weight.
   d. The nominal thickness of each baffle panel shall be 1/2 ± 1/16 IN thick with resin rich surfaces and edges to prevent migration of moisture and fiber "blooming."
5. Both surfaces of flow split target panels shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking.
6. All panels shall be painted with UV resistant paint.
7. All attachment clips shall be 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation:
1. Contractor shall field verify channel dimensions and install the baffle in accordance with the contract drawings, approved shop drawings, and manufacturer's recommendations.
2. Mounting holes shall be factory drilled. Field cutting of baffle panels will be allowed to complete the structure and accommodate in-tank obstructions per the manufacturer's instructions.
3. All field cut or drilled edges shall be coated per the manufacturer's recommendations to prevent fiber blooming or fraying.
4. All of the clips required for installation shall be supplied by the baffle manufacturer.
5. All hardware used shall be 316 stainless steel.

END OF SECTION

SECTION 11322
GRIT CYCLONES AND CLASSIFIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grit cyclone and classifier.

B. Coordination:
   1. Coordinate delivery, installation, and startup of equipment.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Supplied by a single manufacturer or supplier
   2. Equipment to be the standard product of the manufacturer
   3. Experienced in the manufacture of forced vortex grit separation and grit washing equipment
   4. Manufacturer to provide a list of installations where similar equipment is in operation with a minimum of 10 installations operating for a period of 5 years
   5. To insure a consistent high standard of quality, the manufacturer of this equipment shall comply with the requirements of the ISO 9001 Quality System and such compliance shall be verified by an independent certification agency approved by the International Organization for Standardization

1.3 DESCRIPTION

A. One (cyclone) integrally mounted on one grit washer.

B. System to include cyclone and grit classifier with motors, supports and specified accessories.

C. Grit is pumped to the cyclone that discharges to the grit classifier and then to the grit hopper as shown on the Drawings.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 11005 for requirements.
   2. Sufficient product data to verify compliance with the specifications and to illustrate the construction or assembly of the products
   3. Manufacturer, model, and type
   4. Overall dimensions and total weights of the product
   5. Complete and detailed assembly, foundation, and installation drawings prepared to scale
   6. Detailed specifications and data describing the materials used, and the parts and accessories that together make up the equipment.
   7. Electrical wiring diagrams
   8. Drawings and layouts to scale customized for this installation.
   9. Paint product data
   10. Sufficient data to verify compliance with specifications. Calculations supporting design including speed reduction ratio, service factor, and bearing life.
      a. Grit cyclone:
         1) Name of manufacturer.
         2) Type and model.
         3) Cyclone efficiency.
      b. Grit classifier:
         1) Name of manufacturer.

2) Type and model.
3) Screw rotative speed.
4) Bearings, including life calculations.

c. Motors:
1) Manufacturer.
2) Type and model.
3) Rated size and rotative speed.
4) Temp rating and service factor.

d. Drive assemblies:
1) Manufacturers.
2) Type and model.
3) Rated capacity.
4) Speed reduction ratio.
5) Service factor.
6) Torque rating.
7) Bearing type and life.

11. Applicable standards, such as ASTM or Federal Specification numbers.
12. Contractor's instructions for storage and handling.

B. Operation and Maintenance Manuals:
1. See Section 01342.
2. Operating instructions with descriptive literature, including a cross-sectional view of equipment, which indicates materials of construction, weights, principle dimensions and other important details.

1.5 DELIVERY, STORAGE AND HANDLING

A. Shipping:
1. Ship equipment, material, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which they are intended.

B. Receiving:
1. Store and safeguard equipment, material, and spare parts.

1.6 SITE CONDITIONS

A. Location:
1. Headwork – Grit Removal Facility (Area 13).
2. Exterior location.

B. Exposures:
1. Corrosive environment due to wastewater:
a. Partial submergence.
b. Splashing.
c. Hydrogen sulfide gases.
d. Hydrocarbon gases.

C. Influent liquid:
1. Grit forced vortex underflow from screened raw wastewater.
2. Total suspended solids feed concentration to each cyclone: 1,000 mg/L to 3,000 mg/L.
3. Designed for continuous or intermittent operation.
4. Ambient air temperature: 45-90 DegF.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Grit Cyclone: 13GRC001.
   1. Quantity: 1.
   2. Size: 10 IN cyclone.
   3. Overflow connection: 6-IN.
   4. Inlet connection: 4-IN.
   5. Tank drain: 2-IN.
   6. Wash water connection: 3/8 IN.
   7. Grit discharge opening: 3 to 5.5 IN.
   8. Designed to eliminate short-circuiting.
   9. Inlet flow rate: 250 gpm.
   10. Design inlet pressure: 7 psi.
   11. Maximum inlet pressure: 15 psi.
   12. Underflow rate: 15 gpm.
   13. Apex diameter: 2 IN.
   14. Vortex finder length: 4 IN.
   15. Inlet and overflow end connections: Flanged.
   16. Arrangement: One cyclone attached to one grit classifier.

B. Grit Classifier: 13GRC002.
   1. Quantity: 1.
   2. Tank: 12 IN full flare.
   3. Auger: 12 IN diameter.
   4. Feed box: Coordinate with cyclone.
   5. Discharge: Coordinate height for discharge into grit container.
   6. Sized to require underflow rate from grit cyclone.
   7. Drive Assembly:
      a. 480v, 3 phase, 60 Hz, 1.15 service factor.
      b. Premium efficiency.

2.2 MATERIALS

A. Grit Cyclone:
   1. Cone Housing: 316 stainless steel.
   2. Cone Lining: Neoprene.
   3. Flanged inlet, overflow ports: 316 stainless steel.
   4. Inlet head housing: 316 stainless steel.
   5. Inlet Head Liner: Neoprene.
   6. Vortex Finder: Ni-hard cast iron, 550 Brinell hardness.
   7. Apex housing: 316 stainless steel.
   8. Apex Liner: Neoprene.
   9. Cylinder Housing: 316 stainless steel.
   10. Cylinder Lining: Neoprene.
   11. Retainer ring: 316 stainless steel.

B. Grit Classifier:
   1. Tank Assembly: 316 stainless steel.
   2. Supports: 316 stainless steel.
   3. Hardware: 316 stainless steel.
   4. Auger: Ni-hard cast iron, 550 Brinell hardness, minimum.
   5. Spiral assembly: 316 stainless steel.
   6. Sluice water and grit chute: 316 stainless steel.

2.3 FABRICATION

A. General:
   1. Chains, sprockets, bearings, and operating mechanisms to be out of water
   2. Welds to be continuous and all surfaces sealed
   3. Edge Grinding: sharp corners to be dulled with power grinder

B. Grit Cyclone:
   1. Heavy-duty volute feed chamber
   2. Cyclone lined with neoprene
   3. Constructed so any section liner is replaced independently
   4. Cyclone underflow discharged to classifier through 316 stainless steel feed box
   5. Hinge and quick disconnect coupling between apex and lower cone section
   6. Tapped for 1-IN NPT gauge connection
   7. Minimize overhung weight
   8. Design to be installed above, to one side, and supported by grit washer and independent support to floor
   9. Inlet and overflow end connections: flanged
   10. Provide inlet pressure gauges and diaphragm seals:
      a. In accordance with Section 13442
      b. 0-15 psi in 0.2-psi increments
      c. Include sealed diaphragm and pressure gauge system

C. Grit Classifier Assembly:
   1. Preassembled 316 stainless steel unit suitable for operation with cyclone.
   2. Grit removed via discharge into grit hopper as shown on Drawings.
   3. Drive assembly:
      a. Supported by grit classifier unit.
      b. 1.15 service factor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Use procedures recommended by manufacturer.

B. Accurately install anchor bolts.

C. Connect piping.

3.2 FIELD TESTING

A. See Section 11005.

B. “Bump” motors to check for correct connections.

3.3 FIELD QUALITY CONTROL

A. Provide services of manufacturer’s field representative for a minimum of two days in two trips.

B. Manufacturer’s representative to provide operations and maintenance instruction.

END OF SECTION

SECTION 11364
DEWATERING CENTRIFUGE

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Furnish materials, equipment, tools, and incidentals necessary for the manufacture, assembly, shop test, delivery, installation, startup, and operation of one solid bowl centrifuge. The centrifuge will be used to dewater digested primary and waste activated sludge.
   1. Complete Centrifuge Unit:
      a. Centrifuge, 62CG002.
      b. Control Panel, 62PNL002.

B. All equipment shall be installed, adjusted, performance tested and placed in operation in accordance with these Specifications, Drawings and the manufacturer's recommendations.

C. Equipment to be provided shall include, but not be limited to:
   1. Centrifuge bowl.
   2. Scroll conveyor.
   3. Gear box.
   4. Feed tube.
   5. Vibration isolators.
   6. Drive system.
   7. Lubrication system.
   8. Back drive system.
   9. Centrifuge support frame.
   10. LCP with measuring and control devices.
   11. Flexible connectors.
   12. Special tools and accessories.
   13. Maintenance agreement.
   14. Any other features/equipment required to make a complete system.

D. Power Supply. Unless otherwise indicated, power supply to the equipment shall be single 480V, 60 Hz, 3 phase.

1.2 QUALITY ASSURANCE

A. All equipment described in this specification shall be supplied the manufacturer:
   1. Manufacturer shall be regularly engaged in the design and manufacture of solid bowl centrifuge.
   2. Prototype units for dewatering not acceptable.

B. Maximum space available for all equipment is shown in the drawings at the end of this Section.

C. Provide size and type of machine required to meet the performance specifications in paragraph 1.5.

D. Requirements of regulatory agencies and reference standards:
   1. Comply with all local and federal regulations.
      a. Standard Methods for Examination of Water and Wastewater.
      b. EPA Sampling Procedures and Protocols for the National Sewage Sludge Survey.
      c. EPA POTW Sludge Sampling and Analysis Guidance Documents.
   2. Comply with all necessary local and federal codes including:
      a. American Institute Steel Construction.
      b. American National Standards Institute.
      c. American Society of Mechanical Engineers.
      d. American Society for Testing and Materials.

e. American Welding Society.
f. Institute of Electrical and Electronics Engineers.
g. National Electrical Code.
h. National Electrical Manufacturers Association.
i. Steel Structure Painting Council.
j. Uniform Building Code.
k. Standard Methods.

E. Source Quality Control:
1. Shop testing:
a. Test centrifuge and control system before shipment.
b. Test as specified in Article 3.3.
c. Control system test.
2. Electrical and control panels shall meet and be labeled pursuant to UL-508A.

1.3 SUBMITTALS

A. See Section 01340 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings and Submittals to include:
1. Product Technical Data.
2. Requirements in Section 11005.
3. Source quality control test reports.
4. Control panel wiring diagrams and panel layout drawings.
5. Test results (field and factory testing).

C. Operation and Maintenance Manuals:
1. See Section 01342 for requirements for:
a. The mechanics and administration of the submittal process
b. The content of Operation and Maintenance Manuals.
2. Operating and maintenance manuals shall be written using US customary units. Operating and maintenance manuals shall be specific to equipment purchased.

D. Drawings and Data:
1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, drives, parts, devices, and accessories forming apart of the equipment furnished, shall be submitted in accordance with the Submittals section. The data and specifications for each unit shall include, but shall not be limited to, the following:
2. Anchor bolt locations, mounting hole size(s), anchor bolt counts, and loadings of individual equipment pads.
3. Overall dimensional drawings showing details of construction.
4. Locations of major components and motor drives accessories including instruments, and other components necessary for complete centrifuge system.
5. Discharge and inlet locations, sizes, and bolting requirements.
6. Installation drawing:
a. Indicating all service connections.
b. All component weights.
c. Location of center of gravity of centrifuge bowl/scroll assembly.
7. Structural loadings:
a. Vertical load transmitted to structure with location of each load.
b. Vibration characteristics of equipment and frame, including natural frequency of stand and operating frequencies of centrifuge.
8. Bearing life calculations.
9. Water cleaning design documentation.
10. Frame structure calculations and shop drawings sealed by a registered professional engineer in the State of Colorado.

a. Include vibration analysis demonstrating that the natural frequency of the support structure meets the requirements of the centrifuge manufacturer. Vibrations in 3 principal directions shall be considered.
b. Include analysis for lateral stability, including seismic forces. Seismic design criteria shall be as required by the contract documents or local Building Department, whichever is more stringent.
1) Structural Seismic Design
a) Site Class C
b) Seismic Design Criteria B
c) S_{DS} = 0.204 (g)
d) S_{D1} = 0.082 (g)
e) Importance Factor, I_E = 1.25

11. Typical system description of operations.
a. List component identification on schematic diagrams.
b. Identify all input/outputs to PLC.
12. All drawings and data marked to show only items applicable to work. Show all data, bill of materials, rated capacities, material of construction, layouts of all components, and all feed and discharge piping arrangements. Show details of construction dimensions, and anchor bolt locations.
13. Recommended cleaning instruction, procedures and safety precautions for equipment. Provide detailed cleaning instructions for particular cleaning system as specified.
14. Control Panel shop drawings including:
a. Outline dimensions, conduit entry areas, total weight, lifting points.
b. Schematics and internal wiring diagrams, including wire numbers.
c. Equipment interconnect drawings showing all field wiring external to the manufacturer's equipment, including terminal designations
d. Bill of materials and technical data on panel components
e. Nameplate schedule.
f. Clarifications and exceptions.
15. Instruments and Control System:
a. List of Instrumentation provided and supplier/part numbers.
b. List of PLC Hardware and part numbers.
c. Provide soft copy of PLC program before and after startup.
1) List of points available to/from the SCADA over the plant EtherNet.
d. Provide soft copy of OIT configuration before and after startup.
e. Description of PLC/OIT controls: screens, alarms, logging, logic, PID loops.
16. Setting plans with tolerances for anchor bolts.
17. Supplied tools and spares.
18. Recommended spare parts not supplied.
19. Installation inspection reports.
20. Test reports certifying the most severe service abrasion resistant materials supplied are in accordance with ASTM G65, Procedure A abrasion test. At a minimum the report should include the following:
a. Typical material analysis.
b. ASTM standards.
c. Manufacturer's name.
21. Recommendations for both short and long term storage of each major component.
22. Weights and lifting points of all equipment and subassemblies.
23. Identify any special handling requirements.
24. Shop and field-testing procedures.
25. Training lesson plan.

E. Product data:
1. General:
a. Materials.
b. Parts.

c. Accessories.
d. Assembly.

2. Centrifuge:
   a. Bowl dimensions.
   b. Operating G-force and G-volume.
   c. Motor sizes, types and manufacturers, and other information required in Section 11005.
   d. Bowl and conveyor speeds.
   e. Automatic back drive assembly.
   f. Lubrication system.
   g. Any special cooling systems.
3. Motors:
   a. Motor manufacturer and model number.
   b. Complete motor nameplate data.
   c. Weight.
   d. NEMA design type.
   e. Enclosure type.
   f. Frame size.
   g. Winding insulation class and temperature rise.
   h. Allowable starts per hour.
   i. Performance data:
      1) Guaranteed minimum efficiencies at 100 percent, 75 percent, and 50 percent of full load
      2) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
      3) Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
   j. Bearing data and lubrication system.
   k. Thermal protection system including recommended alarm and trip settings.
   l. Motor space heater voltage and wattage.
   m. Fabrication and/or layout drawings:
      1) Dimensioned outlined drawing.
      2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).
      3) Size, quantity and location of terminal boxes and conduit entries.
   n. Certifications:
      1) When utilized with a variable frequency controller, certify motor is inverter duty and the controller and motor are compatible.
         a) Include minimum speed at which the motor may be operated for the driven machinery.
4. Variable frequency drives: See Section 16265.
5. Hard surfacing of scroll.
6. Sample guarantees.
7. Shop painting.
8. Installation instructions.

F. Submit operating and maintenance manuals.

G. Samples:
   1. Test results prior to shipment.

1.4 MANUFACTURER QUALIFICATIONS

A. Manufacturer shall be regularly engaged in the design and manufacturer of solid bowl centrifuges. Manufacturer shall provide a list of a minimum of 4 separate installations in North America within the past four years.

B. Manufacturer shall have an experienced base of operation in North America that furnishes experienced technical resources and service personnel to carry out start-up and troubleshooting.

C. Service Network in North America providing responses to technical inquires within 24 hrs and delivery of spare parts on site within 24 hrs.

D. Manufacturer to have an established service center within 8 hours of Owner's facility.

E. All communication shall be in English and all measurements shall be in English.

F. Provide documentation that manufacturer meets the minimum above requirements.

1.5 JOB CONDITIONS

A. Site conditions:
   1. Altitude, 8 ± ft, MSL.
   2. Outdoor installation: Temperature range: 30 DegF to 100 DegF.

1.6 PERFORMANCE WARRANTY

A. The manufacturer shall be guarantee the performance of the dewatering system supplied based on the minimum performance requirements described in this specification.

B. If the centrifuge does not meet the minimum performance requirements, described in this specification, the manufacturer, at his expense, shall make modifications to the equipment until requirements are met.

C. A retainage of 20 percent of the equipment cost will be withheld by the Owner until after performance testing. The Owner will pay retainage after demonstrating that the centrifuge meets minimum performance requirements.

1.7 WARRANTY

A. The manufacturer shall warrant against any defects in materials or workmanship to the centrifuge for a period of 24 months from successful completion of Acceptance Testing or 30 months from the date of delivery.

B. The manufacturer shall repair or replace any equipment found to be defective in workmanship or materials during the warranty period and provide written notice of the defect's cause and manufacturer's remedy.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Alfa Laval.
   2. Andritz.
   3. Or approved equal.

B. Motors:
   1. Baldor.
   2. General Electric.
   3. Marathon Electric.
   4. Reliance Electric.
   5. Siemens.
   6. Teco-Westinghouse.
   7. U.S. Motors.
   8. Or approved equal.

C. Variable Frequency Drives:
   a. Refer to Section 16265.

2.2 EQUIPMENT

A. Dewatering Centrifuge:
   1. Number of units: 1.
   2. Minimum performance requirements:
      a. Average hydraulic capacity: 200 gpm.
      b. Average solids loading: 50 lbs/min.
      c. Inlet consistency: 2.0 percent – 4.5 percent solids.
      d. Outlet consistency: 18 percent, minimum.
      e. Polymer usage: 24 to 36 lbs/dry ton solids.
      f. Minimum solids capture rate: 95 percent.
   3. Feed to the dewatering centrifuge is anaerobically digested primary and waste activated sludge.
   4. Motor:
      a. Main drive: 75 HP, maximum, TEFC, 1800 rpm, 480 VAC, 3 phase, 60 Hz, 1.15 service factor. Inverter duty, premium efficiency.
      b. Back drive: 25 HP, maximum TEFC, 1800 rpm, 480 VAC, 3-hase, 60 Hz, 1.15 service factor, inverter duty, premium efficiency.

2.3 MATERIALS

A. All parts in contact with sludge, liquid, or polymer not otherwise specified: Stainless steel type 316.

B. Bowl: Centrifugal castings of duplex stainless steel.

C. Scroll Conveyor: Stainless steel type 316 hub. Duplex stainless steel conical section flights. 316 stainless steel horizontal section flights.

D. Casing: Stainless steel type 316.

E. Feed tube: Stainless steel type 316.

F. Frame: Mild carbon steel.

G. Belt guard: Mild carbon steel.

H. Abrasion resistant materials:
   1. Conveyor flight edges:
      a. Protected by replaceable sintered tungsten carbide tiles.
      b. Scroll abrasion protection designed for 15,000 hrs operations minimum.
      c. Flight coverage: From solids discharge end to at least two complete flights beyond the feed zone.
      d. Each assembly shall be individually replaceable with ability to monitor wear by means of visual inspection.
      e. Tile assemblies shall extend 0.75-IN beyond the radial edge of the conveyor flight.
      f. The remaining scroll conveyor edge and face shall be protected from abrasion using flame sprayed hard surfacing containing a minimum of 40 percent tungsten carbide.
   2. Conveyor feed zone: Field replaceable liner coated with tungsten carbide on wearing surface.
   3. Feed ports and feed compartment: Protected field replaceable sintered tungsten carbide insets or replaceable tungsten carbide wearing.
   4. Solids discharge ports: Protected by field replaceable tungsten carbide wear saddles.
   5. Upper and lower solids discharge end of casing protected by replaceable stainless steel liner.
   6. Sintered tungsten carbide wear test:
      a. Submit tiles to test specified in ASTM G65-80, "Conducting Dry Sand/Rubber Wheel Abrasion Tests", Procedure A.
      b. Material rejected if abrasion exceeds 3.0 mm.

I. Shop painting:
   1. All carbon steel and cast iron shall be properly prepared and cleaned in accordance with The Society for Protective Coatings (SSPC).
   2. Paint system shall be manufactures standard system consisting of:
      a. Prime coat:
         1) One (1) coat, 7 mils. Catalyzed epoxy primer.
      b. Finish coat:
         1) One (1) coat, 7 mils. Aliphatic acrylic urethane.

J. Anchor bolts: 316 Stainless steel, minimum 1/2 IN DIA.
   1. Sized and provided by manufacturer.

K. Flexible connections: Black neoprene.

2.4 FABRICATION AND MANUFACTURE

A. General:
   1. The centrifuge shall be a countercurrent machine used to dewater sludge.
   2. Centrifuge shall be continuous feed, horizontal solid bowl, scroll conveyor type with flow of solids and liquids from a central zone.
   3. Centrifuge dynamically balanced prior to shipment.
   4. Operating noise level: Maximum 90 dBa at 3 FT under free field conditions.
      a. Measured at manufacturing facility with inlet and outlet openings closed and without process flow.
   5. Centrifuge designed to incorporate the latest technology in the configuration of the internal parts to maximize solids content.

B. Bowl:
   1. General:
      a. Designed to withstand all centrifugal forces encountered at operating speeds with an adequate factor of safety:
         1) For high speed units: Designed to operate at a maximum of 2,900 rpm.
      b. Supported on cylindrical roller type bearings mounted in pillow blocks and fitted for external lubrication:
         1) Bearings: Life of 100,000 hrs at 24-hr/day service using DIN ISO 281, SKF Life Equation.
      c. Free of cracks, shrinkage, porosity, or other defects discovered by means of a liquid penetrant test.
      d. Minimum bowl diameter of 29 IN.
   2. Dewatering bowl:
      a. Designed to maximize solids concentration.
      b. Adjustable pond depth using power tube weirs without removing rotating assembly from frame.

C. Pool depth:
   1. Adjustable:
      a. Adjustable by use of weir plate dams at large diameter end of bowl where liquid is discharged.
      b. Weir plates easily adjusted without dismantling the assembly.
      c. Variable settings.
      d. Range in depth: 0 IN to 1.0 IN based on spillover point.
   2. Cylindrical portion of bowl:
      a. Length: 108 IN minimum for high speed units.

D. Scroll Conveyor:
   1. Cylindrical - conical scroll type, contoured to shape of bowl.
   2. Supported by grease lubricated roller bearings.

3. Bearings:
    a. Protected by seals.
    b. Grease lubricated from external fittings.
    c. B-10 life of 100,000 hrs.
4. Equipped with helical flights independently mounted concentrically with centrifuge bowl.
5. Comprised of one compartment:
    a. Designed to evenly distribute feed solids and polymer to bowl.
    b. Provided with separate floc feed pipe inside sludge feed.
6. Tiles:
    a. Operating life to: 15,000 hrs.
    b. Minimum height: 3/4 IN for tungsten carbide.

E. Case:
1. Fabricated.
2. Contains and directs solids and liquid discharge from centrifuge, acts as protective guard, and provides complete enclosure.
3. Equipped with lifting eyes.
4. Bolted in place.
5. Case bottom: Flanged for attachment of discharge hoppers.

F. Base:
1. Supports centrifuge.
2. Mounted on vibration isolators:
    a. Capable of dampening vibration in all directions:
        1) Minimum 90 percent vibration dampening.
    b. Rubber buffer or spring type.
3. Equipped with lifting eyes.

G. Air leakage:
1. Limited by gaskets on casing flange and a rubbing lip type seal on the feed tube.
2. Alternatively, limited by serpentine flow path of close tolerance.

H. Bearings:
1. Pillow block with spherical rollers.
2. Lubrication:
    a. Grease lubricated provided heat removal calculations are submitted with Prequalification package.
3. Minimum DIN ISO 281, SKF Life Equation life: 100,000 hrs.
4. No transfer of thrust to supports.

I. Main drive:
1. Motor:
    a. 460V, 3-phase, 60 Hz, 1800 rpm, premium energy efficient (minimum 95.4 percent efficient at full-load).
    b. Rated for continuous duty.
    c. Horsepower:
        1) 75 HP maximum.
    d. Horizontal squirrel cage induction type, inverter-duty, suitable for use with a VFD.
    e. TEFC, Class F insulation.
    f. Anti-condensation motor space heater operating at 120VAC, sized to keep the motor interior free from condensation when the motor is not running.
    g. Service Factor: 1.0.
    h. Mounted on slide base with double adjusting bolts.
    i. Capable of making two complete starts in succession with coasting to rest between starts.
    j. Capable of at least one restart within one hour after any shutdown.
    k. Minimum temp rise at start: 165 DegF.
    l. Maximum time to full rated rpm at start: 10 minutes at 90 percent nameplate voltage.

m. Noise level not to exceed 91 dBa at 3 FT from motor in all directions.
n. Oil or grease lubricated antifriction bearings conforming to ABMA standards, with a design bearing life for 90 percent survival rating at 50,000 hours.
o. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.

2. Belt Drive:
   a. Belt drive system.
      1) Consisting of multiple belts to withstand full starting torque of the system.
   b. Provide guards to cover.

J. Backdrive system with microprocessor controller:
1. 460V, 3-phase, 60 Hz, premium energy efficient (minimum 94.5 percent efficient at full-load).
2. Rated for continuous duty.
3. Horsepower:
   a. 25 HP maximum.
4. Horizontal squirrel cage induction type, inverter-duty, suitable for use with a VFD.
5. TEFC, Class F insulation.
6. Anti-condensation motor space heater operating at 120VAC, sized to keep the motor interior free from condensation when the motor is not running.
7. Service Factor: 1.0.
8. Oil or grease lubricated antifriction bearings conforming to ABMA standards, with a design bearing life for 90 percent survival rating at 50,000 hours.
9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.
10. Manual mode: Provide for operation at an adjustable scroll differential speed with internal scroll shaft torque/current allowed to vary up to a maximum setpoint.
11. Automatic mode controlled by PLC.

K. Variable frequency drives:
1. Refer to Section 16265.

L. Balance:
1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.
2. Excessive vibration is sufficient cause for equipment rejection.
3. Unit mass and distribution such that resonance is avoided.
4. Maximum shaft vibration:
   a. Displacement (peak-to-peak): 3.0 mils max at pillow block.
5. Maximum vibration:
   a. Displacement (peak-to-peak) at any point on the machine: 3.0 mils max.
   b. Acceleration (rms): 8 rms at wet operating speed.
6. Install accelerometer type vibration monitors on each pillow block to automatically shut down centrifuge in event of excessive vibration:
   a. Provide inhibit of switch during startup and shutdown.
   b. Provide digital output and panel indicator.
7. Critical speed:
   a. Provide critical speed calculations which demonstrate at operating speed, the entire assembly is at least 20 percent below the first critical speed.

M. Polymer addition at feed inlet:
1. Introduced at point on centrifuge feed pipe.
2. Polymer introduction point specifically designed for this purpose.

N. Chutes and hoppers:
   1. Provided by Construction Contractor. Centrifuge Manufacturer shall coordinate with Construction Contractor chute and hopper sizes and configurations as necessary.
   2. To be independently supported (no load onto centrifuge casing flange).

O. Flexible connectors:
   1. All connections to centrifuge to be flexible:
      a. Centrate hopper: Bolted to centrifuge with flexible connection at flanged outlet.
      b. Sludge hopper: Bolt flexible connector between centrifuge and hopper.
      c. All pipe connections including sludge feed, polymer feed.
   2. Length of each flexible connector: 12 IN minimum.
   3. Provide for movement of 1 IN in all directions minimum.
   4. Provided by the Centrifuge Manufacturer.

2.5 SYSTEM CONTROL

A. Manufacturer shall provide one NEMA 12 304 stainless steel centrifuge Local Control Panel (LCP) which houses the PLC, OIT, VFD's, starters and terminal blocks associated with the centrifuge. The panel shall have a three-point latching mechanism on the gasketed doors, and filters on all air ventilation openings. The centrifuge LCP shall be located remote from the centrifuge.

B. The free-standing LCP will be installed by the Construction Contractor in the vicinity of the centrifuge.

C. Manufacturer shall provide one PLC and one OIT for the centrifuge controls. The PLC shall provide the logic and control functions specified in this section and approved by the Owner.

D. Manufacturer shall factory wire all control and instrument circuits to unit mounted terminal boxes. All terminals shall be labeled.

E. Centrifuge Local Control Panel (LCP) shall be as follows:
   1. Free standing centrifuge Local Control Panel shall be approximately 72 IN wide x 90 IN tall x 18 IN deep.
   2. The PLC shall be an Allen-Bradley or approved equal.
   3. The OIT (Operator Interface Terminal) shall be a 10-IN PanelViewPlus6 terminal with a touch-screen interface and Ethernet communications.
   4. The LCP shall contain an EtherNet Switch by *N-Tron* which shall communicate with the plant PLC by a CAT6 cable installed by the Construction Contractor. The PLC, OIT, and both VFDs in the LCP shall also be connected to the EtherNet Switch in the LCP.
   5. Suitable for a single 480Vac, 60 Hertz, 3-phase power and containing as a minimum:
      a. Main disconnect circuit breaker with front door interlocked operating handle. Circuit breaker shall have a minimum rating of 65,000AIC.
      b. Variable frequency drives (VFD) with circuit breaker disconnects for main and backdrive motors.
   6. Provide solid state overload devices for each motor.
   7. Provide control power transformer 480Vac to 120Vac with two primary leads and one secondary lead fused, and one secondary lead grounded.
   8. All control devices mounted on the face of the panels shall be rated NEMA 4X.
   9. As a minimum, the following control devices shall be door mounted in the centrifuge operating/LCP and available without opening the panel:
      a. Control Power On Lamp (white).
      b. Emergency-Stop pushbutton.
   10. The LCP shall energize the anticondensation motor space heaters when the centrifuge motors are de-energized.

F. The LCP shall provide all direct operator interface of the centrifuge using the touchscreen OIT mounted on the front of the LCP. All control signals between the OIT, PLC, and VFDs shall use the Ethernet network. All hard-wired input/output signals to/from the centrifuge machine shall be terminated in the LCP.
   1. At a minimum, the OIT shall be capable of:
      a. Local Start PB (push-button).
      b. Local Stop PB.
      c. System/Alarm Reset PB.
      d. Flushing Sequence Start/Stop CS (control switch).
      e. Flushing Sequence Running indication.
      f. Centrifuge Ready indication.
      g. Centrifuge Main Drive Running indication.
      h. Centrifuge Main Drive VFD Fault Alarm.
      i. Centrifuge Main Drive Amps.
      j. Centrifuge Back Drive Running indication.
      k. Centrifuge Back Drive VFD Fault Alarm.
      l. Centrifuge Back Drive Amps.
      m. Centrifuge Runtime Hours by month (last 12 months).
      n. Sludge Feed Pump Running indicator (from Plant PLC).
      o. Sludge Feed Pump Failure alarm (from Plant PLC).
      p. Sludge Feed Pump Ready/Auto indicator (from Plant PLC).
      q. Sludge Flowmeter display (0-400 gpm) (from Plant PLC).
      r. Sludge Flow Totalization by day and week (from Plant PLC).
      s. Sludge Feed Pump Discharge Pressure display (from Plant PLC).
      t. Polymer Feed Pump Running indicator (from Plant PLC).
      u. Polymer Feed Pump Failure alarm (from Plant PLC).
      v. Polymer Feed Pump Ready/Auto indicator (from Plant PLC).
      w. Emergency Stop indicator.

G. Manufacturer shall provide a surge protection device and filtering in the LCP to prevent any abnormal operation of the control and instrumentation system from noise, interference, transients, etc., generated either internal or external to the control panels.

H. At a minimum the following dry contact inputs shall be provided to the centrifuge LCP:
   1. Centrifuge Cover switch.
   2. Centrifuge Vibration HI alarm switch.
   3. Centrifuge Vibration HI-HI shutdown switch.
   4. Low Water pressure switch.

I. At a minimum the centrifuge LCP shall provide the following outputs:
   1. Form-A Dry Contact Outputs:
      a. Wash water valve open/close.
      b. Feed valve solenoid open/close.
   2. Soft Digital Outputs to the Plant PLC:
      a. Sludge Feed Pump start/stop.
      b. Polymer Feed Pump start/stop.
      c. Centrifuge Running.
      d. Centrifuge E-Stopped.
      e. Flushing Cycle running.
      f. LCP Power On.
   3. Eight (8) additional spare discrete outputs using 10A Form C contacts.

J. At a minimum the following analog inputs shall be provided to the centrifuge LCP:
   1. Hard-wired 4-20 mA Analog Inputs:
      a. Centrifuge vibration.
      b. Gear end bearing temp
      c. Inlet end bearing temp.

K. Sequence of Operation:
   1. Local Control Mode:
      a. The operator shall start and stop the sludge dewatering system manually.
      b. The centrifuge shall have programmed start and stop sequences once operator initiates a centrifuge start or stop manually at the LCP.

L. Interlocks and Fail-safes in modes (local or remote):
   1. Provide shut down contacts for the following upon emergency shutdown of the centrifuge:
      a. Sludge feed pump.
      b. Polymer feed pump.

M. Centrifuge Shutdown Alarms:
   1. When any of the following fault conditions occur, the appropriate fault indicator shall be illuminated on the OIT, the alarm horn shall sound and the centrifuge and associated equipment will be de-energized. The faulted condition shall be clearly identified:
      a. Main drive VFD fault.
      b. HI-HI vibration.
      c. Back drive VFD fault.
      d. HI-HI torque.
      e. HI-HI feed end bearing temperature.
      f. HI-HI drive end bearing temperature.
   2. When any of the following fault conditions occur, the appropriate fault indicator shall be indicated on the OIT and the alarm horn will sound. The centrifuge will continue to operate.
      a. HI gear end bearing temperature.
      b. HI inlet end bearing temperature.

2.6 VARIABLE FREQUENCY DRIVES

A. Refer to Section 16265.

2.7 SOURCE QUALITY CONTROL

A. A factory acceptance test (FAT) shall be performed on the centrifuge controls (LCP). All start/stop and running sequences and all safety and alarm systems shall be tested. The Owner or designated Witnessing Engineer shall sign the test procedure and results, certifying that the system was tested and shown to operate as designed in the manufacturer's shop.
   1. All travel costs for Owner and/or their representatives shall be paid for by Manufacturer.
   2. Notification shall be required and mutually agreed upon between Owner and Manufacturer for scheduling of FAT no less than four (4) weeks ahead of test date.

B. Test results of motors shall be included in the Operations & Maintenance Manual.

2.8 MAINTENANCE MATERIALS/SPARE PARTS

A. Provide the following maintenance and spare parts. Additionally, provide price list, expected delivery time and ordering information for the same items.
   1. One (1) set of Special tools including bowl lifter, conveyor lifter, and bowl truck.
   2. One (1) set of lubricants for start-up.
   3. One (1) set of spare O-rings and seals.
   4. One (1) set spare drive belts.
   5. Three (3) sets spare plate dams.

PART 3 - EXECUTION

3.1 GENERAL

A. The manufacturer is responsible for all aspects of the centrifuge system. All internal wiring and skid-mounted wiring required in the shop shall be the responsibility of the manufacturer. Responsibilities include design and fabrication, shop performance tests, safe delivery to site, check out installation by Contractor, field checkout tests, field performance tests, equipment startup services, furnishing all tools, supplies, spare parts and special equipment, and training.

3.2 PREOPERATING CHECKS

A. Per Manufacturer's installation checklist:
   1. Performed by factory authorized representative.
   2. Supervise unloading and storage of units.
   3. Inspect installation and make mechanical check of centrifuge system.
   4. Manufacturer to submit Installation Inspection Report for completed installation:
      a. Report to be submitted within five calendar days of the inspection.
      b. Report to include list of all deficiencies and recommended corrective actions.
   5. After correcting all deficiencies, whether by Construction Contractor or Manufacturer to:
      a. Certify in writing that centrifuge system properly installed and adjusted.
      b. Ready for start-up and mechanical testing.
   6. Manufacturer to submit qualifications of factory representative to Engineer for approval.

3.3 FIELD TESTING AND ADJUSTING

A. It is required that start-up and testing of centrifuge be started as soon as possible after installation.

B. After installation and after all components operable, submit unit to complete normal start, normal stop, and emergency stop cycles.

C. Perform an 8-hr minimum running test on the centrifuge.
   1. At beginning and end of test, and at one-hour intervals between, check:
      a. All thermometers.
      b. Pressure gauges.
      c. Flow indicators.
      d. All safety devices.
      e. Differential speed control.
      f. Bearing temperatures.
      g. All instruments and controls.
   2. Check no load amperage of motor.
   3. Tests run by manufacturer's authorized representative with assistance from Manufacturer.
   4. All readings to be recorded and submitted to Owner in written form.

D. Correct all malfunctions and retest as directed by Owner, until equipment is operating properly:
   1. Each retest shall be for the specified eight-hour period.
   2. Manufacturer to certify in writing that centrifuge is ready for performance testing.

3.4 PERFORMANCE TESTING

A. After operational testing and adjusting described above is completed.

B. Perform centrifuge performance test:
   1. Commence within two weeks of having the centrifuge installation complete and ready for startup.
   2. Demonstrate centrifuge can perform as specified in Section 2.2. Owner is responsible for delivering sludge to Range of specifications listed in Section 2.2.
   3. Run a minimum of five (5) tests.
   4. Tests will be made in five (5)-hour runs.
   5. Tests to be witnessed by Engineer and/or Owner’s designated representative.

6. Tests to be scheduled by Manufacturer in conjunction with Owner.

C. Collect samples at the following locations:
   1. Solids discharge.
   2. Centrate discharge.
   3. Centrifuge pipe prior to polymer addition.
   4. Samples collected at start and end of each test run and at 45 minute max intervals in between. Sample volume shall be at least 500 ml for each sample taken at each sample time.
   5. Each day's samples will be combined for a composite sample for testing.
   6. Each day's composite will be split with the Owner.
   7. Test results will be averaged over the test period.

D. Suitably label and split samples preserve as needed, and deliver promptly Owner's split sample for analysis.

E. Manufacturer shall have the following tests performed by an independent EPA accredited laboratory to determine solids concentration and suspended solid recovery. Testing shall conform to standards referenced in Part 1 of these specifications. Laboratory shall test samples for:
   1. Centrifuge cake solids: Total solids.
   2. Centrate: Suspended solids.
   3. Centrifuge feed: Suspended solids and volatile solids.
   4. Computation to determine solids recovery efficiency to be determined from following formula:

$$\% \text{ recovery} = \frac{C(F-E)}{F(C-E)} \times 100$$

Where C = % solids (total solids)
F = % feed solids (suspended solids)
E = % centrate solids (suspended solids)
All values expressed as a decimal

F. Owner will provide polymer. Polymer used will be the Owner's existing standard polymer stock.
   1. Record polymer usage by weight during each performance run.
   2. Determine polymer concentrations from OWNER's weight record.
   3. Compute lbs polymer per dry ton solids.

G. Consumed horsepower:
   1. Connect recording watt meters by Manufacturer to centrifuge drive motor and back drive system.
   2. Watt meters to record watts consumed by centrifuge during each test.
   3. Compute consumed horsepower per gpm (hp/gpm) of feed.

H. If performance fails to meet the specifications:
   1. Manufacturer will be allowed to make corrections and retest as needed for a period of one month.
   2. All adjustments and retests to be made within 90 days of first test at Manufacturer's cost.
   3. If after a month of performance testing the equipment does not meet the required performance, the Owner will notify the manufacturer in writing of the unacceptable performance.

I. After successful completion of acceptance tests, centrifuge manufacturer shall prepare written report:
   1. Summarize details of tests.
   2. Provide test results.
   3. Compare test results with acceptance criteria.
   4. Present data in tabular and graphical form.

3.5 START-UP AND OPERATOR TRAINING

A. General:
   1. Provide manufacturers field services.
   2. Qualified factory representative to supervise:
      a. Start-up centrifuge.
      b. Instruction of Owner's personnel in operation and maintenance of centrifuge.
   3. These services in addition to all other specified services.
   4. Provide at least 2 days of training and all related expenses.
   5. Two additional follow-up inspections and training as requested by Owner with 14 days advance notice to manufacturer during the two-year warranty period.
   6. Provide per diem salary and expenses for additional or fewer days of training.

B. Training:
   1. To take place after completion of installation, testing and start-up of centrifuge.
   2. Training in accordance with Specification Section 01650.
   3. Minimum course content:
      a. Submit course outline.
      b. Submit example of class materials, if other than shop drawing submittals.
      c. Subjects including:
         1) Theory of operation.
         2) Start-up procedures.
         3) Shutdown procedures.
         4) Troubleshooting.
         5) Selection of proper polymer types and dosages.
         6) Replacement of blocks, bearings, back drives, etc.
         7) Operating adjustments for performance optimization.
         8) Preventative maintenance.
         9) Maintenance procedures.
         10) Emergency procedures.
         11) Recordkeeping.
         12) Back drive operation.
         13) Instrumentation and controls.
         14) Others deemed important by Manufacturer.
   4. One training session by Manufacturer may be video taped by Owner.

END OF SECTION

SECTION 11373
SUBMERSIBLE MIXERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Contractor shall furnish a total of four (4) submersible mixers for use in the anoxic cells.
2. Furnish all labor, materials, tools and equipment necessary for complete installation in the anoxic cells of the aeration basins tanks as shown on the Contract Drawings and specified herein.
3. Submersible power cable.
4. Single guide rail system.
5. Hoist base and Davit Crane.
6. Lifting cable.
7. Support cable.
8. Controls.
9. All appurtenant equipment.

1.2 REFERENCE CODES AND STANDARDS

A. Except as otherwise indicated, the current editions of the Standards listed in Section 11060 Pumping and Mixing Equipment: Basic Requirements and the following apply to the work of this Section:

ASTM A48, Standard Specification for Gray Iron Castings
ASTM A 53, Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
ASTM A283, Low and Intermediate Tensile Strength Carbon Steel Plates

1.3 CONTRACTOR SUBMITIALS

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 and Section 11005.

B. Shop Drawings and Samples: In addition to the requirements of Section 01340, 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 with mounting details for mixer mast assembly and davit crane.
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.
8. Engineering Calculations:
    a. Prepared and stamped by a California registered civil or structural engineer.
    b. Include:
        1) Sizing of all anchors for securing hoist base.
        2) Sizing of all anchors for mixer support mast assembly wall and base brackets.
        3) Sizing of mixer support mast.
        4) Provide equipment anchorage calculations as specified in paragraph 1.4 A.1.p. of Section 11005 demonstrating compliance with the applicable requirements of paragraph 1.5 of Section 11005.

C. O&M Manuals: The Contractor shall provide operations and maintenance data for all equipment furnished for the project in accordance with Section 01342.

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.

1.5 WARRANTIES

A. The equipment furnished under this Section shall be provided with warranties to meet the requirements in the General Conditions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Number of Mixers: 4

B. Liquid Mixed: Mixed Liquor Activated Sludge

C. Design Liquid Suspended Solids: 3,500 Concentration (mg/l)

D. Mixing Cycle: Continuous

E. Zone Configuration and Dimensions: See Drawings

F. Dimensions of Tank to be Mixed:
1. Length: 50 FT.
2. Width: 20 FT.
3. Side water depth: 14.5 – 15.0 FT
4. Note: Manufacturer to review the drawings to verify the configuration of the basin and location of flows into the basin

2.2 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 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.

B. Unit responsibility:
   1. 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.
   2. To ensure the integrity of the mounting system the mixer Manufacturer shall supply the support guide brackets and square mast, as specified above.

C. Manufacturer:
   1. Wilo-EMU USA.
   2. Landia.
   3. Flygt.
   4. Or approved equal.

2.3 SUBMERSIBLE MIXERS

Mixer 1A, 31MX101
Mixer 1B, 31MX102
Mixer 2A, 31MX201
Mixer 2B, 31MX202

A. General
   1. Type: The motor shall drive the submersible mixer propeller through a planetary gear reduction drive system that locates the motor shaft in line with the propeller shaft. 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 unsubmerged, for 2 hours minimum.
   3. Mounting: The mixers shall be designed to be easily raised, lowered, and removed for inspection or service, and rotated horizontally without the need for personnel to enter the tank. A sliding guide bracket shall be an integral part of each mixer. The guide bracket shall guide the mixer into position and be capable of carrying the entire weight of the mixer and the maximum loads created by the mixer. The mixer, 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 normally 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 groove bearing. The inboard, motor end, bearings shall be an angular contact or deep groove 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:
   a. The shaft connecting the propeller to the gear reducer shall be constructed of AISI 329 (1.4462) stainless steel.
   b. Minimum propeller shaft diameter (D), measured at the outermost bearing shall be: 1.77 inches (45 mm).
   c. The propeller shaft shall be supported such that the length (L) from the outermost bearing to the hub of the propeller shall not exceed 3.88 IN. The shaft overhang ratio of the distance from the bearing to the hub of the propeller (L) divided by diameter of the shaft at the bearing shall not exceed 2.2.
8. Shaft Seals:
   a. Each mixer shall be provided with two sets of lapped end face type mechanical seals or an outside lapped end face 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 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.
   c. 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, and shall be capable of running in either direction without damage. Shaft seals that rely on the tank fluid as a lubricant will not be considered acceptable or equal.

B. Performance Requirements:
   1. Maximum motor speed: 1,700 rpm.
   2. Maximum propeller speed: 320 rpm
   3. Minimum propeller diameter: 23.6 IN
   4. Number of propeller blades: 3
   5. Drive type: Gear driven.
   6. Minimum horsepower rating (output): 5
   7. Maximum shaft horsepower (clear water): 5
   8. Power supply voltage, phase, hertz: 480, 3, 60
   9. Minimum number of poles: 4
   10. Minimum thrust produced, (N): 1,000
   11. Minimum flowrate: 4,200 gpm
   12. Maximum weight: 300 LB
   13. The mixers shall be selected and positioned in the anoxic tanks to achieve a uniform concentration of mixed liquor suspended solids in the liquid under the specified operation condition at all locations within the selector zone in which the mixers are mounted.
   14. Mixer systems shall be capable of providing mixing energy to each anoxic tank at no less than 0.020 HP per 1,000 GAL.
   15. Manufacturer to confirm mixer direction and install height during submittal phase to achieve mixing requirements.

C. Materials of Construction:
   1. Except as noted below, 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 Polyurethane or Type 316 stainless steel.
   3. The propeller shaft shall be of Type 420 stainless steel.
   4. The mechanical seals shall contain a stationary face ring of silicon carbide and a rotating face ring of silicon carbide.
   5. All anchor bolts nuts and washers shall be 316 stainless steel.

6. Motor housing and gear casing: cast iron, ASTM A48 40B, with two-component ceramic-based coating minimum 16 mils DFT, or equal.

D. Controls:
1. Each motor shall be provided with temperature and moisture protection system meeting the requirements below:
   a. Provide each motor with integral temperature sensors, one on each leg, which opens on high temperature.
   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. Provide a control and status relay unit equal to Flygt MINI CAS 120 loose for mounting in plant motor control center.

E. Motor and Power Cable:
1. General: The motor shall be a squirrel cage, induction, shell type design, housed in an air filled, sealed, watertight chamber. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least ten evenly spaced starts per hour and have a minimum 1.15 service factor. The motor shall be suitable for service in a Class 1, Division 2 environment and bear UL or FM approval. The stator winding shall be insulated with moisture resistant Class H insulation which will resist a temperature of 180 DegC (356 DegF). The stator shall be dipped and baked three times in Class F varnish. The rotor bars and short circuit rings shall be made of aluminum.
2. Cable: Provide pump cable of sufficient length to connect to terminal junction box where indicated. Pump cable shall be sized according to the NEC and ICEA Standards, suitable for submersible service. The cable shall be rated for 600-volt and 90 DegC with a 40 DegC ambient temperature and shall be FM approved.
3. Cable entry: Cable entry seal design shall provide a watertight submersible seal. The cable entry housing shall be an integral part of the back plate or upper lid. The cable entry shall have a double set elastomer grommets or a single grommet with cable strain. The cable entry shall be comprised of one or two cylindrical elastomer grommets, each flanked by washers designed with a close tolerance fit against the cable outside diameter and the entry inside diameter. The assembly shall bear against a shoulder and be compressed to form a watertight seal. The cable entry shall be designed to insure a watertight seal between the electrical junction chamber and the motor, preventing fluid leakage into the motor.

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 FT vertical intervals along the basin wall.
2. Provide and install stop clamps for mixers installed in Zones 1B and 2B (swing zones).
3. Wall components of the mounting assembly including mixer mounting base plate, 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 4 IN by 4 IN by 3/16 IN if square or 4 IN 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. Power cable support: Provide a minimum 1/4 IN diameter 316 stainless steel power cable support cable with each mixer 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 clamps at 5 FT intervals.

6. Lifting cable: Provide a minimum 1/4 IN diameter, 316 stainless steel lifting cable 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. Adjustable hoists:
   a. Provide four (4) hoists each having a 42 IN reach, a 109 IN mast height, and a lifting capacity equal to but not greater than 550 pounds. Furnish as similar as practical to the two existing mixer hoists. 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 316 stainless steel construction.
   b. The hand winch shall be of 316 stainless steel construction having cadmium plate finish. An anchor hole in the flange of the drum shall provide easy attachment and removal of the lifting cable to allow the cable 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 hoist shall be capable of rotating 360 degrees under load enabling the mixer to be removed from the tank in a single lifting and rotating motion.
   d. The system shall be capable of lifting the mixer to sufficient height to clear the handrail.
2. Lifting lugs: Equipment weighting over 100 pounds shall be provided with lifting lugs.
3. Identification plate: an identification plate shall be securely mounted on the equipment in a readily visible location. The plate shall bear the 1/4 IN die-stamped equipment identification number and equipment data.
4. Anchors: Concrete anchors shall be in conformance with Section 05505 and minimum 5/8 IN diameter Type 316 stainless steel. Coordinate required size and location with Shop Drawings. The mixer Manufacturer shall size and determine the proper location for anchors, and shall furnish the anchors.
5. Hoist wall mounting socket: Each submersible mixer shall be provided with a hoist wall mounting socket as shown on the Drawings. The wall mounting socket shall be capable of supporting the hoist described above and shall be installed on the edge of the walkway deck.

H. Spare Parts:
1. Each size and type of mixer shall be supplied with the following parts:
   a. Two (2) sets motor shaft bearings.
   b. Two (2) sets seals, gaskets, and O-rings.

I. Protective Coating:
1. Shop and field painting shall be in accordance with requirements specified in Section 09905.

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. Comply with Section 01650.

B. Factory Testing: Mixers shall be tested at the factory. The Owner may, at Owner's discretion, witness the factory test. 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 FT 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.

C. Functional Testing: A functional wet test shall be conducted at plant startup in accordance with Section 01650. The functional wet test should verify operation without excessive noise, vibration, cavitation, or overheating and document motor voltage and current draw.

D. Performance Testing: A factory trained representative shall inspect the installation of the mixers before the tank is 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 01650. Verify operation without excessive noise, vibration, cavitation, or overheating. Document motor voltage and current draw.

3.4 TRAINING

A. Comply with requirements as indicated elsewhere.

END OF SECTION

SECTION 11376
ROTARY-LOBE BLOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Channel air agitation blowers, blower panel, and appurtenances for the PE/Mixed Liquor Splitter Box.
      a. Equipment list:
         1) Blower No. 1 – 32B100.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI).
   2. American National Standards Institute (ANSI).
   3. American Petroleum Institute (API):
      a. 617, Rotary Assembly Dynamic Balancing.
   4. American Society of Mechanical Engineers (ASME):
      a. PTC 10, Performance Test Code – Compressors and Exhausters.
   5. American Bearing Manufacturers Association (ANSI/ABMA):
      a. 9, Load Ratings and Fatigue Life for Ball Bearings.
      b. 11, Load Ratings and Fatigue Life for Roller Bearings.
   6. Institute of Electrical and Electronics Engineers (IEEE):
      a. 85, Test Procedure for Airborne Noise Measurements on Rotating Electric Machinery.

1.3 SYSTEM DESCRIPTION

A. The channel air agitation blower will supply air to the PE/Mixed Liquor Flow Splitter Box to keep solids in suspension. Under normal operation, the blower will run at full speed. Operator will have flexibility to run blowers at set blower speed or set flow rate.

B. General: channel air agitation blowers and appurtenances shall include the following items supplied by blower manufacturer:
   1. Rotary Positive Displacement Blower, motor and Variable Frequency Drive (VFD).
   2. Air intake filters.
   3. Silencers, inlet , discharge, and vent.
   4. Butterfly valves in bloweroff circuit.
   5. Check valves.
   6. Relief valves.
   7. Flexible pipe connectors.
   8. Pressure gauges.
   9. Sound enclosure.
   10. Weather-Proof enclosure.
   11. Appurtenances as required.

C. Design Requirements:

PARAMETER	VALUE
Type of blower	Rotary lobe, positive displacement
Number of blowers	1
Rated speed	1,800 revolutions per minute (rpm), maximum

PARAMETER	VALUE
Rated inlet air flow at rated speed	125 scfm
Minimum inlet air flow	75 scfm
Inlet filter pressure loss	0.20 pounds per square inch
Rated relative humidity	100% RH
Rated barometer	14.7 psia
Rated inlet temperature	97 DegF
Rated discharge pressure	5.0 psig

1. Motor: In accordance with Section 11005, except as otherwise specified or supplemented below:
   a. Provide winding temperature switches.
   b. Provide motor winding space heater:

Power supply	480 volt, 3 phase, 60 Hz
Horsepower	5
Speed	VFD, 1,800 rpm (maximum)
Enclosure	TEFC
Service factor	1.15

2. Drive: The blower shall be V-belt driven with the drive designed for a minimum 140 percent of motor hp, and include an adjustable motor slide base. Sheaves shall be two part, with taper lock style attachment to the shaft. Sheaves shall be dynamically balanced as required by the manufacturer's maximum rim speed. V-belt design shall calculate the forces on the blower input drive shaft and motor so as not to exceed maximum bearing side load. A totally enclosed guard built to OSHA specifications shall be painted safety yellow. In lieu of V-Belt Drive, a direct couple between the blower and drive motor may be acceptable, with no changes to the basic mechanical layout allowed. Direct couple shall be "S-Flex" style, two-piece EPMD with retaining ring (E-Type), with a 1.5 service factor manufactured by Lovejoy or approved equal.

1.4 SUBMITTALS

A. Product data and shop drawings including:
   1. Blower panel device layout and material list.
   2. Literature and drawings describing equipment performance and construction in sufficient detail, including parts list, dimensions, materials, and details of construction and installation.
   3. Complete control panel drawings including wiring diagrams.
   4. Certified dimensional data for components, including foundation and anchor bolts and details.
   5. Equipment data:
      a. Blower information:
         1) Manufacturer.
         2) Model.
         3) Blower speed in revolutions per minute.
         4) Blower site capacity, actual cubic feet per minute.
         5) Discharge pressure, psia.
         6) Horsepower required including loss in V-belt drive.

7) Weight of blower.
8) Weight of motor.
9) Free-field noise level at 3 FT from blower acoustic enclosure.

b. Motor performance and construction data including VFD.
c. Descriptive brochures and applicable performance and construction data for each item of auxiliary equipment along with their weights.
d. Details of blower enclosure construction and materials, suitable for outdoor installation.

1.5 MANUFACTURER QUALIFICATIONS

A. Minimum 15 years experience in manufacturing similar equipment utilized in water and wastewater treatment plant.

B. Supplied accessories including motor.

C. Assumes responsibility for compatibility of components furnished.

D. Furnishes services of factory representatives with complete knowledge of proper installation, operation and maintenance of equipment to inspect and approve final installation and supervise test runs of equipment.

E. Package system shall be supplied by the blower manufacturer. Verification to be part of shop drawing review.

F. Equipment supplier must have a service facility within (200) miles of job site.

1.6 ENVIRONMENTAL CONDITIONS

A. Blower shall be suitable for continuous service and intermittent operations.

B. Site conditions for determining rated ACFM noted in Article 1.3 C. Design Requirements.

1.7 SPARE PARTS

A. Furnish one set of special tools with equipment when required for normal operation and maintenance.

B. Spare Parts Include:
1. 1 complete set of bearings.
2. 4 complete sets of ventilation and air intake filters.
3. 4 lubrication oil filter cartridges.
4. 2 complete sets of gaskets and O - rings.
5. 2 sets of drive belts or direct couplings.

C. Label spare parts as specified in Section 01600 and box for storage

PART 2 - PRODUCTS

2.1 BLOWERS

A. Manufacturers: One of the following, modified as necessary to meet the Specification requirements:
1. Roots, series Easy Air X2 package with a Ram WHISPAIR frame.
2. Sutorbilt, equivalent product.
3. Aerzen, equivalent product.
4. Kaeser Compressors, equivalent product
5. Or approved equal.

2.2 MATERIALS

A. General:
   1. Channel Air Agitation Blower Package Assembly: Complete with sound attenuating enclosure, weather-proofed enclosure (suitable for outdoor installation), blower, drive, inlet and discharge silencers, valves and appurtenances.
   2. Blower Rating: As specified above.
   3. Rotation direction of blower shall match requirements of piping.

B. Blower and drive:
   1. General:
      a. Blower shall deliver oil-free air.
      b. Blower and Motor Mounting: On common base.
      c. Lifting Provisions: Lifting eyes on blowers, motors and base so each major component or entire unit can be lifted.
      d. Piping Connections: 125 LBS class flanges meeting ANSI B16.1.
   2. Type: Positive displacement rotary blowers using 2 impellers to pressurize a trapped volume of air at a controlled rate prior to exposing it to a discharge pressure.
   3. Casing and Head Plates:
      a. Blower Casing: One piece with separate head plates and end covers.
      b. Casing and Head Plates: Made of close-grained, machined cast iron.
      c. End Covers and Head Plates: Reinforced with bosses at penetrations with cast, machined support feet.
      d. Housing: Feedback plenum on the discharge port that bleeds back some of the discharge air to a closed pocket as the rotor tip passes to reduce pulsation and noise.
   4. Impellers:
      a. Material: Ductile iron or cast iron, ASTM A48 Class 30B.
      b. Design: Straight, 2- or 3-lobe, involute type.
      c. Balance: Statically and dynamically, by removing metal from impeller body.
      d. Operation: Free of rubbing without need for liquid seals or lubrication.
      e. Timing: Positively by a pair of accurately machined, heat treated, alloy steel timing gears. Helical gears shall be machined from hardened alloy steel and bolted to timing hubs. Timing hubs shall be serrated on the inner diameter and placed over matching serrations on the shaft. Timing gears and hubs shall be locked in the axial position by a lock nut to assure no slippage.
      f. Shafts: Alloy steel forgings, pressed into each end of each impeller and pinned.
      g. Impeller Assembly Support: Anti-friction type bearings, sized for a minimum ABMA L-10 life of 100,000 hours.
   5. Lubrication:
      a. Positive Oil Seal: Provided at each bearing.
      b. Seal Design: Capable of preventing lubricant from leaking into air stream.
      c. Vent Provisions: Capable of venting impeller side of oil seal to atmosphere while eliminating possible carryover of lubricant into air stream.
      d. Drive-end Bearings: Splash oil lubricated from an oil reservoir in the drive end cover housing.
      e. Timing Gears and Gear-end Bearings: Splash oil lubricated from an oil reservoir in the drive end cover housing.
      f. Blowers Shipment: With openings sealed after injection of rust inhibitor.
   6. Weatherproof enclosure: 316 stainless steel construction suitable for outdoor installation.

2.3 APPURTENANCES

A. Inlet air filter/silencer:
   1. Provide filter/silencer installed at the blower inlet connection inside enclosure.
   2. Galvanized Carbon Steel housing with front access for paper or pleated filter elements and suitable clamps.

3. MERV rating of {____} percent and can achieve removal efficiency of 5-micron particle size and larger.

B. Silencers:
1. Manufacturers: One of the following or equal:
   a. Burgess-Manning, Model BMSI-L, BMSS-L, or equal.
2. Construction: Combination multi-chambered reactive/adsorptive type of all welded steel construction with flanged connections with diameter and drilling conforming to ASME B16.1 Class 125.
3. Discharge Silencer: Furnished with copper wool absorption material.
4. Silencers Sizing: For design conditions and specifically designed for use with positive displacement blowers, size as indicated on the Drawings unless a larger size is recommended by the manufacturer.
5. Mounting of Silencers: Inlet, discharge, and vent. Complete support of inlet, discharge, and blowoff silencers is required as part of the package.
6. Noise attenuation of silencers shall as a minimum, meet the following:

OCTAVE BAND CENTER FREQUENCY, HERTZ	ATTENUATION, dbA
63	12
125	20
250	27
500	30
1,000	31
2,000	29
4,000	25
8,000	21

C. Combination Base: Base shall have combination type discharge silencer. Provide flexible connectors between the blower discharge connection and the discharge silencer inlet connection. The base/discharge silencer shall be manufactured using carbon steel, have plain pipe stub connections and incorporate an oil pan in the design. The base/discharge silencer will have connections for a pressure relief valve, pressure gauge, discharge temperature gauge, mechanical unloading valve and 1/2-IN drain built into the silencer. Packed/absorptive type silencers are not acceptable.

D. Vibration mounts shall be supplied and capable of leveling the blower package to insure proper oil level to increase service and longevity of the equipment. The blower manufacture must insure proper selection for the specific blower system supplied.

E. An 80-dBA or less at 3 FT free field guaranteed noise enclosure should be provided for each blower system. The enclosure outer material must be zinc coated steel with a surface preparation and paint as follows: Powder coat with texture finish 40-100 microns (65 microns average) RAL 5015 blue powder coat process to be proven to pass 500-hour salt spray test satisfactory with no rust evidence. The enclosure shall include a vent system and (3) removable panels for easy access and maintenance. The ventilation fan shall be mounted on blower drive shaft; separately wired electric enclosure fans are not acceptable. The noise enclosure shall be provided with 1 IN foam and the foam shall comply with UL94-HF 1 for flammability. The noise enclosure shall provide up to 22-dba attenuation, free field.

F. Relief Valve: Spring type, full-nozzle type; sized to relieve full blower capacity with 10 percent accumulation; 10 LBS per square inch gauge set pressure. Relief valve outlet shall be bronze body, screwed or flanged connections per ANSI B16:
   1. Manufacturers: One of the following or equal:
      a. Kunkle Valve Co.

G. Butterfly Valves:
   1. Lined with 10 mils of epoxy suitable for temperatures to 280 DegF.
   2. Sealed with EPDM seals suitable for temperatures of 280 DegF.

H. Check Valves: Dual disc, wafer style with torsion spring induced closure; consisting of following components: manufactured by Val-Matic or equal:
   1. Valve body: Carbon Steel or ASTM A 126 cast iron.
   2. Disc: ASTM B 148-9A, aluminum bronze.
   3. Spring: ASTM A 276, Type 316 stainless steel.
   4. Pins and Thrust Bearings: ASTM A 276 Type 316, stainless steel.
   5. Seals, EPDM rated for minimum 280 DegF.

I. Switches: Provide the following switches mounted on the blower inside of enclosure as part of the package:
   1. High discharge air temperature switch:
      a. With thermowell, suitable for direct or remote mounting in discharge piping.
      b. Adjustable over range of 80 to 300 DegF or as recommended by blower manufacturer. Initial setting as recommended by blower manufacturer.
      c. NEMA 4.
   2. High discharge air pressure switch:
      a. Range as recommended by blower manufacturer: initial setting as recommended by bower manufacturer.
      b. NEMA 4.
   3. High inlet filter vacuum switch:
      a. Range as recommended by blower manufacturer: initial setting as recommended by bower manufacturer.
      b. NEMA 4.

J. Other Safety Devices and Controls: As recommended by blower manufacturer.

K. Rubber expansion joints:
   1. Provided at inlet and discharge flanges of blowers.
   2. Suitable for pressures up to 15 LBS per square inch gauge and temperature up to 280 DegF.
   3. At discharge joints, provided with control rods to restrict axial pipe movement.
   4. Manufacturers: One of the following or equal:
      a. General Rubber
      b. Or equal.

L. Discharge Piping and Silencer Insulation: As indicated on the Drawings.

M. Provide unloading valves for each blower for proper operation of the system.

N. Supports and Bracing: As required to support blower, associated equipment and piping, and to prevent excessive or harmful vibration or movement of equipment or piping.

2.4 LOCAL CONTROL PANEL

A. NEMA 4X.

B. Main breaker with cover mounted handle.

C. Suitable for single 480 volt, 3 phase power supply.

D. Panel to conform to Specification Section 13448 construction.

E. Provide all power supplies needed for operation.

F. Provide barriers on separate compartment for 480 volt wiring.

G. Provide isolated contacts for run, fail and Auto signals to Plant RTU. Set up for remote start/stop.

2.5 SURFACE PREPARATION AND PAINTING

A. Prepare and shop paint surfaces as specified in Section 09905.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install adequate supports and bracing to support blower, associated equipment and piping, and to prevent excessive or harmful vibration or movement of equipment or piping resulting from operation of the system.

B. Install blower/motor support structure. Properly align and mount blower and motor.

3.2 MANUFACTURER'S FIELD SERVICES

A. Require manufacturer to inspect system before initial testing and start-up and certify that system has been correctly installed and prepared for testing and start-up as specified in this Section and Sections 15050 and 15958.

B. Training: As described below:
   1. Require manufacturer's representative to perform the following services in four separate trips (minimum) as described below:
      a. Installation assistance and inspection: One man-day.
         1) Advise/observe the Contractor on the installation of rotary lube blowers.
         2) Check and verify that installation of the rotary lube blowers is in accordance with the Drawings and manufacturer's installation instructions.
      b. Certification of installation, field testing, and start-up assistance: Two man-days.
      c. Operator Training: Two separate half man-days, one during Testing Phase and one during Commissioning Phase.
      d. Post start-up services: One man-day.
   2. Each man-day consists of 8 working hours.
   3. The specified durations are the minimum required time on the job site and do not include travel time.

C. Require manufacturer's representative to complete all certificates, reports, and forms in Specification Section 01600.

3.3 FIELD TESTING

A. After installation of equipment, approval of installation by manufacturer's representative, and operation equipment for sufficient period to make corrections and adjustments, test channel air agitation blower system in the presence of Engineer.

B. During test period, take and record readings of essential data at 30-minute intervals, including but not limited to noise, vibration, oil and air temperature, and operating pressures.

C. Test blowers in accordance with PTC-10.

3.4 CORRECTIVE MEASURES

A. When units or system performance or operation fails to meet specifications, take corrective measures, or remove and replace units with acceptable units.

B. Operate equipment for 7-day operating period as specified in Section 01660.

END OF SECTION

SECTION 11651
STORAGE EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shop and storage equipment:
      a. Chemical tote storage enclosure.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 30, Flammable and Combustible Liquids Code.
   2. Occupational Safety and Health Administration (OSHA).
   3. Manufacturer model numbers listed in this Section establish the minimum construction quality standards and functional requirements.

1.3 SYSTEM DESCRIPTION

A. Provide single-source responsibility for equipment listed by this Specification Section.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings.
      a. Fabrication details and rough-in diagrams.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Samples:
   1. Full range of colors available for Engineer color selection.

C. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.5 DELIVERY, STORAGE AND HANDLING

A. See Section 01600.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Storage equipment:
      a. U.S. Chemical Storage.
      b. Or approved equal.

B. Where listed, manufacturer or supplier catalog numbers are taken from the following catalogs:
   1. U.S. chemical Storage: Chemloc Non-Fire Rated.

C. Submit request for substitution in accordance with Specification Section 01640.

2.2 EQUIPMENT

A. Schedule of Items:
   1. Chemical tote storage enclosure:
      a. Heavy gage steel (18-gauge minimum) storage cabinet with coil roll-up doors.
         1) Doors to provide three-point locking devices for security with keyed cylinder lock.
         2) Cabinet to contain one (1) full width shelf across mid-point for storage of totes.
      b. Finish: Baked-on enamel.
      c. Sufficient to hold four (4) 350 gallon chemical totes.
   2. Open type shelving:
      a. Heavy gage steel, open-type shelving.
         1) Upright members of welded single "T" fabrication with slotted and keyholed for adjustable shelving.
      b. Reinforced metal shelves adjustable from the front on 1-1/2 IN centers.
      c. Provide heavy-duty steel shelf clips for instant adjustment.
      d. Shelf frames supported by lateral back cross braces.
      e. Open rack end frames supported by cross braces.

2.3 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Furnish Owner two (2) 12 OZ spray cans of touch-up paint for each equipment color provided.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings.

B. Comply with Section 10400.

END OF SECTION

SECTION 11923
LIQUID POLYMER BATCHING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. An automatic polymer feed system to include a polymer make-down unit, and polymer solution pumps as shown in the Contract Drawings.
   2. The polymer make-down unit shall be capable of automatically metering, diluting, activating and feeding a liquid polymer with water. It shall also be capable of automatically metering diluted polymer based on input flow signals.

B. Equipment List:

TAG NUMBER	ITEM
65PBU001	Packaged Polymer Activation/Dilution Unit
65PBU002	Packaged Polymer Activation/Dilution Unit
65PBU003	Packaged Polymer Activation/Dilution Unit
65PBU004	Packaged Polymer Activation/Dilution Unit
65PMP001	Neat Polymer Metering Pump
65PMP002	Neat Polymer Metering Pump
65PMP003	Neat Polymer Metering Pump
65PMP004	Neat Polymer Metering Pump

1.2 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340.
   2. See Section 11005.

B. Operation and Maintenance Manuals:
   1. See Section 01342.

1.3 SYSTEM RESPONSIBILITY

A. All equipment specified in this section will be designed and furnished by the polymer equipment manufacturer who is responsible for component compatibility and suitability to the application.

B. The polymer equipment manufacturer shall be experienced, reputable, and qualified in the supply of polymer equipment systems. The manufacturer shall have at least ten (10) installations of equivalent complexity that have been in operation for at least five (5) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to the compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Acrison.
   2. Siemens Water Technologies.
   3. Fluid Dynamics, Dynablend.
   4. Velodyne, Velo Blend.
   5. Or approved equal.

2.2 MATERIALS

A. Frame: 304 stainless steel.

B. Skid: 304 stainless steel.

C. Pipe and Fittings: PVC.

D. Valves: PVC.

E. Mixing Chamber: PVC.

F. Dimensions:
   1. Skid: 56 IN wide x 54 IN deep x 50 IN high.

2.3 EQUIPMENT AND DESIGN CRITERIA

A. Polymer Make-down Unit Mixing Chamber:
   1. Polymer and water shall be mixed in a controllable, variable intensity two zone chamber designed to create sufficient mixing energy. Constant speed mixers are not acceptable. This design shall include a motor-driven direct drive impeller that will create high fluid sheer. Polymer activation efficiency shall be consistent over the dilution water range.
   2. Mixing chamber shall be transparent to allow viewing of mixing intensity.
   3. Impeller Motor:
      a. Size: 1/2 hp, minimum
      b. Speed: 1800 rpm, maximum.
      c. TEFC washdown duty enclosure.
      d. Motor to be direct coupled to impeller shaft.
      e. Provide a mechanical shaft seal with an integral seal flush assembly.
   4. Provide a mixing chamber pressure relief valve with a range of 25 to 75 psi.

B. Dilution Water Flow Control:
   1. Polymer mixing unit shall have a signal generating flow meter and an on/off motor operated ball valve for on/off control of dilution water. Valve shall be capable of supplying water from 2 to 20 gpm.

C. Neat Polymer Metering Pump (65PMP001, 65PMP002, 65PMP003, 65PMP004):
   1. Quantity: 1.
   2. Capacity Range: 0.5 to 10 gph.
   3. Type: Peristaltic pump with built in variable speed control for drive motor.
   4. Accessories:
      a. Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be designed with an open, unobstructed path to the valve seat. The minimum open area up to and including the valve seat shall be 3/16 IN. The valve body shall be constructed of Teflon with Viton seals. The valve poppet and spring shall be stainless steel. The spring shall be outside of the polymer flow path to prevent build-up and plugging. The locking pin used to hold the valve in place shall be

attached to the mixing chamber with a lanyard. The valve shall be readily accessible for cleaning and shall not require tools for removal, cleaning or replacement. Conventional check valves, valves that rely on ball seals, and or check valves that are installed inside the mixing chamber, or which require mixing chamber disassembly for servicing will not be accepted.

D. Tote Mixer:
   1. A mixer shall be supplied for mixing neat polymer tote contents.
   2. All materials of construction shall be compatible with polymer.
   3. Motor:
      a. Size: 3/4 hp, minimum.
      b. Speed: 1800 rpm, maximum.
      c. TEFC Enclosure.
      d. Motor shall be 1 PH, 120V.
      e. Operation: On/Off with 0 – 60 minute timer.
      f. Collapsible 12 IN diameter impeller.
   4. Mixer shall be mounted to tote per manufacturer recommendations.
   5. Provide 8 FT power cord with molded in grounding plug, or as required to termination point.
   6. Provide a stainless steel wall mounting bracket with drip pan.

E. Electrical and Controls:
   1. Electrical Connections:
      a. Standard, 120 V, single phase, 60 Hertz.
      b. 4-20 mA signal input for flow pacing.
   2. Unit shall be powered through an on-off-remote circuit. Unit is powered in the on position. Unit is powered through the tank level controls.
   3. Unit shall have a radio controller to automatically pace the neat polymer metering pump with dilution water flow based on an operator input setting of solution concentration.
      a. Controller shall include a 6 IN color touch screen display. Alpha numeric displays shall not be acceptable.
   4. Unit shall have a dilution water loss of flow sensor which, sensing that water flow has been interrupted for any reason, will place the system on standby. Manual restart shall be required.
   5. Provide 120V rated dry contacts for Auto, Run and Fail.

2.4 MAINTENANCE

A. System shall be open design to allow easy access to all components.

B. Mixing chamber shall be easily disassembled and reassembled to allow access to all parts exposed to neat polymer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The equipment shall be installed per the Contract Documents and manufacturer's recommendations.

B. Testing:
   1. Upon completion of the assembly, each polymer equipment module shall be functionally tested.
   2. All electrical devices shall be interconnected and tested as a unit.
   3. All start/stop, safety, and alarm sequences shall be tested and certified. All connecting pipe, tanks, and pumps shall be leak tested.
   4. Certified test results by the manufacturer for operation and check lists are to be included in the Operation and Maintenance Manual.

C. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Conduct startup of equipment and perform operational checks.
   4. Provide Owner with a written statement that manufacturer's equipment has been installed properly, has been started up and is ready for operation by the Owner.

3.2 WARRANTY

A. Polymer feed system shall be warranted for a period of 18 months from the date of shipment or 12 months from the date of start-up by a factory-authorized technician, whichever occurs first.

3.3 TRAINING

A. Comply with Section 01650.

END OF SECTION

SECTION 11932
PUMPING EQUIPMENT: CHEMICAL METERING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chemical metering pumps.
      a. Packaged pump skids and associated piping valves and accessories.
      b. Spare pumps.

1.2 DEFINITIONS

A. System Integrator: Pump distributor and service company capable of providing a complete skid mounted chemical metering pump and accessories per this Section.

1.3 QUALITY ASSURANCE

A. Referenced Standards
   1. American Gear Manufacturers Association (AGMA)
   2. American National Standards Institute (ANSI)
   3. American Society for Testing Materials (ASTM)
      a. A48, Standard Specification for Gray Iron Castings
      b. A126, Gray Iron Castings for Valves Flanges, and Pipe Fittings
   4. American Bearing Manufacturers Association (ABMA)

B. Coordinate and integrate entire system including, but not limited to, metering pumps, electrical equipment, controls, hardware, valving, piping, gauges, and complete skid mounted system through the System Integrator.

C. System integrator shall have had and shall provide written confirmation of a minimum of 5 years of operational experience with at least three installations of pumping equipment applications similar to the systems described herein and on the Drawings and within the past three years.

D. Package Chemical Feed System(s) shall be supplied complete. Manufacturer will have a local authorized service center in their territory to provide service and support to the package system. The service center will have and maintain factory-authorized service technicians for installation, maintenance and repair as necessary and specified.

1.4 SYSTEM DESCRIPTION

A. The following systems are required.
   1. Ferric chloride metering pumps.
   2. Sodium hydroxide metering pumps.
   3. Sodium hypochlorite metering pumps.
   4. Sodium bisulfite metering pumps.

B. System shall be supplied through a single System Integrator and shall include:
   1. Mounting skid and back panel.
   2. Chemical metering pumps.
   3. Calibration column.
   4. Magnetic flow meters (indicator and transmitter).
   5. Pressure relief valves.
   6. Discharge pressure indicator/transmitter.
   7. Pulsation damper.
   8. Junction box.
   9. Isolation valves.

10. Pipe fittings.
11. Piping.
12. Controls.
13. Electrical components.

C. Spare Metering pumps to be on shelf.

1.5 SUBMITTALS

A. Shop Drawings:
1. Drawings and product data:
a. Technical information on all components.
b. Fabrication drawings.
2. See Section 01340 for requirements for the mechanics and administration of the submittal process.

B. Operating and Maintenance Manuals:
1. See Sections 01342 and Section 11060 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.

C. Miscellaneous Submittals:
1. System Integrator's written confirmation of minimum of 5 years of successful operation of proposed pump equipment in above mentioned chemical applications. Provide references, including phone numbers, for at least three packaged, skid-mounted installations the above chemicals.
2. System Integrator's certificate of proper installation.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship equipment and tubing in clearly marked containers.

1.7 WARRANTY

A. The equipment furnished under this Section shall be free of defects in materials and workmanship for a period of 24 months from Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pumps:
a. Pre-Packaged Peristaltic Chemical Metering Pump System provided through Watson-Marlow.
b. Spare peristaltic chemical metering pump provided through Watson-Marlow.
c. Or equal.

2.2 DESIGN REQUIREMENTS

A. Chemical Characteristics:
1. Ferric chloride:
a. Concentration: 40 percent.
b. Specific gravity: 1.4
2. Sodium hydroxide:
a. Concentration: 50 percent.
b. Specific gravity: 1.5.
3. Sodium hypochlorite:
a. Concentration: 10-15 percent.

b. Specific gravity: 1.2.
4. Sodium bisulfite:
a. Concentration: 25 percent.
b. Specific gravity: 1.3.

B. Chemical Metering Pumps:
1. Ferric Chloride:
a. 0 to 50 gph at 30 psi:
1) Watson-Marlow Model 520 UmAN/REL
2) Or equivalent model.
2. Sodium Hydroxide:
a. 0 to 50 gph at 30 psi:
1) Watson-Marlow Model 520 UmAN/REL.
2) Or equivalent model.
3. Sodium Hypochlorite:
a. 0 to 50 gph at 30 psi:
1) Watson-Marlow Model 520 UmAN/REL.
2) Or equivalent model.
b. 0 to 250 gph at 30 psi:
1) Watson-Marlow Model 620 UmAN/RE.
2) Or equivalent model.
4. Sodium Bisulfite:
a. 0 to 50 gph at 30 psi:
1) Watson-Marlow Model 520 UmAN/REL.
2) Or equivalent model.
b. 0 to 250 gph at 30 psi:
1) Watson-Marlow Model 620 UmAN/RE.
2) Or equivalent model.

2.3 MATERIALS

A. Material of construction suitable for chemicals in Section 2.2A.

B. General:
1. Tubing: Marprene.
2. O-rings: Viton
3. Pump head rotor: Polyphenylene sulfide (PPS).
4. Main roller: 304 stainless steel.
5. Main roller bearings: 316 stainless steel carbon steel (sealed).
6. Roller arms: PPS.
7. Rotor Guide Rollers: Nylatron.
8. Track: PPS; aluminum Trimite polyester powder coat, electrostatically applied and baked.
9. Drive: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat.
10. Hardware: 316 stainless steel.
11. Enclosure: NEMA 4X.

2.4 EQUIPMENT

A. Provide chemical feed pumps meeting the following parameters:
1. Ferric chloride:
a. Application: Headworks odor control and chemically enhanced primary treatment (CEPT).
b. Tag Number:
1) Headworks odor control: 76PMP003.
2) CEPT: 76PMP001.
3) Swing Standby pump: 76PMP002.
c. Delivery Capacity:
1) 35 gph maximum.

2) 0.5 gph minimum.

d. Total Discharge Head:

1) 30 psi at maximum capacity.

2) 20 psi at minimum capacity.

e. Pump speed: 220 rpm maximum.

f. Driver 100 VA maximum, for 120 V, single phase.

g. Electric variable speed (SCD).

h. Direct Connected.

i. Suction and discharge: 1/2 IN diameter.

j. Pump suction lift: 8 FT.

k. IP66 power and control terminal boxes.

l. Tube monitor.

m. Skid mounted, triplex, two duty and one swing standby.

n. Located at ferric chloride storage and feed area near influent wetwell.

2. Sodium Hydroxide:

a. Application: Alkalinity control.

b. Tag Number: 77PMP101, 77PMP102.

c. Delivery Capacity:

1) 35 gph maximum.

2) 1 gph minimum.

d. Total Discharge Head:

1) 30 psi at maximum capacity.

2) 20 psi at minimum capacity.

e. Pump speed: 220 rpm maximum.

f. Driver 100 VA maximum, for 120 V, single phase.

g. Electric variable speed (SCD).

h. Direct Connected.

i. Suction and discharge: 1/2 IN diameter.

j. Pump suction lift: 8 FT.

k. IP66 power and control terminal boxes.

l. Tube monitor.

m. Skid mounted, duplex, duty/standby.

n. Located at sodium hydroxide storage and feed area near chlorine contact basin.

3. Sodium Hypochlorite:

a. Application: RAS chlorination.

b. Tag Number: 75PMP003 and 75PMP004.

c. Delivery Capacity:

1) 30 gph maximum.

2) 1 gph minimum.

d. Total Discharge Head:

1) 30 psi at maximum capacity.

2) 20 psi at minimum capacity.

e. Pump speed: 220 rpm maximum.

f. Driver 100 VA maximum, for 120 V, single phase.

g. Electric variable speed (SCD).

h. Direct Connected.

i. Suction and discharge: 1/2 IN diameter.

j. Pump suction lift: 8 FT.

k. IP66 power and control terminal boxes.

l. Tube monitor.

m. Skid mounted, duplex, duty/standby.

n. Located at metering pump room.

4. Sodium Hypochlorite:

a. Application: Final effluent disinfection.

b. Tag Number: 75PMP001 and 75PMP002.

c. Delivery Capacity:

1) 250 gph maximum.

2) 0.5 gph minimum.

d. Total Discharge Head:
   1) 30 psi at maximum capacity.
   2) 20 psi at minimum capacity.

e. Pump speed: 265 rpm maximum.

f. Driver 100 VA maximum, for 120 V, single phase.

g. Electric variable speed (SCD).

h. Direct Connected.

i. Suction and discharge: 3/4 IN diameter.

j. Pump suction lift: 8 FT.

k. IP66 power and control terminal boxes.

l. Tube monitor.

m. Skid mounted, duplex, duty/standby.

n. Located at metering pump room.

5. Sodium bisulfite:
   a. Application: Final effluent dechlorination.
   b. Tag Number:
      1) Chlorine contact basin effluent channel: 75PMP101.
      2) Final effluent wetwell: 75PMP102.
      3) Swing Standby pump: 75PMP103.
   c. Delivery Capacity: 75PPMP101, 75PMP102:
      1) 50 gph maximum.
      2) 0.5 gph minimum.
   d. Delivery Capacity: 75PPMP103:
      1) 250 gph maximum.
      2) 10 gph minimum.
   e. Total Discharge Head:
      1) 30 psi at maximum capacity.
      2) 20 psi at minimum capacity.
   f. Pump speed: 220 rpm and 265 rpm maximum.
   g. Driver 100 VA maximum, for 120 V, single phase.
   h. Electric variable speed (SCD).
   i. Direct Connected.
   j. Suction and discharge: 1/2 IN and 3/4 IN diameter.
   k. Pump suction lift: 8 FT.
   l. IP66 power and control terminal boxes.
   m. Tube monitor.
   n. Skid mounted, triplex, two duty and one swing standby.
   o. Located at metering pump room.

2.5 FABRICATION

A. Pump:
   1. Capable of operating dry without damage to any components for 30 minutes.
   2. Repeatable accuracy: 0.1 percent of maximum output or better.
   3. Nameplate showing chemical, capacity in gallons per hour and pressure ratings.
   4. Pump shall be UL listed for chemical use.

B. Drive:
   1. Designed for continuous 24-hour operation, at temperatures up to 40°C.
   2. Power: 115 V, 1-phase.
   3. Highly maintenance free design.
   4. Leak detector: Optical-type leak sensor mounted to the drain part of the pump head for leak detection and pump shut down in the event of a tubing failure.
   5. Self-supporting drive.

C. Pump designed to prevent backflow and siphoning.

D. Tubing:
   1. 64 shore A durameter.
   2. Wall thickness: 2.4 mm to 4.0 mm.
   3. Inside diameter: 9.6 mm, minimum.

E. Rotor Assembly:
   1. Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:
      a. Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution:
         1) Compressing rollers: 316 stainless steel with low friction stainless steel bearings and PTFE seals, minimum diameter of 18mm.
      b. Provide non-compressing guide rollers constructed of corrosion resistant Nylatron.
   2. Clutch: Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch shall automatically reengage rotor to gearbox upon one complete revolution.
   3. Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gear motor via a slotted collet and central retaining screw.

OR

   4. Rotor assembly shall be equipped with two compression rollers, which shall be retractable for tube loading, SIP, or CIP flushing cycles. Compression rollers shall be located 180 degrees apart for compression of the tube against the track twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Occlusion gap shall come factory set to accommodate 4.0 mm wall thickness tube. To maximize pump efficiency, pumps without retractable rollers and/or more then 2 compressing rollers are not acceptable.
   5. The rotor assembly shall be close coupled to the output shaft of the drive gear motor by a 19 mm keyed shaft and shall be axially secured to the shaft by a through center retaining screw. Pump head track shall be secured to the drive via two slotted screws and shall be self-locating.

F. Pump head: Secured to a plate located on the drive via a slotted screw and shall be self-locating.

G. See Section 11060. Transparent and lockable-hinged pumphead guard to view direction of rotation and operator safety.

H. Controls:
   1. Control panel:
      a. Control panel as required to provide functions specified.
      b. Variable speed drive.
      c. Integral with pump.
      d. 120 V, single phase input power.
   2. Signal to plant PLC:
      a. 4-20 ma flow.
      b. 4-20 ma discharge pressure.
   3. Isolated, dry contact outputs for plant PLC:
      a. Run.
      b. Fail.
   4. Signal from plant PLC:
      a. 4-20 ma pacing signal.
      b. Isolated contact start/stop command.
   5. Full local control at pump and local-remote switching for remote signals.
   6. Control panel shall perform following functions:
      a. Display variables and operating information.
      b. Local control.
      c. Monitors pump and generates alarms.
      d. Provides local power disconnect for pumps per NEC.

2.6 ACCESSORIES

A. Provide chemical metering skid.
   1. Skid:
      a. Minimum 3/4 IN thick rigid polypropylene.
      b. Solid base, back panel, side panels, open front and top.
      c. Pedestals to elevate metering pumps.
      d. Skid assembled using thermal welding.
   2. Each skid to include:
      a. Chemical metering pumps.
      b. Calibration column:
      c. Tube element.
      d. Magnetic flow meter to discharge of each pump suitable for chemical being metered.
      e. Pressure relief valves: PVC with Teflon or Viton diaphragms.
      f. Piping: Schedule 80 PVC.
      g. Isolation valves: See valves specification sections and suitable for chemicals mentioned.
      h. Pressure indicator/transmitters: Per Section 13442 with diaphragm protection.
      i. NEMA 4X enclosure.
      j. All necessary control/signal cables for metering pumps.
      k. Skid and all piping as shown on Drawings.

B. Supply following items for each metering pump:
   1. One (1) tube element of the specified size.
   2. Two (2) one-meter long flexible reinforced PVC hoses for connection of pump to suction and discharge process pipes.
   3. Two (2) quick release to ½ IN or ¾ IN NPT adaptors per specified suction/discharge sizes.

2.7 SOURCE QUALITY CONTROL

A. Each pump shall have factory run-in test prior to shipment. See Section 11060.

2.8 MAINTENANCE MATERIALS

A. Provide the following spare parts per each pump size specified:
   1. One rotor assembly per pump model.
   2. Provide on 0 – 50 gph at 30 psi and one 0 – 250 gph at 30 psi spare metering pumps to be on shelf.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. See Section 11060.

B. See Section 01650.

C. Ensure that the metering pump equipment supplier has a factory-trained representative at the site during the startup of the metering pump equipment. The representative shall schedule his visit to the site to allow review of the installation prior to startup, observe and assist with startup, and provide training in the operation and maintenance of the pumps for the Owner’s staff. A minimum of 12 hours on site shall be provided by the manufacturer’s representative during a minimum of 2 visits for startup and training.

3.3 MANUFACTURER'S INSPECTION AND CERTIFICATION

A. See Section 11005.

END OF SECTION

SECTION 11947
INDUCTION MIXING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chemical induction units (71CI006 and one spare unit).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Coordinate power cable length, hoist details, support rails, and all other appurtenant items for equipment mounting and removal.

C. Coordinate connection between site tubing and tubing provided under this Section.

D. Manufacturer of chemical induction unit shall have at least 10 years prior experience in manufacturing of similar unit for similar application and minimum 3 installations in full operation of similar application in last 5 years.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340.
   2. See Section 11005.
   3. List of materials of construction.
   4. Packing, shipping, handling, storing and installation instructions.
   5. List of three installations with contact information.
   6. Confirmation of compliance with submergence requirements.
   7. Details of equipment support/hoist system including hoist baseplate setting template.
   8. Source quality control reports.
   9. Manufacturer's recommendation for induction unit mounting style (horizontal or vertical).

B. Operation and Maintenance Manuals:
   1. See Section 01342 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Induction units:
      a. Siemens Water Technologies - Water Champ.
      b. The Mastrrr Company – Gas Mastrrr Series 32PT.
      c. Or equal.
   2. Hoist:
      a. Thern.
      b. Or equal.

2.2 MATERIALS

A. Induction Unit (71CI006 and one spare unit):
   1. Motor housing: 316 stainless steel.
   2. Impeller/propeller: Grade 2 Unalloyed Titanium or Hasteloy-C airfoil design.
   3. Shaft, housing and miscellaneous parts in contact with the chemical: Titanium.
   4. Mechanical seal:
      a. 316 stainless steel/Hastelloy C.
      b. Silicon carbide faces.
   5. Mounting hardware and brackets: 316 stainless steel.
   6. Miscellaneous materials: Resistant to 10 to 15 percent sodium hypochlorite solution.
   7. No aluminum materials shall be used.

B. Hoist:
   1. Mounting socket: 304 stainless steel.
   2. Lifting cable: 316 Stainless steel. Cable shall be rated for lifting two times the weight of the chemical induction unit.
   3. Boom and mast: 304 stainless steel.

2.3 EQUIPMENT

A. General:
   1. Each chemical induction unit (CI) shall be of a submersible design and shall be able to transport the chemical to be induced from the source to the point of application at or above the minimum vacuum required to operate the chemical feed equipment.
   2. The CI shall be located per the manufacturer's recommendations.
   3. The CI shall be capable of inducing the chemical into the wastewater stream at a velocity of approximately 60 FT per second. The CI shall be capable of dispersing the chemical within an axial discharge pattern created by the airfoil designed propeller.
   4. The manufacturer shall coordinate the length of the power cable, hoist cables, mounting system, vacuum tubing and all other pertinent items with the elevations as shown on the drawings.

B. Performance and Design Requirements:
   1. Induction Units (71CI006 and one spare unit):
      a. Induction capacity: 250 Gal/HR sodium hypochlorite solution.
      b. Minimum submergence of equipment: Not to exceed hydraulic limitations. (See dwg 00G012 and 00G013.)
      c. Solids passage: 1/2 IN DIA.
      d. Horsepower: 5 HP.
      e. Orientation in flow: See Drawings.
   2. Contractor shall provide one spare chemical induction unit identical to 71IC006.

2.4 ACCESSORIES

A. Support/Mounting System:
   1. Consists of all required brackets, support members, guide rails with pivot bracket and stainless steel anchorage.
   2. Type 316 stainless steel guide rail system for each CI as recommended by the CI manufacturer of sufficient length to raise the entire CI above the mounting elevation.
   3. Assure rails designed adequately based on available rail anchorage locations. Provide all required support.
   4. Allows removal and replacement of equipment without entering structure.

B. Hoist:
   1. Removable mast supported in floor-mounted socket.
   2. Manual winch with stop device and free fall brake.
   3. Adjustable boom sufficient to reach equipment as located on Drawings.
   4. Lift: Sufficient to set and remove equipment, including adjacent aluminum stop logs.

5. Rate winch and cable for minimum of three times the weight of the induction unit.
6. Provide a hoist for induction unit location.
7. Provide locking features to ensure that the hoist arm/boom can be rotated and locked into position to keep from obstruction of working surface.

C. Power Cable:
1. SOOW-type, four conductor.
2. Rated for 600 V.
3. Conductors:
   a. Three #12 AWG.
   b. One #12 ground.
4. Unspliced submersible designed with submersible plug and sufficient length to extend from control panel to Induction Unit's final resting position.

D. Induction Unit Control Panel (71LCP006):
1. NEMA 4X with FRP or stainless steel material of construction with lockable disconnect in accordance with UL-508 standards and shall be UL labeled.
2. Microprocessor-based submersible motor protection system monitors chemical induction unit for overcurrent, undercurrent, high temperature, moisture detection (Capital Controls unit) and rapid cycling and trips the starter offline whenever a fault occurs.
3. HAND/OFF/AUTO switch controlling auto restart after fault condition is given.
   a. When in AUTO, a restart is attempted after a timed interval (up to 3 auto restarts before fault is generated).
   b. If fault condition is given, unit can only be started at panel using push button reset on motor protection device.
4. Single 480 V, 3 PH, 60 Hz power input.
   a. Control panel shall include motor starter and all controls.
5. Provide auxiliary switch position contacts for remote indication of switch position.
6. Fail contact for fault alarms to SCADA.
7. Status indicating lights for run and stop.
8. Auto or Run contact to SCADA.
9. Fault indication light.
10. Remote start/stop command from plant PLC to the local control system. Automatic operation will be enabled only if the RUN contact is closed.

E. Chemical Tubing and Quick Coupler:
1. Chemical liquid tubing shall be a minimum 3/4 IN diameter flexible PVC hose suitable for the chemical service conditions specified and shall have OPW Kamlok or equal fittings on each end.
   a. Hose shall have smooth inside bore with helically-wound reinforcement.
   b. Manufacturer shall provide both the hose shank couplers on all hose and the male adapters which will be connected to the chemical feed piping including a ball check valve or backpressure valve designed for the particular application.

2.5 FABRICATION

A. Completely shop assemble.

B. Motors:
1. 5 HP, 60 Hz, 460 V, Class F insulation.
2. Hermetically sealed, water cooled enclosure.
3. Integral shaft.
4. Electrical cable connection shall be through a removable water-block lead connector that is field replaceable.
5. The motor thrust bearing shall be designed for a minimum of 1500 lbs.
6. Motor windings hermetically sealed.

2.6 EQUIPMENT PAINTING

A. Standard factory applied coating is acceptable for equipment covered by this Specification.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests:
   1. Test each unit and provide documentation for:
      a. Motor amp draw.
      b. Vacuum produced.
      c. Feed rate capacities (test to be on atmospheric air).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Induction Unit 71CI006:
   1. Install at SE side of PE Diversion Box upstream of Chlorine Contact Basins.

B. Orient chemical discharge piping in relation to Induction Unit per manufacturer’s recommendations for most efficient mixing.

C. Deliver spare chemical induction unit to Owner.

D. Install hoist baseplate using drilled in epoxy anchors to side wall.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise adjustments and installation checks.
   3. Conduct initial pre-startup of equipment and perform operational checks.
   4. Provided through Contractor a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
   5. Instruct Owner's personnel for 4 HRS at jobsite on operation and maintenance.

END OF SECTION

SECTION 11980
COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Compressed air system for hydropneumatic tank and soda ash dust collector, including:
      a. Reciprocating air compressor with controls.
      b. Air filters.
      c. Air receiver.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 and Section 11005.
   2. Fabrication drawings:
      a. Air receiver fabrication drawing showing all tap locations and ASME data plate information. Show location of all control equipment.
   3. Manufacturer's installation instruction.
   4. Manufacturer's statement of proper installation and start-up.

B. Operation and Maintenance Manuals:
   1. See Section 01342.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Air compressor:
      a. Ingersoll-Rand.
      b. Worthington.
      c. Or approved equal.
   2. Air dryer:
      a. Hankison.
      b. Ingersoll-Rand.
      c. Or approved equal.

2.2 AIR COMPRESSOR UNIT

A. General:
   1. Provide an air compressor unit with the following components:
      a. Reciprocating air compressors: Two each.
      b. Air receiver: One each, complete with control and low pressure alarm pressure switches, pressure relief valves, filters, condensate drain complete and ready for operation.

c. Controls: As specified.
2. Compressors and motors shall be mounted on a heavy steel base which is mounted on the horizontal air receiver.
3. Unit shall be factory assembled piped and wired requiring field connection of air discharge piping and electrical power.

B. Reciprocating Air Compressors:
1. Each compressor shall have the following performance and configuration:
a. Capacity: 8 scfm at 100 psig.
b. Maximum pressure: 150 psig.
c. Horsepower: 5.
d. Non-lubricated cylinder(s).
e. One stage.
f. Quantity: Two (1 duty, 1 standby)
2. Compressor features:
a. Cast iron crankcase and cylinder(s).
b. Cylinder(s) bolted to crankcase.
c. Splash lubrication.
d. Finned intercooler.
e. Fan-type balance flywheel.
f. Stainless steel finger valves.
g. Centrifugal unloader.
h. Dry-type inlet filter/silencer with 4 micron replaceable element.
i. Air-cooled aftercooler.
j. Automatic start-stop, with lead-lag operation and alternation of lead compressors.
3. Motor:
a. See Section 11005.
b. Totally enclosed, fan cooled.
c. V-belt drive with belt guard.
d. 460 V, 3 PH, 60 HZ.

C. Controls:
1. Provide complete automatic control panel with all starters, controls, control switches, alarms in NEMA 4X stainless steel enclosure.

2.3 AIR RECEIVER

A. Performance and Design.
1. Quantity: 1.
2. Size: 80 gallon minimum.
3. Working pressure: 200 psi.
4. Tested pressure: 300 psi.

B. Fabrication and Manufacture:
1. Per ASME Boiler and Pressure Vessel Code.
2. Fabricated steel base or legs.
3. Manual outlet and drain valves, pressure relief valves, pressure gauge and automatic drain.
4. Necessary valves, piping and connections.
5. Cylindrical type, mounted vertically.

2.4 AIR FILTER

A. Pre-Filter:
1. Provide particle filter sized for 10 scfm.
2. Filter shall remove 99.95 percent of particles down to 1.0 micron.
3. Filter shall be equipped with a differential pressure indicator.
4. Provide automatic electric drain valve for condensate.
5. Provide with replaceable filter element.

B. Final Filter:
   1. Provide coalescing filter sized for 10 scfm.
   2. Filter shall remove 99.99 percent of particles down to 0.01 microns.
   3. Filter shall be equipped with a differential pressure indicator.
   4. Provide automatic electric drain valve for condensate.
   5. Provide with replaceable filter element.

2.5 ACCESSORIES

A. Automatic electric stainless steel drain valves:
   1. Provide automatic drain valve for condensate from filters:
      a. Valve shall have solenoid actuated valve.
      b. Solenoid shall have integral timer with adjustable setpoint for opening frequency 1 to 24 HRS and length of time open, 1 to 10 seconds.
      c. Power supply to be 110 V, 1 PH, powered from compressor control panel.

2.6 FABRICATION

A. Complete all brackets or connections and openings for air receiver and vessels prior to testing in manufacturer's plant. No field welding or drilling permitted.

2.7 SOURCE QUALITY CONTROL

A. Air Receivers and Vessels:
   1. Test and stamp in accordance with ASME code.

2.8 MAINTENANCE MATERIALS

A. Filter Element:
   1. Provide a minimum of six filter replacement elements for each filter type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with Section 11005.

B. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. See Section 01650.

B. Employ and pay for services of manufacturer's representative to:
   1. Inspect final installation.
   2. Supervise startup and perform final adjustments.
   3. Instruct Owner's representative for a minimum of 4 hours on operation and maintenance procedures.
   4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

END OF SECTION

SECTION 11982
SAMPLING AND MONITORING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Automatic sequential/composite sampler unit, complete with weatherproof insulated fiberglass enclosure, integral programmable controllers, and accessories.
   2. Unit shall be designed for use in highly corrosive environments and shall be corrosion resistant.
   3. Unit shall have a dedicated pump.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10400 - Identification Devices.

1.2 QUALITY ASSURANCE

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Complete construction details, electrical and control diagrams, dimensional data, details of refrigerator units, and other associated items.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Refrigerated automatic composite samplers:
      a. Hach Sigma, Model 900 MAX AWR.
      b. Teledyne ISCO 5800.
      c. Or equal.

B. The following items are included as part of this Project:
   1. 11CS003 – Pinole RS composite sampler.
   2. 11CS004 – Hercules RS composite sampler.
   3. 11CS005 – Combined RS composite sampler.

2.2 AUTOMATIC COMPOSITE SAMPLER

A. General:
   1. Provide complete functional automatic composite samplers furnished by the same manufacturer.
   2. Enclosure:
      a. The sampling units shall have a weatherproof-insulated fiberglass enclosure.
      b. Sampler shall be capable of operating in an ambient temperature range that encompasses 32 to 120 DegF.
      c. Provide a heater with electronic thermostat integral with the sampler.
   3. Sampler shall be capable of both sequential or composite sampling:
      a. Sampler shall be configured for composite sampling.
   4. The samples shall be automatically composited in a 5-gallon polyethylene container located in a refrigerated compartment maintained between 0 and 4 DegC.
   5. Sampling intervals: Capable of taking samples at intervals selectable in single increments from 1 to 9,999 flow pulses or timed intervals selectable in 1 minute intervals up to at least 5,999 minutes between consecutive uniform time intervals.
   6. Sample volume: Selectable in 1.0 milliliter increments from 10 milliliter to 9,999 milliliter.
   7. A positive purge shall be provided before and after each sampling to prevent clogging and cross-connection.
   8. Suction lift: Sampler shall be capable of drawing a sample to a minimum vertical height of 26 FT.
   9. Pump:
      a. Peristaltic type.
      b. Pumping rate: Minimum pumping rate shall be 2.0 FT per second through 3/8-IN or 5/8 IN inside diameter tubing at 15 FT of vertical lift.
      c. Power: 120 volt, single-phase, 60 Hz.

2.3 SAMPLER CONTROL

A. Each Individual Sampler Unit:
   1. Capable of fully automatic operation and be paced by transmitters located in the following primary elements:
   2. Equip each flow meter with a contact integrator which provides a switch closure output to the sampler at a rate proportional to the measured flow.
      a. The number of closures and duration of each shall be coordinated to provide the desired sample volume.
      b. Provide with each sampler a contact to reset the contact integrator in the flow-totalizer-integrator.

B. Provide each sampler with a timer mechanism to allow for alternate timed operation of the unit.
   1. Provide selector switch to allow selection of either flow proportioned sampling or time sampling.

C. Provide electronics in samplers capable of receiving a 4:20 mA DC control signal from which the sampler can be paced at a rate proportional to the flow.

D. Coordinate the control requirements of each sampler with the Instrumentation and Controls Design.

2.4 IDENTIFICATION AND TAGGING

A. Comply with Section 10400.

2.5 ACCESSPROES

A. Provide 1 set of the following for each sampler furnished:
   1. 1 spare sample tube.
   2. 10 FT of spare pump tubing.

3. 1 spare strainer.
4. 24 extra 1000 ml polyethylene bottles with rack.
5. 1 extra 5-gallon polyethylene container.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install sampling equipment in locations and arrangements so as not to interfere with access or egress from buildings or other equipment.

END OF SECTION

SECTION 13121
METAL BUILDING SYSTEMS
(PUBLIC WORKS BUILDING)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Complete metal building system including but not limited to:
      a. Design.
      b. Materials.
      c. Fabrication.
      d. Shipment.
      e. Erection.
      f. Components as specified.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 621, Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
   2. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges (referred to herein as AISC Code of Standard Practice).
   3. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      a. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
      b. A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
      c. C991, Standard Specification for Flexible Fibrous Glass Insulation for Metal Buildings.
      d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. American Welding Society (AWS):
      a. D1.1/D1.1M, Structural Welding Code - Steel.
   5. FM Global (FM).
   6. International Accreditation Service (IAS):
      a. AC472, Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems.
   7. Metal Building Manufacturer's Association (MBMA):
      a. Low Rise Building Systems Manual.
   8. Research Council on Structural Connections (RCSC):
      a. Specification for Structural Joints Using High-Strength Bolts.
   9. The Society for Protective Coatings/NACE International (SSPC/NACE).
      a. SP 6/NACE No. 3, Commercial Blast Cleaning.
   10. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

11. Building code:
    a. California building Code (2013) edition including all amendments, referred to herein as Building Code.

B. Qualifications:
    1. Manufacturer's qualifications:
        a. Manufacturer must be member in good standing of the MBMA.
        b. Manufacturer must be currently approved by IAS Accreditation Committed under the Inspection Programs for Manufacturers of Metal Buildings Systems IAS AC472.
    2. Erector qualifications:
        a. Erector (installer) must be approved in writing by metal building manufacturer.
        b. Erector must have minimum of 10 years current experience in erection of similar structures.
    3. Manufacturer's Civil or Structural Engineer: Registered in the State of California.

1.3 DEFINITIONS

A. Code: The word "code" refers to the Building Code.

B. Installer, Erector or Applicator:
    1. Installer, erector or applicator is the person actually installing, erecting or applying the product in the field at the Project site.
    2. Installer, erector and applicator are synonymous.

C. PVDF: Polyvinylidene fluoride.
    1. Nomenclature as listed in Bibliography of the MBMA Low Rise Building Systems Manual.

1.4 SYSTEM DESCRIPTION

A. Building shall be non-insulated, clear span rigid frame type with vertical walls and gable type roof.
    1. Provide full height wall liner panels and ceiling liner panel.
    2. Provide cross bracing in the side walls perpendicular to the rigid frame.

1.5 SUBMITTALS

A. Shop Drawings:
    1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
    2. Product technical data including:
        a. Acknowledgement that products submitted meet requirements of standards referenced.
        b. Manufacturer's technical reference manual containing all of the manufacturer's standard construction details and specifications.
            1) Manufacturer's erection manual containing all details and methods for installation of building frame, roof system, wall system, and accessories.
            2) Edit to mark out items not used for this installation.
    3. Design and fabrication drawings:
        a. Erection drawings minimum scale: 1/8 IN = 1 FT-0 IN.
        b. Details and sections minimum scale: 1-1/2 IN = 1 FT-0 IN.
        c. List of all design loads and combination of loads.
        d. Size and location of each component of the building.
            1) Include clearance under structural framing members, both horizontal and vertical.
            2) Include cross-section of components.
        e. Fasteners and details of fasteners connecting each component of the building.
        f. Size, location and details of anchor bolts, base plates, and all other components fastened to the foundation.
            1) Size anchor bolts and base plates assuming 4000 psi concrete.
        g. Details of wall panels, roof panels, finishes, flashings, closures, closure strips, trim, gutters, downspouts, calking, and all other miscellaneous components.

B. Samples:
   1. Metal color and finish samples of roof and wall panels, roof trim, wall trim, and interior liner panel colors for Engineer's selection.
   2. Color chart is not acceptable.

C. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

D. Informational Submittals:
   1. Manufacturer's and Erector's Qualifications.
   2. Manufacturer's approval of erector.
   3. Manufacturer's Certificate of Accreditation per IAS AC472 or AISC Quality Certification.
   4. Structural calculations stamped and signed by a professional Civil or Structural Engineer licensed in the State of California.
      a. Include list of design loads and loads transmitted to foundation through columns or walls and location where loads occur.
      b. Submit calculations for information only.

1.6 WARRANTY

A. Manufacturer's standard warranty.

B. Manufacturer's standard warranty for factory applied PVDF coating system against blistering, chipping, cracking, peeling, or color fading of wall and roof panels.

C. Manufacturer's 20 year weather tightness warranty of roof assembly.

D. Provide written notice of any exceptions taken to warranties.
   1. Any exceptions may be grounds for not accepting the manufacturer, at the discretion of the Owner or Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Metal building systems:
      a. Butler Manufacturing.
      b. NCI Building Systems.
      c. Nucor Building Systems.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Structural Members: Galvanized steel.

B. Anchor Bolts:
   1. ASTM A307, ASTM A36/A36M, or equal, galvanized steel.
   2. Embedment details to be developed by Engineer upon receipt of anchor bolt and loading information for approved Shop Drawings from building manufacturer.

C. Fasteners:
   1. Building frame, girts, and purlins: Galvanized ASTM A325, ASTM A490 or ASTM A307 bolts.
   2. Roof and wall panels: Stainless steel.
   3. Miscellaneous fasteners: Corrosion resistant.

D. Any structural member to be hot-dipped galvanized shall be minimum 12 GA thickness.

E. Roof and Wall Panels: Steel.

F. Translucent Panels: Fiberglass or acrylic.

G. Gutters and Downspouts: Aluminum.

H. Grout: See Division 03.

I. Closures: Neoprene.

J. Calking and Sealants: See Specification Section 07900.

K. Trim: Same material as wall or roof panel.

2.3 ACCESSORIES

A. Wall Liner Panel:
   1. Profile: Similar to "BUTLERIB II Wall System by Butler Manufacturing.
   2. Minimum 26 GA steel.
   3. Galvalume:
      a. ASTM A792/A792M, Grade 50B.
      b. Provide AZ50 coating for painted surfaces and AZ55 coating for unpainted surfaces.
   4. Height: See Contract Drawings.
   5. Finish: Manufacturer's standard baked enamel.

B. Roof Liner Panel:
   1. Profile: Flat panel.
   2. Minimum 26 GA steel.
   3. Galvalume:
      a. ASTM A792/A792M, Grade 50B.
      b. Provide AZ50 coating for painted surfaces and AZ55 coating for unpainted surfaces.
   4. Finish: Manufacturer's standard baked enamel.

C. Overhead Doors: Manufacturers standard (aluminum).

D. Metal Pedestrian Doors and Frames: Manufacturers standard (hollow metal).

E. Framed Openings:
   1. Walls:
      a. Provide all necessary subframing, including connections, to support wall openings for doors, windows, louvers, pipe or duct penetrations, etc.
         1) Material gage to be determined by metal building manufacturer for size of opening.
      b. Size and location of opening as shown on the Drawings.
      c. Jamb, lintel and girts:
         1) Steel:
            a) Factory applied prime coat per Specification Section 09905.
         2) Metal building manufacturer responsible for providing correct size opening for penetration scheduled, shown or specified.
      d. Provide trim to cover all exposed areas of opening frames to match with the wall panels.
   2. Roofs:
      a. Provide all necessary roof subframing to support roof mounted equipment and to frame roof penetrations.
         1) Material gage to be determined by metal building manufacturer for size of equipment or opening.
      b. Location of roof mounted equipment and/or roof or wall opening as shown on the Drawings.
      c. Purlins, angles, clips:
         1) Steel:
            a) Factory applied prime coat per Specification Section 09905.

2) Metal building manufacturer responsible for providing correct size of opening for penetration scheduled, shown or specified.

F. Roof Crickets:
1. Provide roof crickets on all roof curbs to direct water to each side of the curb.
2. Roof cricket material shall be same material as roof panels.

G. Gutters and Downspouts:
1. Size:
a. Provide minimum 4 x 4 IN gutter and minimum 3 x 5 IN downspout in manufacturer's standard profile best suited for project.
2. Minimum 0.040 IN aluminum.
3. Corrosion protection treatment and final finish same as roof panels.
4. Expansion joints: 150 FT maximum spacing but not less than 1 per side of building requiring gutters.
5. Locate/arrange downspouts to avoid drainage on sidewalks, landings, stoops, driveways, etc.

H. Roof Penetration Flashing (Maximum 13 IN DIA):
1. Flashing material: EPDM rubber with an aluminum sealing ring base.
2. Minimum projection above the weather surface of the roof: 8 IN.
3. Configuration of the flanges to match the roof panel.

2.4 BUILDING DESIGN CRITERIA

A. Critical Dimensions:
1. Roof slope: Manufacturer minimum.
2. Provide minimum clear height of 12 FT at lowest interior structure line.

B. Building Foundation:
1. All footings, foundations, anchor bolts and piers have been designed based on assumed loadings and reactions.
a. Member sizes and geometry may vary depending on the building being supplied.
b. Do not construct these members until Engineer has verified design with approved Shop Drawings of metal building being supplied.

C. Modifications:
1. Buildings which vary dimensionally from those indicated may be bid providing:
a. Minimum interior horizontal dimensions and clear heights are maintained.
b. Door and window locations and sizes are maintained.
c. Foundation re-design and all construction costs are included in Bid.
2. Building dimension changes in either horizontal or vertical direction resulting in either 21 percent change of envelope volume or lighting height or spacing shall be addressed by incorporating any necessary changes to mechanical or electrical systems or any other building component impacted, at no additional cost to Owner.
a. Design changes must be approved by Engineer prior to constructing changed item or system.
b. Does not apply to structural member sizes.
3. Contractor is responsible for incorporating any necessary changes to foundations, mechanical, or electrical systems or to any other building component.
a. Design changes must be approved by Engineer prior to constructing changed item or system.
4. Completed building to be free of excessive noise from wind induced vibrations under ordinary weather conditions to be encountered at location of erection, and meet all specified design requirements listed below.

D. Roof Live Loads:
1. Roof panels:
a. Per Building Code.

b. 50 psf uniformly distributed live load.
c. 200 LB concentrated (point) live load (over a 1 x 1 FT area) located at center of maximum roofing (panel) span.
d. The most severe condition governs.

2. Roof framing members:
   a. Per Building Code.
   b. Roof framing members do not need to be designed for 50 psf uniform or 200 LB concentrated live loads.
3. The above loads are in addition to other applicable equipment loads and shall be applied to the horizontal projection of the roof.

E. Wind Loads:
1. Design structure for wind loading as set forth in the Building Code.
   a. Project site conditions are as follows:
      1) Basic wind speed: 115 mph.
      2) Site exposure: Class C.
      3) Risk Category: III.
      4) Enclosure type: Enclosed.

F. Seismic (Earthquake) Loads:
1. Design structure for seismic forces as set forth in the Building Code.
   a. Project site conditions are as follows:
      1) Importance factor: 125.
      2) Spectral response acceleration (Ss): 1.736.
      3) Spectral response acceleration (S1): 0.688.
      4) Site class: D.
      5) Spectral response coefficient (Sds): 1.15.
      6) Spectral response coefficient (Sd1): 0.688.
      7) Seismic design category: D.

G. Auxiliary Loads:
1. Consider other superimposed loads as part of the design requirements and combine with the normal design (dead, live, seismic and wind) loads as prescribed hereafter.
   a. Static loads:
      1) 8 psf. MEP load.
2. Magnitude and location of auxiliary loads as shown on Drawings and as specified.
   a. Contractor to coordinate and verify magnitude and location of auxiliary loads before fabrication.

H. Combination of Loads:
1. The combining of dead, live, wind, seismic and auxiliary loads for design purposes as set forth in the Building Code, unless otherwise specified.
2. Horizontal sway deflection of building due to combination of required design loads: Shall comply with the Building Code.
3. Deflection of purlins and secondary members not to exceed L/180 of its span when supporting applicable vertical live, dead, and auxiliary loads.
4. Wind beams supporting masonry walls: Do not deflect more than L/240 of its span when resisting applicable loads.
5. Lintel beams supporting brick/masonry: Do not deflect more than the lesser of L/600 of span or 0.3 IN.

2.5 FABRICATION

A. General:
1. Fabricate building structure, roof and wall panels, accessories and trim in accordance with requirements of AISC and MBMA.
2. Provide all necessary clips, flashing angles, caps, channels, closures, bases and any other miscellaneous trim required for complete water and airtight installation.

a. Provide an inside closure at the base of all corrugated panels and an outside closure at the top of all corrugated panels in addition to all other closure strips required.
   1) Form closure strips to fit the corrugation of the metal panels and securely support in place.
   2) Closure strips shall fit between corrugated panels and trim or flashing as required to completely separate the interior of the building from the exterior.
b. Provide flashing at all intersections of wall panels and roof panels, and above all openings in wall and roof panels, in addition to all other flashing required.
   1) Form flashing:
   2) To completely contain water on the outside of the building.
      a) To be watertight and securely fastened in place.
c. Provide calking at all edges where metal panel trim or flashing is adjacent to the foundation of the building in addition to all other calking required.
   1) Securely adhere calk material to the foundation and the metal panels trim or flashing.

3. At door and window and louver openings, provide additional framing and fasteners as required to structurally replace the wall panel and/or framing displaced.
4. Fabricate and prepare material for shipment knocked down.
5. Factory punch frame to receive all fasteners.
6. Finishes:
   a. Clean ferrous surfaces of oil, grease, loose rust, loose mill scale, and other foreign substances.
      1) Clean all primary and secondary structural steel members, not noted as being galvanized, in accordance with SSPC SP 6/NACE No. 3.
   b. All structural components shall have primer paint coats applied in the shop and finish coats applied in the field.
      1) Shop paint, prime and finish coats, all surfaces which will be inaccessible after erection.
      2) Paint in accordance with Specification Section 09905.
      3) Paint surfaces of all components not exposed to view.
      4) Manufacturer's standard shop applied primer is not acceptable as substitute for primer specified.
   c. Wall and roof panels:
      1) Exterior surface:
         a) Thermosetting fluoropolymer resin enamel.
            (1) Minimum 70 percent "KYNAR" resin.
         b) Meet requirements of AAMA 621.
         c) FM Class 1 rated.
         d) Exposed screw heads shall match color of panel.
      2) Interior surface:
         a) Same finish as exterior surface.

B. Roof Panels:
   1. 24 GA minimum, galvalume per ASTM A792/A792M.
   2. Standing seam interlocking rib configuration.
   3. Factory applied color coating.
   4. Meet requirements of AAMA 621.
   5. Length: Sufficient to cover entire length of any unbroken roof slope up to 40 FT.
   6. Panel width: 36 IN.
   7. Profile: 2 IN.
   8. Panel depth: Standard.
   9. Concealed fasteners.

C. Wall Panels:
   1. 26 GA minimum, galvalume per ASTM A792/A792M.
   2. Factory applied color coating.
   3. Meet requirements of AAMA 621.

4. Length sufficient to cover entire height of any unbroken wall up to 40 FT.
5. Panel width: 36 IN.
6. Profile: 1 IN.
7. Panel depth: Standard.
8. Concealed fasteners.

2.6 SOURCE QUALITY CONTROL

A. See the QUALITY ASSURANCE Article, Qualifications Paragraph in PART 1 of this Specification Section for manufacturer's internal quality control requirements.

B. Testing:
   1. Owner may employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
   2. Independent testing agency shall have a minimum of five (5) years performing similar work and shall be subject to Owner's approval.

2.7 MAINTENANCE MATERIALS

A. Provide 8 OZ of touch up paint for each color provided on the building.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
   1. Install tolerances in accordance with AISC 303, Code of Standard Practice.
      a. Install products straight without bowing, sagging, or warping.
   2. Install all fasteners.
   3. Install base plates on grout bed.
      a. Grout bed to be 1 IN thick unless noted otherwise on the Drawings.

B. Place roof insulation over roof support members.
   1. Tape all joints and tears in vapor barrier with tape recommended by vapor barrier manufacturer.

C. Place wall insulation between girts and wall panels.
   1. Tape all joints and tears in vapor barrier with tape recommended by vapor barrier manufacturer.

D. Separate the roof support member from the roof panel, except at each concealed structural fastener, with a spacer of material having a density of not less than 2 pcf and, if of a combustible material, having a flame spread rating no greater than 25.

E. Fasten roof panels to purlins or secondary support members in accordance with manufacturer's recommendations.

F. Install liner panels in accordance with manufacturer's recommendations.
   1. Completely seal air tight around all building structural members and bracing when these members penetrate the liner panel.

G. Install wall panels to supporting structure with concealed fasteners.
   1. Finish of fasteners to match panel finish.

H. Install door frames, window frames, louvers, trim and other miscellaneous items in accordance with manufacturer's instructions and details.

3.2 FIELD QUALITY CONTROL

A. All inspections and tests are to be performed at the Project site by a third party independent testing agency.

B. Inspect field welding in accordance with AWS D1.1/D1.1M, Section 6 including the following non-destructive testing:
   1. Visually inspect all welds.
   2. Test 50 percent of full penetration welds and 10 percent of fillet welds with liquid dye penetrant.
   3. Test 20 percent of full penetration welds with ultrasonic or radiographic testing.

C. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints, Section 9.
   1. Inspect while work is in progress.

D. Inspect structural steel which has been erected.

E. Prepare and submit test reports to Engineer.

3.3 ADJUSTING AND CLEANING

A. Touch up paint any scratched factory finished surfaces or remove and replace as directed by Engineer.

B. Remove and replace any damaged wall or roof panels, frames, etc., as directed by Engineer.

END OF SECTION

SECTION 13123
REINFORCED FIBERGLASS ENCLOSURE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fiberglass Reinforced Plastic (FRP) shelter.

1.2 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instruction.
   3. Fabrication and/or layout drawings.
   4. Electrical and fire suppression system design drawings.
   5. Certification of FM approval.
   6. Recommended anchoring and grounding requirements.
   7. Engineering calculation for anchoring of the shelter with associated anchoring clips.
   8. Structural calculation design drawing stamped and signed by a California professional engineer.
      a. Submit shelter color selection to the Owner.

B. Operation and Maintenance Manual:
   1. See Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fiberglass reinforced shelter:
      a. Plasti-Fab, Inc.
      b. Warminster Fiberglass.
      c. Bebco Industries.
      d. Or approved equal.

2.2 MANUFACTURED UNIT

A. Fiberglass Reinforced Shelter:
   1. Shelter design shall conform to Seismic Design Category D (CBC 2013).
   2. Dimensions:
      a. Footprint: See construction drawings.
      b. Wall height: 8 FT minimum.
      c. Door width: 3 FT minimum.
      d. Door height: 7 FT minimum.
   3. No windows.
   4. Open base and top lift design.

5. Provide bulk head at wall penetration for electrical conduit and mechanical piping as shown on Drawings.
6. Door to be weather-tight (sealed) and equipped with locking system that may be engaged for disengaged from outside (with key) and from inside (without key).
7. Insulation, minimum 4 IN wall thickness.
8. Provide weather proof, and chemical and corrosion resistant shelters.
    a. The shelters shall be capable of withstanding splash and spillage of following liquids:
        1) Municipal raw sewer.
        2) Chemicals:
            a) Sodium hydroxide: 50 percent concentration.
            b) Ferric chloride: 40 percent concentration.
9. Design and provide exhaust fan and heater based on area classification, weather condition and room size. Exhaust fan design shall be based on 6 air exchange/hour.
10. Provide adequate lighting to read and record metering pump display screen, and for typical plant operation.
11. Provide shelter color selection to Owner.
12. Mount to concrete slab on grade with epoxy anchor bolts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. FRP Enclosure:
    1. Verify that area to receive unit(s) has been leveled to tolerances indicated in Division 3.
    2. Verify anchor bolt requirements.
        a. Bolts and setting of bolts to be provided by Contractor.
        b. See Section 03151.

3.2 INSTALLATION

A. Install all components of the specification section per manufacturer requirements.

B. Protect installed unit from damage until final building acceptance by Owner.

END OF SECTION

SECTION 13206
COVERS: FIBERGLASS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fiberglass reinforced plastic (FRP) flat walkable cover units for enclosure of round tank.
   2. All hardware, fasteners, and supports required for attaching cover units to concrete structure.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society for Testing and Materials (ASTM):
      a. ASTM D256 – Determine the Pendulum Impact Resistance of Notched Specimens of Plastics.
      b. ASTM D570 – Water Absorption of Plastics.
      c. ASTM D638 – Tensile Properties of Plastics.
      d. ASTM D696 – Coefficient of Linear Thermal Expansion of Plastics between -30ºC and 30ºC.
      e. ASTM D790 – Flexural Properties of Unreinforced and Reinforced Plastics and Insulating Materials.
      f. ASTM D2583 – Indentation Hardness of Rigid Plastics by Means of Barcol Impressor.
   2. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on International Building Code, associated standards and all amendments, referred to herein as Building Code.

B. Shop Drawing submittal shall be stamped by a professional structural engineer registered in the State of California verifying cover and anchorage design.

C. Cover manufacturer shall be responsible for designing the interface between the fiberglass cover structure and the concrete tank walls, taking into account the forces created due to the different coefficients of expansion of the two materials.

D. Manufacturer of cover system shall have minimum of (5) years experience in design and fabrication of the type and size of system specified in this Section.

E. Manufacturer shall submit information on (5) wastewater treatmentplants in which its cover have been installed and operational for at least (3) years.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Certification that cover system provided meets or exceeds specified loadings.
   3. Proof of registration from professional engineer stamping submittals.
   4. Stamped drawings showing dimensional layout and supports.
   5. Details of materials of construction.
   6. Details on joint attachment, connections, panel attachment, cover/wall interface, attachment of walkway, hatches, light poles and ductwork supports/curbs/details.
   7. Horizontal and vertical forces from the cover to wall due to dead load, live load conditions and temperature.
   8. Procedure for cover erection.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Meet the requirement of relevant sections and the manufacturer's written instructions.

B. Handle and store cover system components using equipment and components that will prevent puncture, scratching, and abrasion of fiberglass laminates.

1.5 WARRANTY

A. Provide one year manufacturer's materials and workmanship warranty covering all components of the cover system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Covers:
      a. Glass-steel, Inc.
      b. Enduro.
      c. Or equal.
   2. Sealant and gaskets:
      a. Dow 790.
      b. GE Silicone.

2.2 MATERIALS

A. FRP Physical and Mechanical Properties:
   1. Tensile strength: 30,000 psi minimum.
   2. Flexural strength: 2.5×10^6 psi minimum.
   3. Barcol hardness: 60 minimum.
   4. Notched izond impact: 12 ft-lbs/in minimum.
   5. Water absorption: 0.60 percent minimum.

B. Resin:
   1. Industrial quality, fire retardant isothalic resin.
   2. Pigmented to ensure that resulting component is opaque.
   3. Containing ultra-violet stabilizers for protection against sunlight.

C. Glass Reinforcement:
   1. Continuous strand rovings and mat 50% by weight.

D. All surfaces shall have a Remay veil for UV resistance in addition to all walking surfaces having a UV resistant non-skid surface.

E. All laminates shall be pultruded (dense, and free of voids and dry spots, cracks and crazes).

F. Hardware:
   1. All fasteners, handles, latches, and brackets shall be provided by the launder cover manufacturer.
   2. Fasteners, handles, and latches shall be Type 316 stainless steel.
   3. Brackets may be Type 316 stainless steel or FRP.

G. All other items not specifically designated otherwise to be Series 300 stainless steel.

H. Sealant and Gaskets: Silicone.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Flat walkable cover system shall consist of pultruded fiberglass panels which are attached together to form a continuous monolithic cover system over the opening to be covered, as shown on the Contract Drawings.

B. Covers shall be designed and manufactured to act as a walking access area and contain any odors from escaping.

C. Neither the cover nor the means to support it shall interfere with equipment below.

D. Individual cover panels shall be fabricated in maximum 8'0"wide panels by full span between supports. When panels lengths are beyond the span that the primary panel will span a structural bracing system will added to the bottom of the cover as an integral structural stiffening system. When required, separate structural members not part of the cover itself can be added where required. Size and configuration of the separated support system shall be designed by the cover manufacturer to accommodate load and deflection requirements of the project.

E. All cover walking surfaces will have a non-skid walking surface. All exposed surfaces will have a surfacing veil as an integral part of the pultruded components.

F. All supports under the cover panels will have sponge neoprene seals between the support and the cover edge in contact with the supports. All cover sections will have seals attached to the sides, and ends if required, of either sponge neoprene or a hollow J-Bulb neoprene seal. All seams within the cover assembly will be sealed so that when the entire system is installed it will form an air and water tight system.

G. Access doors will be integral to the cover with Type 316 stainless steel piano hinge for the door hinge and a Type 316 stainless steel twist lock for lifting the door to the cover. The handle on the twist lock will fold flat to the cover when not in use.

H. Performance and Configuration Requirements:
   1. Fiberglass cover:
      a. 45 FT DIA.
      b. Low profile.
      c. Design loadings:
         1) Dead load:
            a) Cover and framing self weight.
            b) Equipment, pipe, duct weight attached to cover.
         2) Live loads:
            a) Uniform loading: 20 psf over the projected area.
            b) Concentrated loading: 300 LBS distributed uniformly over an area 2.5 FT by 2.5 FT that produces the maximum load effects on cover.
         3) Wind loadings: Calculate wind loads based on the Building Code.
            a) Ultimate design wind speed: Vuh = 115 MPH.
            b) Normal design wind speed: Vasd = 88 MPH.
            c) Risk Category: III.
            d) Exposure C.
         4) Design cover to withstand stresses due to ambient temperature changes as follows:
            a) Low range: -40 DegF.
            b) High range: 130 DegF.
         5) Capable of 0.5 IN WC induced by ventilation system.
         6) Seismic loadings: Calculate seismic loads based on the Building Code.
            a) Risk category: III.
            b) Spectral response acceleration: $S_S = 1.736$ $S_1 = 0.688$
            c) Spectral response acceleration: $S_{DS} = 1.157$, $S_{D1} = 0.688$
            d) Site Class: D.
            e) Seismic design category: D.

2.4 FABRICATION

A. Self-supporting from periphery structure primary horizontal thrust contained by an integral tension ring.

B. Allow for thermal expansion.

C. Fabricate dome surface paneling as a watertight system under design load conditions.

D. Provide tension and compression ring to withstand horizontal cover thrust.

E. Design dome to support the weight of the duct, duct supports and hangers.

F. Provide connection points for duct support and hangers in accordance with process drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide sleeve for all duct penetrations.

C. Provide a 1/8 IN seal between all fiberglass to concrete connections.

D. Perform fabrication and erection such that dome is plumb, level and in proper alignment.

E. Field refabrication, weather shielding or force fitting of structural components are not allowed.

F. Apply all sealants and gaskets such that they are confined to the joint area.

G. Remove all excess sealant from panels.

H. Ensure gaskets are continuous in the joint.

I. Cover raw edges of fiberglass panels, seal and firmly clamp in an interlocking manner to prevent slipping or disengagement under all load and temperature changes.

J. Install continuous, flexible, airtight seal between cover and wall which provides for cover movement. Attach to concrete with stainless steel strap and set screws.

END OF SECTION

SECTION 13211
HYDROPNEUMATIC (SURGE) TANK

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials and equipment necessary for the fabrication and erection of a minimum 6,770 gallon, steel, horizontal hydropneumatic/surge tank and all tank accessories in accordance with the Drawings and as described in this section.

B. Tank and accessories shall be shop fabricated, tested and certified in accordance with ASME codes and requirements, and with other appropriate codes and regulations including, but not necessarily limited to, AWWA and OSHA.

C. All materials including coatings shall be NSF certified.

1.2 REFERENCES

A. The following standards shall apply to the Work of this Section where applicable. All of the latest revisions shall apply:
   1. American Water Works Association (AWWA)
      a. D100, Standard for Welded Steel Tanks for Water Storage
      b. D102, Standard for Painting Steel Water Storage Tanks
   2. American Welding Society (AWS)
      a. Publication D1.1, Structural Welding Code, Steel
   3. American Society for Testing and Materials (ASTM)
      a. A 36, Structural Steel
      b. A 53, Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
      c. A 283, Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
      d. A 442, Pressure Vessel Plates, Carbon Steel, Improved Transition Properties
      e. A 516, Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
      f. A 517, Pressure Vessel Plates, Alloy Steel, High-Strength, Quenched and Tempered
      g. A 537, Pressure Vessel Plates, Heat-Treated, Carbon-Manganese-Silicon Steel
      h. A 573, Structural Carbon Steel Plates of Improved Toughness
      i. A 580, Stainless and Heat-Resisting Steel Wire
      j. A 588, High-Strength Low-Alloy Structural Steel With 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick
      k. F 593, Stainless Steel Bolts, Hex Cap Screws, & Studs
      l. F 594, Stainless Steel Nuts
      m. A 633, Normalized High-Strength Low-Alloy Structural Steel
      n. A 662, Pressure Vessel Plates, Carbon-Manganese, for Moderate- and Lower-Temperature Service
      o. A 678, Quenched and Tempered Carbon Steel Plates for Structural Applications
   4. American National Standards Institute (ANSI)
   5. Occupational Safety and Health Administration (OSHA)
   6. International Conference of Building Officials (ICBC)
   7. Uniform Building Code (UBC)
   8. 2013 California Building Code (CBC)
   9. National Association of Corrosion Engineers (NACE)
      a. Standard RP0178-91, Standard Recommended Practice - Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service.

b. Visual Comparator - Surface Finishing of Welds (Complements NACE Standard RP0178)
c. NSF International (NSF).
d. ANSI/NSF Standard 61, Drinking Water System Components - Health Effects

1.3 STANDARDS FOR THE WORK

A. Complete System: Provide a complete, operable system with all elements properly interconnected. Furnish and install a complete surge control system, including surge tank, tank supports, concrete slab, air compressor and controls, electrical components, connecting piping, fittings and valves and appurtenances as shown on the Drawings. If a specific dimensioned location is not shown for interconnections or smaller system elements, select appropriate locations and show them on Shop Drawing submittals for review.

B. Provide equipment and material new and without imperfections. Erect in a neat and workmanlike manner; aligned, leveled, cleaned and adjusted for satisfactory operation; installed in accordance with the recommendations of the manufacturers and the best standard practices for this type of work so that connecting and disconnecting of piping and accessories can be readily made and so that all parts are easily accessible for inspection, operation, maintenance and repair. Locate oil and lubrication fittings clear of and away from guards, base, and equipment and within reach from the operating floor. Coordinate location of all motor connections in order to properly orient encased electrical conduits. In order to meet these requirements with equipment as furnished, minor deviation from the Drawings may be made as favorably reviewed by the Engineer.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:
1. Standards:
   a. The tank, foundation, and all accessories shall, at a minimum, comply with ASME and AWWA standards and guidelines, latest revision at the time of bidding, unless herein modified, deleted, or amplified.
   b. The tank must be designed in accordance with ASME Boiler and Pressure Vessel Code, Division 1, Section VIII, latest edition, the Uniform Building Code, latest edition, the 2013 California Building Code, and ANSI B 16.5.
   c. The minimum plate thickness for any tank shell plate, stiffener, or accessory item shall be 1/4 in unless otherwise approved in writing.
   d. The tank shall be ASME certified and tagged as such.
2. Design Loads:
   a. The tank and foundation shall be designed using the most conservative foundation, member sizes, and support steel thicknesses as determined by utilizing the ASME, UBC, CBC, and/or AWWA design loads and allowable loads and stresses.
3. Seismic Zone:
   a. The tank is located in Pinole, CA.
   b. The tank and foundation shall be designed using the most conservative design for seismic loading in accordance with the requirements of CBC 2013 and or AWWA.
4. Soils Investigation:
   a. A soils investigation has been conducted by an independent soils laboratory.
   b. A copy of the soil borings and report shall be available at the office of the Owner.
5. Foundation Design:
   a. The reinforced concrete hydropneumatic tank foundation design is shown on the Drawings. However, Contractor shall confirm the dimensions, reinforcement and configuration, and coordinate the fabrication of the tank and the foundation accordingly.
6. Foundation Construction:
   a. The tank foundation excavation shall be prepared per Section 02200.

7. Corrosion Allowance:
    a. A minimum corrosion allowance of 1/16 IN shall be provided in the tank.
8. Seal Welding:
    a. All welded connections and welded interfaces on the container interior both above and below the high water line shall be welded all around to eliminate crevices and open joints.
    b. This applies to all structural and accessory components.
    c. “Skip welding” or “Stitch welding” will not be allowed.
9. Measurements:
    a. Measurements shall be taken prior to the water test.
10. Design and Drawing Certification:
    a. All designs, drawings, and details for this project shall be performed under the supervision of a Professional Structural Engineer registered in the State of California and shall have the dated seal and signature of that Engineer affixed to all submittals in accordance with Section 01340 - Submittals.

1.5 ACCEPTABLE MANUFACTURERS

A. The manufacturer shall be experienced in the design and operation of treated wastewater surge control systems for a minimum of 5 years and shall provide a list of similar installations for engineer review.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Hanson Tank.
    2. Wessels Company.
    3. AA Tank.
    4. Young Engineering.
    5. Pulsro.
    6. Or approved equal.

1.6 SUBMITTALS

A. Submit the following in accordance with Section 01340.
    1. Construction Drawings:
        a. Manufacturer’s drawings, data, etc. shall be reviewed by the Engineer in accordance with Section 11005.
        b. Review of these drawings shall not relieve the Contractor from responsibility for compliance with the specifications or for the adequacy of the design and construction methods or for completion of the Project on time.
        c. If necessary to verify the structural adequacy of a structural member and/or connection, the Contractor shall provide design and detailing data to the Engineer.
        d. Drawings shall include the dimensions of the tank, the thicknesses of all plates and the sections of all principal members. Show sizes and arrangement of equipment, foundation, and anchor bolts required, performance characteristics, fan curves and pump curves, control diagrams, wiring diagrams motor data sheets, methods of assembly and connections to other work.
        e. Manufacturer’s calculations and drawings shall bear the seal of a licensed Professional Engineer registered in the State of California.
        f. Manufacturer’s drawings shall not deviate in substance from the Contract Drawings and Specifications as to location, size, type and design of equipment.
    2. Calculations:
        a. Submit ASME calculations for heads, shell and penetrations, tank support calculations per L.P. Zink practice and UBC and CBC wind and seismic requirements, and ASME Forms U-1A and U-3.

3. Details:
    a. The location and size of all manholes, vents, piping, and ladders shall be detailed on the construction drawings.
    b. These construction drawings shall include all member thicknesses, dimensions, welding details, material specifications, shop and field assembly instructions (including any temporary attachments or openings), cleaning and painting instructions, and foundation interface dimensions and loadings.
    c. Upon specific request of the Engineer, design calculations may be required to support the construction drawings.
    d. Detailed control panel, electrical and control wiring, and layout diagrams showing component designation and rating. Show terminations for SCADA connections at control panel.
4. Capacity Chart:
    a. Contractor shall submit copies of the tank capacity chart using one-half (1/2) foot increments.
5. Roll-Out:
    a. Submit a roll-out layout of the tank showing all weld seams, the types and thicknesses of each weld seam, total footage of each type of weld, approximate number of radiographs, and if and where the tank will be cut and rewelded for erection, rigging, or ventilation purposes, including distinctions between seams welded in the shop, on the ground, and in the air.
    b. This drawing shall also be used to record all actual radiograph locations.
    c. This drawing shall be submitted prior to tank fabrication and erection.
6. Product Data:
    a. All drawings, catalog cuts or other descriptive information submitted to the Engineer for review shall bear a signed approval by the Contractor that the submitted material meets these specifications.
7. Certifications:
    a. Provide the following certifications at a minimum:
        1) Welder's Qualifications:
            a) All welders shall be certified to the process, procedure and positions used in the assembly of the tank.
            b) The Contractor shall submit copies of each welder's qualifications prior to fabrication.
        2) Mill Test:
            a) Submit mill test certifications of all load bearing plate, annular plates, structural components, and safety related components prior to the start of fabrication.
        3) Welding Procedures:
            a) Submit welding procedures for all joints utilized in the fabrication of the tank and accessories.
        4) Affidavits: Furnish under the product information category affidavits from the manufacturers stating that the equipment has been properly installed and tested and is ready for full time operation.
8. Contract Closeout Submittals:
    a. Written Report:
        1) At the conclusion of the erection of the tank, the Contractor shall submit a written report which shall include completed copies of the "roll-out" drawing referred to above shall be submitted prior to starting the field painting of the tank.
    b. “As-Built" Drawings:
        1) The Contractor shall submit one (1) translucent reproducible set and two (2) blueline or blackline sets of Engineer reviewed "As-Built" drawings and catalog cuts and descriptive literature needed by the Owner for proper operation of the tank and accessories.
        2) This documentation shall be submitted to the Engineer prior to acceptance of and final payment for the project.

1.7 DELIVERY, STORAGE AND HANDLING

A. Requirements:
   1. Deliver, store and handle materials in strict accordance with the manufacturer's recommendations.

B. Protection:
   1. Protect all parts from damage during handling and storage.
   2. Do not allow parts to rest directly in contact with the ground, and do not allow the shop or finish coating to become damaged.

C. Material Storage:
   1. All materials and equipment stored at the site shall be protected from the elements where such exposure would be detrimental, and shall be adequately supported to prevent bending, warping, damage to painted surfaces, and other degradation of material properties.
   2. Painted components shall also be stored on supports to minimize contact with the ground.

D. Handling:
   1. Allow shop applied coatings (paint) to cure adequately before stacking for storage or transportation.

1.8 PROJECT CONDITIONS

A. Location:
   1. The Contractor shall be responsible for establishing the proper location and elevation of the tank at the site.
   2. See site plan for the tank location.

B. Safety and Health:
   1. The Contractor shall comply with safe working practices and all health and safety regulations and requirements of Federal OSHA, state and local health regulatory agencies, Material Safety Data Sheets (MSDS), and the paint manufacturer.
   2. This compliance shall be accomplished without supervision from the Owner, Engineer, other direct or indirect agents of the Owner.
   3. Should vents, holes, rigging attachments, or any other modification, cutting, or welding be required to meet safety standards, they may be accomplished at the expense of the Contractor upon submitting of details in writing to, and with subsequent review by the Engineer.

1.9 PERMITS AND APPROVALS

A. The Contractor shall obtain and pay for all local and state permits and certificates required in conjunction with this Work.

1.10 SUPPLIER’S AND/OR MANUFACTURER’S SERVICES

A. Prices bid for the item(s) specified in this section shall include the following services of technical representatives at the jobsite.

B. The number of days and scope of services indicated are minimum requirements not including travel time.

C. Time for travel and all associated expenses shall also be included in the prices bid for the Work.
   1. One labor day: Inspection and functional testing of installed equipment.
   2. One labor day: Start-up and training of Owner’s personnel in two sessions.

D. Start-up services and training of Owner’s personnel shall be at such times as requested by the Owner.

1.11 FIRST ANNIVERSARY INSPECTION

A. All work shall be guaranteed for a minimum of one (1) year after the date of final acceptance.

B. This guarantee shall be provided for in the Contractor's performance bond or a separate maintenance bond.

C. The Contractor shall be present for the one year evaluation and shall furnish an experienced foreman, rigging, and assistance for the evaluation.

D. Repairs requiring extensive work and rigging may be delayed until a time mutually agreeable to the Owner and Contractor.

PART 2 - MATERIALS

2.1 HYDROPNEUMATIC/SURGE TANK

A. The hydropneumatic/surge pressure tank shall be of all welded steel construction, ASTM A36, built in accordance with and meeting all the requirements of the ASME Boiler and Pressure Vessel Code, Division 1, Section VIII for "Unfired Pressure Vessels".
   1. Spot Radiography shall be provided as a minimum.
   2. The maximum allowable working pressure of the tank shall equal the design pressure as stated herein.
   3. The tank shall be code stamped and code inspected.
   4. All seams shall be double-welded butt joints.

B. The tank shall be minimum 6,770 gallon nominal capacity with dimensions approximately as indicated on the Drawings.

C. The tank shall be designed for a minimum working pressure of 200 psi and shall be hydrotested to a pressure of 1.5 times the design minimum working pressure prior to the application of internal or external coatings.

D. 16 IN diameter connection to hydropneumatic tank.

E. Ancillary equipment and accessories for the tank will include a sight glass gauge, pressure transmitter, air water level probes, air solenoid, vacuum relief valves, air release valve and drop tube (must release air under pressure) air charge control panel for 120-VAC in a NEMA 4X stainless steel enclosure, and other items as shown on the Drawings.

F. Certification of the shop testing shall be provided.

G. The tank shall be furnished with all outlets, fittings, foundation supports, equipment mounting brackets and manhole(s) as indicated on the Drawings or as required in accordance with code.

H. Fittings for connections to the tank shall be set so that connections will be parallel and perpendicular to the axis of reference when the tank is installed.

I. Fittings shall be securely welded to the tank with continuous full Penetration weld in accordance with ASME Code, and shall be at least equal size to the connection piping.
   1. All inlets and outlets 3" and larger shall be flanged, with nozzle necks of schedule 80 pipe minimum.
   2. All threaded couplings 2" and smaller shall be either stainless steel or be 3,000 LB, WOG forge steel, per ASTM A 105, Grade 70.

J. Threads shall comply with ANSI B2.1.

K. The tank shall be designed for a two bracket (leg) support for attachment to the foundation as indicated in the plans.
   1. Reinforcement plates shall be incorporated as necessary to fully support the tank when loaded with water.
   2. The brackets shall have holes for attachment of anchor bolts embedded in the slab.
   3. Anchor bolts, nuts and accessories shall be stainless steel rated for the loads.

L. The contractor is responsible for verification of all dimensions, location and orientation of fittings, and clearances of accessories whether or not specifically called for in the Plans.

M. The tank shall be equipped with a stainless steel nameplate mounted on the shell, above the manhole, showing all the required ASME information including the capacity, dimensions, materials, certifications, fabricator name and address, contract number, year erected, and other pertinent information.
   1. If the tank nameplate is of different metal than that of the shell, the nameplate shall be sufficiently insulated from the shell as to not corrode or cause corrosion due to contact of dissimilar metals.
   2. The nameplate shall be protected from the application of paint on the exposed surface.

N. All openings in the tank shall be plugged or capped prior to shipment to prevent the entrance of foreign materials during shipment or storage.

O. The surge tank shall be provided by a manufacturer with a minimum of five (5) years of experience in design, analysis, operation, and construction of surge control systems.

P. Seismic: Submit a design and seismic calculations for the surge tank and supports prepared by a Structural or Civil Engineer registered in the State of California. The design shall comply with the 2013 California Building Code.

Q. Controls: The design of the electric control of the surge control system shall be the responsibility of the manufacturer of the equipment system and/or equipment package. The manufacturer shall design their own functional electric control devices and circuitry, in consultation with the project specifications, to meet the equipment control requirements. All such systems and package controls shall be furnished by the equipment manufacturer.

R. Surge tank assembly, stainless steel solenoid valve(s), instruments, and controls shall be as supplied by Pressure Vessel Technologies, Paramount, CA; ZZ Technologies, Santa Paula, CA; or approved equal.

S. Size surge tank with allowance for water level control bands of 3 IN.

T. Size surge tank with allowance for ten (10) percent volume seal at lowest tank surge pressure following loss of power to the pumps under design conditions.

2.2 HYDRAULIC DESIGN CRITERIA

A. The system for which the tank is to be provided consists of a pumping station and water distribution system. Design of the tanks is based on a surge analysis prepared by Northwest Hydraulics Consultants (NHC) dated May 20, 2015.

B. The pressure vessel is to be connected to the discharge pipeline of the high service pump station.

2.3 OPERATIONAL SEQUENCE

A. The following represents a summary of the control sequencing:
   1. The air release valve will release air if the air-water interface drops below the low water level (end of the air release drop pipe).
   2. The air charge panel shall contain a three position switch labeled “Air Charge Control” with Hand-Off-Auto positions.
   3. The switch will be spring loaded to the hand position so the switch will not stay in hand position.
   4. In “Hand” air will be applied to the tank continuously.
   5. In “Auto” the air solenoid will be activated by the high level switch and a timer with an adjustable on time of 0-30 minutes for excess air will be released through the air release valve.

2.4 AIR RELEASE VALVE

A. Air release valve for pressure tank shall be APCO 200A or equal, suitable for pressure up to 150 psi.

B. Valve shall have 1 IN inlet connection and be designed for release of air under pressure.

C. Internal working parts including float shall be stainless steel or other corrosion resistant material.

D. Materials for valve shall be selected so as to avoid galvanic action.

E. Air release seat shall be of design to insure tight, trouble free closure.

F. Air release orifice shall be 3/16 IN minimum diameter to expedite release of air.

G. Valve shall have venting capacity of at least 120 CFM of air at 35 psi tank pressure.

2.5 VACUUM RELIEF VALVES

A. Provide two 4-IN vacuum relief air inlet valves, in the position and dimensions as indicated on the Drawings, to handle negative pressure wave surge conditions which might damage the pipeline.

B. Vacuum valves shall comply with ASME Boiler and Pressure Code.

C. APCO Model S-1500S flange type, or approved equal.

D. Provide a fine mesh stainless steel insect screen on the valve inlet.

2.6 AIR VOLUME CONTROL AND AIR COMPRESSOR

A. Contractor shall submit on, and provide following approval, a complete and functional air volume control system based on receiving air from the air compressor.

B. Air volume control shall be accomplished through a fully automatic control system using an air inlet solenoid, liquid level switches (probes), timer and air release valve to control the water and air volumes.

C. Control sequencing shall in general follow the operational sequence. The air/water ratio in the surge tank shall be controlled within a range compatible with the surge control system design. (See NHC report dated May 20, 2015) as well as system static and maximum operating pressures.

D. The air volume control system shall be mounted in a NEMA 4X stainless steel enclosure set up for a 120 Vac power supply with front-mounted disconnect and engraved plastic nameplate. Provide the following isolated outputs for SCADA:
   1. Auto Mode.
   2. Low Air Pressure.
   3. High/Low Tank Level.

E. Air supply shall be provided from the onsite air compressor. Air compressor per Section 11980.

F. Provide a suitable 5 micron filter prior to the air inlet to the air volume control system.

2.7 POP SAFETY VALVE

A. The safety relief valve shall comply with ASME Boiler and Pressure Vessel code.

B. Pop safety valve for pressure tank installation shall be Crane Company 2651, Farris Type 1855 OL or equal, bronze construction for air release.

C. Valve shall be suitable for 150 psi pressure.

D. Valve shall be furnished set for release at 110 psi pressure.

E. Valve shall be 3 IN size and shall be rated at 1500 CFM of air at 100 psi pressure.

2.8 LIQUID LEVEL SENSING

A. Provide liquid level probes equal to Gems/Warrick with stainless steel probes, Series 3E probe holder and Series 16 controller or approved equal.
   1. Level switches:
      a. LSHH shall generate high level alarm.
      b. LSH shall activate air application cycle.
      c. LSLL shall generate low level alarm.

B. Sensor installation shall include all piping, tank penetrations and electrical connections as necessary for a complete and functional system.

C. Install probe controller in control panel.

2.9 SAFETY RUPTURE DISK

A. Provide a safety rupture disk in the location as indicated on the drawings.

B. Zook Mono Burst Disks, or approved equal.

C. Rupture disk shall sized be for the maximum allowable tank or system pressure to protect the tank and distribution system. Confirm the burst pressure with the Engineer prior to ordering.

2.10 WATER GAUGE GLASS

A. Water gauge glass shall be furnished and installed as shown on the plans for the water pressure tank. Sufficient gauges shall be provided to view entire operating range of water level in tank.

B. Water gauge glass shall be Crane 627 gauge glass unit or equal, complete with angle valve fittings, drain cock, gauge guards, and isolation valves.

C. Unit shall be furnished with plastic sight tube protector.

2.11 MISCELLANEOUS ITEMS

A. All miscellaneous fittings shall be furnished and installed by the Contractor to make the installation complete and operational as shown.

B. Provide pressure gauges as indicated on the drawings or as required to make a complete and functional system.

C. Fittings and other items not specifically covered in these specifications shall be of the same quality and workmanship as specified for similar items.

2.12 SOURCE QUALITY CONTROL

A. Shop Observation:
   1. Shop observation of the fabrication and shop painting by the Engineer and Owner may be anticipated.

PART 3 - EXECUTION

3.1 FOUNDATION

A. Install the foundation in accordance with these Specifications and the Drawings.

B. The hydropneumatic tank shall be mounted on the concrete footing as shown and anchored thereto with anchor bolts imbedded in the concrete footing.

C. Contractor shall be responsible for coordination of the tank anchor requirements and the construction of the footing.

D. Unless otherwise noted by the tank designer, it is not necessary to grout between the tank mounting brackets and the concrete footing provided the top of the concrete footing is sufficiently smooth and level to permit uniform contact between footing and bracket.

3.2 PAINTING

A. The internal coating system and the external prime coat shall be factory applied.

B. The outside of the tank shall be given a commercial blast (SSPC-SP6) and then given one shop coat of approved primer equal to 2 mils dry film thickness.
   1. Finish and prime coatings shall be applied per Section 09905, UV compatible, VOC compliant for use with structures, piping or equipment subject to sunlight and weathering.
   2. Total minimum finished dry thickness shall be per the manufacturer's recommendations or as per Section 09905 whichever is greater.

C. The inside shall be thoroughly sandblasted to a near white metal blast (SSPC-SP10) and given three spray coats of approved epoxy coating, VOC compliant, NSF certified for potable water service to a minimum dry film thickness of 13 mils or as per the manufacturer's recommendations.

D. Painting application shall be in accordance with manufacturer's recommendations.

E. Overspray shall be removed by sanding or brushing between coats, in accordance with the coating manufacturer's recommendations.

3.3 APPURTENANCES

A. All appurtenances shall be installed as shown in accordance with the manufacturer's recommendations.

B. All threaded connections shall be made with NSF certified pipe dope or Teflon tape.

3.4 CLEANING AND DISINFECTION

A. Following painting, cleaning and any contractor testing of potable water facilities, those portions of the facilities which will be in contact with the water delivered to the users shall be disinfected with chlorine, and tested for bacteriological and VOC compliance before they are placed into service.

B. Disinfection by chlorination shall be accomplished in accordance with one or more of the approved methods outlined in the currently applicable AWWA Standards (C652, C601 and/or D105, latest editions) or by one of the methods as described below, whichever is the most restrictive:
   1. Method A:
      a. Fill the reservoir or tank completely to saturation with 25 mg/L chlorine solution and maintain a minimum 25 mg/L concentration for 24 hours; or,
   2. Method B:
      a. Fill the reservoir or tank completely to saturation with 50 mg/L chlorine solution and leave for 3 hours and verify a minimum 50 mg/L concentration after 3 hours; or,
   3. Method C:
      a. Spray on or brush on a 200 mg/L chlorine solution to all portions of the tank or reservoir which will contain and/or contact the potable water supply and allow remaining for 3 hours.

C. Chlorine solutions shall be of the sodium combination rather than calcium or other compound.
   1. All disinfection products proposed for use within the tank shall be approved for said use by the Owner prior to their use.
   2. Any chemicals shall be of known purity and from a reputable source and suitable for potable water use.
   3. Receipts and/or delivery tickets for disinfection materials and chemicals which indicate the type of material, the source or supplier and the quantity shall be provided to the Owner.

D. Proposed disinfection method and chemical(s) shall be approved by the painting or coating manufacturer(s).
   1. The Contractor shall verify the selected disinfection method is compatible with tank and reservoir coating and sealing materials by contacting the manufacturer(s) prior to initiating disinfection procedures.

E. Initial test waters required to fill the tank shall be provided by the Owner at no cost to the Contractor.
   1. Unless formally waived by the Owner in writing, costs associated with supplemental test waters required to perform any retesting shall be borne by the Contractor.
   2. Costs of supplemental test water shall be at the current Owner commercial rate.

F. Any cleaning or test water required to be removed from the tank at the direction of the Owner shall be the responsibility of the Contractor who shall furnish the necessary labor, tools, and equipment, including pumps, without additional compensation.
   1. Disposal, and dechlorination as required, shall be in an approved and permitted manner.

G. All equipment used in the disinfection process shall be in new condition and shall have only seen clean service in potable water facilities.
   1. Contractor shall employ and maintain recognized, safe equipment and methodology at all times during the disinfection process.
   2. Contractor shall remain responsible for all health and safety requirements during these operations.

H. Prior to completion and acceptance the Contractor shall be responsible for ensuring that appropriate water quality testing and regulatory approvals have been obtained as related to the coatings and to disinfection.
   1. Following disinfection, the tank shall be drained after the prescribed contact period and refilled with treated effluent water, and samples shall be, at a minimum, taken for microbiological and VOC analysis in accordance with applicable regulations.
   2. If the results of the analysis indicate that the water is free of coliform organisms and VOC's, and any other tests the jurisdictional health agency or Owner requires, the facility may be put into service following approvals from the Owner and the jurisdictional regulatory agency(ies).

I. Testing and disinfection shall be completed and all repairs made to the satisfaction of the Engineer and Owner before the work is accepted.

3.5 WARRANTY

A. Work performed on the tank cannot be accepted until it has been proven free from leaks and/or problems with materials and coatings and other defects to the satisfaction of the Owner, and until all testing and disinfection have been completed.

B. The acceptance of the completed work as herein specified is subject to the Contractor's warranty for the completed work against defects in materials or workmanship furnished by the Contractor for a minimum period of one (1) year from the date of acceptance of the work.

C. Warrantees and guarantees for specific portions of the materials and workmanship which differ from the overall warrantee period indicated here may also be covered in other sections of these Specifications. Specifically those warrantees for coatings may extend longer than the minimum one (1) year period.

3.6 COMPLIANCE CERTIFICATION

A. Furnish all certificates, including those listed in 1.04 above, in the form acceptable to Owner stating that all the testing and inspections required have been made and that results have been satisfactory.

B. If the tank design has not been based on Owner criteria, the Fabricator and/or Contractor shall furnish a similar certificate stating that the tank has been satisfactorily tested in accordance with the requirements for radiographic testing and any other tests as specified.

C. The manufacturer or his representative shall inspect the installation of the equipment prior to start-up and shall provide functional testing services.

D. The manufacturer or his representative shall certify the correctness of the installation.

3.7 START-UP AND TESTING

A. Factory (Shop) Testing is outlined above.

B. Field testing shall include a test of the tank control system by operating one of the pumps and shutting off the main power disconnect switch for the pumping station.
   1. Attach a pressure strip recorder to record the pressures before and during the test.
   2. For multiple pump systems run additional pumping units and simultaneously shut them down, recording the transient pressures as with the single pump test.

C. Provide Owner with Operations and Maintenance Manuals in accordance with Section 01342.

D. The manufacturer shall be responsible for instructing the Owner's personnel in the operation and maintenance of the equipment.
   1. Provide Operations Personnel with a minimum of two 1-hour training sessions to familiarize them with the operation and maintenance requirements of the surge system.

END OF SECTION

SECTION 13420
CHEMICAL STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chemical Storage Tanks:
      a. Ferric chloride.
      b. Sodium hydroxide.
      c. Sodium hypochlorite.
      d. Sodium bisulfite.

1.2 QUALITY ASSURANCE

A. Referenced Standards
   1. American Society of Testing Materials (ASTM)
      a. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
      b. ASTM D746 - Brittleness Temperature of Plastics and Elastomers by Impact.
      c. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
      d. ASTM D883 – Standard Definitions of Terms Relating to Plastics.
      e. ASTM D1505 - Density of Plastics by the Density-Gradient Technique.
      f. ASTM D1525 - Vicat Softening Temperature of Plastics
      g. ASTM D1693 - ESCR Spec. Thickness 0.125” F50- 10% lgepal.
      h. ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tank.
   2. American National Standards Institute (ANSI):
      a. ANSI B16.5 – Pipe Flanges and Flanged Fittings.
   3. Building code:
      a. International Code Council (ICC):
         1) California Building Code, 2013 Edition, based on International Building Code, associated standards, and all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Tanks shall be constructed by a firm that has at least ten years prior experience in construction of similar cross-linked polyethylene tanks in similar applications.
   2. Tanks shall be manufactured by a firm with a nationally accepted quality standard (i.e., ISO 9001 or equal).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Tank manufacturer’s catalog data.
   3. Complete shop drawings with dimensions and mounting details, including locations and orientation of all fittings and penetrations, accessories, restraints and supports.
   4. Details and materials of inlet/outlet fittings, vents, mountings for level elements, liquid level gage, flexible connections, and manway, with bolt and gasket material.
   5. Wall thickness calculations per ASTM D 1998 using 600 psi design hoop stress @ 100 DegF.
   6. Weight of tanks.
   7. Statement of fabrication is in accordance with test specifications and standards.
   8. Certificate of Compliance from the tank manufacturer stating:

a. All fittings have been installed by the tank manufacturer.
b. Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.
c. Material, specific gravity rating at 600 psi @ 100 DegF design hoop stress.
d. Wall thickness verification.
e. Impact and gel tests.

9. Complete anchor bolt, wind load, and seismic calculations signed and stamped by California registered structural engineer.
10. Anchoring system details.
11. Tank expansion (at discharge nozzle) measured as dimensional difference between empty and full dimensions (radius).
12. Details on packaging.
13. Instructions for handling, storage, and installation of tanks.
14. Resin used and a complete manufacturer specification of the resin used.
15. Statement that materials and resin used are suitable for intended service.
16. Copy of warranty.
17. Supporting information quality management system.
18. Electrical heat bracing and foam insulation data sheets.

B. Samples:
1. Representative samples of the high-density cross-linked polyethylene tanks shall be furnished at the time of shop drawing review. These samples shall be from plant production and shall be representative of quality and impact resistance of tanks to be furnished. The Engineer may reject any tank which does not meet the standard of the representative samples.

C. References:
1. Submit to the Engineer list of previous five similar site installations in the past 36 months or provide a list of three or more customers using tanks for the same chemical application and similar weather conditions for at least ten years. Provide names, contact phone numbers, and applications.
2. Submit to the Engineer supporting information of UL tank manufacturing capabilities.

1.4 WARRANTY

A. The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, for a period of five (5) years from start-up. The severity of the defect will determine the requirement of a site visit. All travel expenses, accommodation, etc., for a service visit due to a defect deemed severe by the manufacturer shall be included in the warranty.

1.5 SITE ENVIRONMENT

A. Outdoor installation.

B. Average minimum atmospheric temperature: 40 DegF.

C. Average maximum atmospheric temperature: 80 DegF.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable for the chemical storage tanks:
1. Poly Processing Company:
a. Model Vertical tanks with IMFO.
b. Or equal.

2. Assmann Corporation:
   a. Model ICT.
   b. Or equal.
3. Or equal.

2.2 MATERIALS

A. Plastic - The tanks shall be molded from Metallocene High Density Cross-linked Polyethylene (HDXLPE). The resin used shall be Paxon 7004 as manufactured by Exxon/Mobil Chemical or of resin of equal physical and chemical properties. The interior of the tank shall have an anti-oxidant resistant medium density polyethylene liner.

B. Filler and Pigments - The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent U.V. stabilizer and a maximum of 0.60 percent.

C. Material Properties - The tank material shall meet or exceed the following test properties, based on molded parts.

PARAMETER	ASTM TEST	VALUE
Density	ASTM D1505	0.940–0.945 g/mL
Environmental stress cracking, F50	ASTM D1693	>1,000 hrs
Tensile strength, ultimate, 2-IN minimum	ASTM D638	2,600 psi
Elongation at break, percent, 2-IN minimum	ASTM D638	>300%
Vicat softening point	ASTM D1525	240-250 DegF
Brittleness temperature	ASTM D746	<-130 DegF
Flexural Modulus	ASTM D790	100,000 psi
Impact resistance at -40 DegF	Phillips SSL-193	>120 ft/lb
Low Temperature Impact ARM-Low Impact for 1/8-IN specimen	-	75 ft.-lbs.
Polyethylene Notch Test (PENT) (176 DegF, 350 psi)	ASTM F1473	>1,000 hrs
Long Term Hydrostatic (LTHS) (Creep) At 140 DegF	-	900 psi
Specific Gravity	ASTM D 1998	1.9

2.3 TANK FABRICATION

A. The high density cross linked polyethylene tanks shall be constructed by the rotational molding process.

B. The high-density cross-linked polyethylene tanks shall be capable of storing 25 wt% sodium hydroxide, 40 wt% ferric chloride, 12.5 wt% sodium hypochlorite and 38 wt% sodium bisulfite at temperatures up to 100 DegF.

C. The tank diameter shall be measured externally. Tolerance on the outside diameter including out of roundness shall be plus or minus three percent. Measurement shall be taken in a horizontal position. The knuckle radius at bottom of wall shall be a minimum of one inch.

D. Wall thickness:
   1. Design in accordance with ASTM D1998.
   2. Design using a hoop stress no greater than 600 psi.

3. Wall thickness calculations shall assume tank contents have a specific gravity not less than 1.9.
4. In no case shall tank thickness be less than design thickness.
5. The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support, but shall not be less than 0.187 IN thick.

E. All edges cut out, such as entrance to manway, shall be trimmed to have smooth edges.

2.4 TANK DESIGN

A. Design Requirements: Storage tanks provided under this section shall have the following characteristics.
1. Hydrostatic design of tank ASTM D-1998 SG = 1.9.
2. Style:
   a. Shall style: Vertical, cylindrical.
   b. Top style: Closed, dome top.
   c. Bottom style: Flat bottom.
   d. Man way: top mount.
3. Exposure: Outdoor.
4. Color: Natural.

CHEMICAL	EQUIPMENT NO.	STRAIGHT WALL MINIMUM CAPACITY (GALLONS)	DIAMETER MAXIMUM (FT)	HEIGHT (INCLUDING DOME) (FT)	MANWAY SIZE (IN)	INSULATED	HEATING PAD
Sodium Hydroxide	77T103	5,000	10	<13	24	Yes	Yes
Ferric Chloride	77T003	5,000	10	<13	24	No	No
Sodium Hypochlorite	75T003	7,000	10	<13	24	Yes	No
Sodium Hypochlorite	75T004	7,000	10	<13	24	Yes	No
Sodium Bisulfite	75T109	7,000	10	<13	24	Yes	Yes
Sodium Bisulfite	75T10	7,000	10	<13	24	Yes	Yes

B. Operational Conditions: Storage tanks provided under this section shall be suitable for the following operating conditions.

CHEMICAL	EQUIPMENT NO.	CONCENTRATION (%)	DESIGN SPECIFIC GRAVITY	pH
Sodium Hydroxide	77T103	50	1.5	>12
Ferric Chloride	77T003	40	1.4	<2
Sodium Hypochlorite	75T003	12.5	1.2	>12

CHEMICAL	EQUIPMENT NO.	CONCENTRATION (%)	DESIGN SPECIFIC GRAVITY	pH
Sodium Hypochlorite	75T004	12.5	1.2	>12
Sodium Bisulfite	75T109	25	1.1 – 1.4	4.8 – 5.2
Sodium Bisulfite	75T10	25	1.1 – 1.4	4.8 – 5.2

2.5 FITTINGS

A. General:
   1. See Drawings.
   2. Tank fittings shall be constructed of PVC, CPVC, or titanium.
   3. Exposed stainless steel and Alloy C-276 shall not be used in any location where this metal can come in contact with the tank contents.
   4. Gasket Material shall be EPDM or Viton.
   5. All sidewall fittings shall keep the chemicals from contacting the tank wall cross section.

B. Integrally Molded Outlets:
   1. Tank manufacturer shall supply one Ultra high molecular weight (UHMW) polyethylene or HDXLPE full drain outlet assembly. Connection shall be built without use of rotational mold parting line thus utilizing one piece construction. Full drain outlet shall be molded into High Density Cross-linked polyethylene tank. Assembly shall consist of molded in UHMW insert with welded polyethylene flange end connection. Molded in UHMW or HDXLPE assembly shall provide full drain of tank contents. Full drain outlet must be connected to a flexible expansion joint allowing for minimum of 1/2 IN lateral movement and 3/8 IN of elongation.
   2. See Drawings for all other tank connection sizes and locations.

2.6 FLOAT OPERATED, TUBE STYLE LIQUID LEVEL INDICATOR

A. See Drawings for location.

B. Float, cable wire and counter weight (indicator) materials should be compatible with the chemical stored in the tank.

C. Dry tube, clear CPVC SCH 80, 3 or 4 IN diameter.

D. The float inside the tank is cabled to an indicator outside, and guided with a tube. The cable wire exists the tank from top and guided with a tube attached to tank side wall. Long radius elbows or pulleys shall be used to assist cable wire movement in/out and up/down. The float shall be provided with a guide support to assists it's travelling and minimize alignment issues from splashing.

E. The outside dry tube shall have an internal marker or level gauge board attached to the tube. The level in the tank shall be marked at 2 IN interval. The indicator should be able to travel full straight shell height of tank.

2.7 MANWAYS

A. Unless otherwise specified, manways shall be integrally molded with the tank. The manway openings shall be a minimum of 24 IN inner diameter. The manway cover shall be sealing type and vapor tight.

B. All 24 IN manways shall be equipped with an emergency pressure relief device designed to allow a minimum flow rate of 4000 CFM in the event the tank is pressurized.

2.8 LADDER

A. Total length: As required from floor level to top of each tank.

B. Maximum center-to-center distance on mounting supports is 2 FT.

C. Designed in accordance with OSHA standards.

D. Material: FRP.

2.9 TANK INSULATION

A. See specification Section 15183.

2.10 TANK HEATING

A. Provide tank heating pads for sodium hydroxide and sodium bisulfite storage tanks.

B. Design and supply heating pads to maintain tank content at 65 DegF.

C. Electrical requirements: 120 V, 1 phase.

2.11 RESTRAINT SYSTEM

A. Design and provide restraint system for all tanks.

B. Design system to meet seismic loads in accordance with CBC 2013.

C. System to consist of stainless steel cables, clips and anchor bolts.

2.12 SAFETY SIGNS

A. See Section 10400.

PART 3 - EXECUTION

3.1 DELIVERY AND INSPECTION

A. The Contractor shall inspect tanks for gouges, pinholes, and other obvious defects, immediately following delivery of the tanks to the project site. Defects in the tanks will be cause for rejection of the tanks.

3.2 INSTALLATION

A. The tanks shall be installed as shown and in accordance with the manufacturer's written instructions. Each tank shall rest on a level, even base of concrete (tank pad) so that the entire bottom of the tank is supported. The tank pad shall have notch cut in order to accommodate the molded outlet connection.

3.3 FIELD TESTING

A. The tanks shall be field tested by filling the entire tank with water and monitoring the tanks as well as fitting connections for at least 24 hours. Any leaks shall be corrected by the manufacturer's representative prior to acceptance. Following successful field tank testing, the tanks shall be completely emptied and dried.

3.4 FIELD REPAIR

A. If after, filling with chemical, a leak is detected, the contractor shall be responsible for all expense associated with removing tank contents, repair of tank by manufacturer's representative and replacing tank contents.

END OF SECTION

SECTION 13440

INSTRUMENTATION FOR PROCESS CONTROL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for complete instrumentation system for process control.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Canadian Standards Association (CSA).
   2. FM Global (FM).
   3. The Instrumentation, Systems, and Automation Society (ISA):
      a. 7.0.01, Quality Standard for Instrument Air.
      b. S5.1, Instrumentation Symbols and Identification.
      c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
      d. S5.4, Standard Instrument Loop Diagrams.
      e. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. National Institute of Standards and Technology (NIST).
   7. Underwriters Laboratories, Inc. (UL):
      a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. Miscellaneous:
   1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.3 DEFINITIONS

A. Architecturally finished area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.

B. Non-architecturally Finished Area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.

C. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

D. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

E. Outdoor Area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.

F. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

G. Calibrate: To standardize a device so that it provides a specified response to known inputs.

1.4 SYSTEM DESCRIPTION

A. Control System Requirements:
   1. This Specification Section provides the general requirements for the instrument and control system.
   2. The instrument and control system consists of all primary elements, transmitters, switches, controllers, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.

B. All signals shall be directly linearly proportional to measured variable unless specifically noted otherwise.

C. Instrumentation Subcontractor:
   1. Furnish and coordinate instrumentation system through an instrumentation subcontractor (instrumentation integrator).
      a. The instrumentation subcontractor shall be responsible for functional hardware operations of all systems, performance of control system engineering, supervision of installation, final connections, calibrations, preparation of Drawings and Operation and Maintenance Manuals, start-up, training, demonstration of substantial completion and all other aspects of the control system not under the scope of work of Calcon Systems. The instrumentation integrator shall be a qualified subcontractor as selected by the Contractor.
      b. The following control system scope of work shall be performed by Calcon Systems, Inc., San Ramon, California, as a subcontractor to the Contractor and includes all PLC/SCADA/Communications programming and certain other coordination services as follows. Contractor may chose to award additional scope of work to Calcon.
         1) All programming of all new and existing PLC controllers that are associated with this project.
         2) All programming of SCADA computers that are associated with this project.
         3) All programming of Alarm call out systems that are associated with this project.
         4) All programming of the communications network from each PLC to the SCADA system computers that are associated with this project.
         5) Review PLC control panel submittals to ensure that all the I/O are correctly assigned and that the correct cards are specified.
         6) Provide/download PLC programs to new PLC control panels if PLC panel “LOCAL” shop testing is required prior to shipment.
         7) Work with subcontractors to review/inspect PLC and instrumentation field wiring terminations to ensure proper installation.
         8) Work with subcontractors/vendors to verify proper programming, scaling, and calibrating of all field instrumentation equipment.
         9) Work with subcontractors/vendors to test and verify each PLC and field instrument I/O point to the PLC and SCADA to verify proper condition changes and analog values.
         10) Work with subcontractors/vendors to test and verify correct process control of all field and instrumentation equipment.
         11) Be available by phone to assist the Contractor and subcontractors on any matters associated with the PLC, SCADA and instrumentation equipment installation.
   2. Contractor to ensure coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
      a. Facsimile information is not acceptable.
   3. Limit the scope of each submittal to one (1) Specification Section.
      a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
      b. Do not provide any submittals for Specification Section 13440.
   4. Product technical data including:
      a. Equipment catalog cut sheets.
      b. Instrument data sheets:
         1) ISA S20 or approved equal.
         2) Separate data sheet for each instrument.
      c. Materials of construction.
      d. Minimum and maximum flow ranges.
      e. Pressure loss curves.
      f. Physical limits of components including temperature and pressure limits.
      g. Size and weight.
      h. Electrical power requirements and wiring diagrams.
      i. NEMA rating of housings.
      j. Submittals shall be marked with arrows to show exact features to be provided.
   5. Loop diagrams per ISA S5.4 as specified in Specification Section 13448.
   6. Comprehensive set of wiring diagrams as specified in Specification Section 13448.
   7. Panel fabrication and modification drawings as specified in Specification Section 13448.
   8. PLC equipment drawings.
   9. HMI graphics.
   10. Nameplate layout drawings.
   11. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
      a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
   12. All Shop Drawings shall be modified with as-built information/corrections.
   13. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
      a. Furnish electronic files on CD-ROM or DVD-ROM media.
      b. Drawings in AUTO CAD format.
   14. Provide a parameter setting summary sheet for each field configurable device.
   15. Certifications:
      a. Documentation verifying that calibration equipment is certified with NIST traceability.
      b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
         1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
   16. Testing reports: Source quality control reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

1.7 SITE CONDITIONS

A. Unless designated otherwise on the Drawings, area designations are as follows:
   1. Outdoor area:
      a. Wet.
      b. Corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
      c. Below grade vaults and manholes:
         1) Subject to temporary submergence when specifically designated on the Drawings or Specifications.
   2. Architecturally finished area:
      a. Dry.
      b. Noncorrosive unless designated otherwise on the Drawings or in the Specifications.
      c. Nonhazardous unless designated otherwise on the Drawings or in the Specifications.
   3. Non-architecturally finished area: As designated elsewhere on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 NEMA TYPE REQUIREMENTS

A. Provide enclosures/housing for control system components in accordance with the following:
   1. Areas designated as wet and/or corrosive: NEMA Type 4X.
   2. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
      a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   3. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
      a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   4. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
   5. Areas designated to be subject to temporary submersion: NEMA 6P.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. System Operating Criteria:
   1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two (2) cycles per minute or a magnitude of movement of 0.5 percent full travel.
   2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
   3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
   4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position final element.

5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 percent of full scale.
6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.3 ACCESSORIES

A. Provide identification devices for instrumentation system components in accordance with Specification Section 10400.

B. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.

B. Install electrical components per Division 16.

C. Panel-Mounted Instruments:
1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

D. See Specification Section 16120.

3.2 FIELD QUALITY CONTROL

A. See Specification Section 01650.

B. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.
1. Documentation requirements include the utilization of the forms located at the end of this Specification Section.
   a. Loop Check-out Sheet.
   b. Instrument Certification Sheet.
   c. Final Control Element Certification Sheet.

C. Instrumentation Calibration:
1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
2. Calibrate all field-mounted instruments, other than local pressure and temperature gages, after the device is mounted in place to assure proper installed operation.
3. Calibrate in accordance with the manufacturer's specifications.
4. Bench calibrate pressure and temperature gages.
   a. Field mount gage within seven (7) days of calibration.
5. Check the calibration of each transmitter and gage across its specified range at 0, 25, 50, 75, and 100 percent.
   a. Check for both increasing and decreasing input signals to detect hysteresis.
6. Replace any instrument which cannot be properly adjusted.
7. Calibration equipment shall be certified by an independent agency with traceability to NIST.
   a. Certification shall be up-to-date.
   b. Use of equipment with expired certifications shall not be permitted.
8. Calibration equipment shall be at least three (3) times more accurate as the device being calibrated.

D. Loop check-out requirements are as follows:
   1. Check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections.
      a. Use actual signals where available.
      b. Closely observe controllers, indicators, transmitters, HMI displays, recorders, alarm and trip units, remote setpoints, ratio systems, and other control components.
         1) Verify that readings at all loop components are in agreement.
         2) Make corrections as required.
            a) Following any corrections, retest the loop as before.
   2. Stroke all control valves, cylinders, drives and connecting linkages from the local control station and from the control room operator interface.
   3. Check all interlocks to the maximum extent possible.
   4. In addition to any other as-recorded documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Owner.

E. Provide verification of system assembly, power, ground, and I/O tests.

F. Verify existence and measure adequacy of all grounds required for instrumentation and controls.

END OF SECTION

Loop Check-out Sheet

Project Name:	Owner's Project No. (if applicable):	Page of
Project Owner:	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

_____

_____

_____

_____

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by:_____ Date:_____
(Work Performed By)

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Loop Check-out Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	Page 1 of 2
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	10050-211-134	Date: 12/19/98	
Control Loop No.	107		

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.
P201 Start Sig				VFD-107	21, 22	PLC Cab	103, 104
P201, Speed inp				VFD-107	27, 28	PLC Cab	67, 68, 69
P201 Start out				VFD-107	31, 32	PLC Cab	72, 73, 74
Press transmit	PIT-107	JS	--	PIT-107	+ / -	PLC Cab	98, 99, 100

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT
MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR	PI-107A	SI-107				
EQUIP STATUS	P201 ON	P201 OFF	V-107 open	V-107 close		
ALARM POINT	PAH-107					

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION
H-O-A sel sw	HS-107A	VFD-107				
L-O-R sel sw	HS-107B	@ P201				
S/S switch	HS-107C	MCC	HS-107D	MCC		

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point
PAH-107	120 psi				
SC-107		2.0	5.0	0.2	80 psi

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

(1) HS-107B in Local: (a) start/stop operation via HS-107A and HS-107C, D (b) Manual/auto operation via HS-107A. In auto, pump stopped on hi press, started on lo press. (2) HS-107B in Remote: Observed operation from PLC-pump stopped on hi press, started on lo press. (3) Observed V-107 open/close automatically in accord with pump run condition. (4) Observed all indications and terminations shown above. (5) Tuned SC-107

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: Joe Smith Date: 12/19/98
(Work Performed By)

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EXAMPLE

Loop Check-out Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	Page 2 of 2
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.:	10050-211-134	Date: 12/19/98	
Control Loop No.	107		

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.
V-107 open ZS				ZSO-107	+ / -	PLC Cab	112, 113
V-107 close ZS				ZSC-107	+ / -	PLC Cab	114, 115

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS	ZOI-107	ZCI-107				
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

AS LEFT SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

Checked terminations and verified indications shown above.

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by: Joe Smith Date: 12/19/98
(Work Performed By)

(Version 1.0 Apr 99)

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EXAMPLE

Instrument Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by:_____ Date Certified:_____

(Version 1.0 Apr 99)

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Instrument Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date: 12/19/98	
Control Loop No.:	222		
Instrument Tag No.	TSH-222	Transmitter/gauge span:	
Manufacturer:	ACE, Inc.	Switch set-point:	50 F
Model No.	TL-2983-SH5	Switch dead band:	5 F
Serial No.	10293583	Switch range:	32-200 F

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)	49.8 F	Contact Close	0.1%	45.1 F	Contact Open	0.2%
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): 1.0% Switch Range

Remarks:

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Temperature (dry block) calibrator	Hart Scientific XL5897T	0.1 F	Yes

Certified by: Joe Smith Date Certified: 12/19/98

EXAMPLE

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Instrument Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date:	12/19/98
Control Loop No.:	106		
Instrument Tag No.	PIT-106A	Transmitter/gauge span:	0-200 psi
Manufacturer:	ACE, Inc.	Switch set-point:	
Model No.	1275-X	Switch dead band:	
Serial No.	3049569TSH	Switch range:	

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%	0.00 psi	4.02 mA	0.13	0.00 psi	4.00 mA	0.00
25%	50.00 psi	8.00 mA	0.00	50.00 psi	8.01 mA	0.06
50%	100.00 psi	12.01 mA	0.06	100.00 psi	12.00 mA	0.00
75%	150.00 psi	16.00 mA	0.00	150.00 psi	16.01 mA	0.06
100%	200.00 psi	20.00 mA	0.00	200.00 psi	19.99 mA	0.06
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): 0.15% span

Remarks: Adjusted zero-otherwise no adjustments required

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Pressure calibrator	Hathaway/Beta XL5946P	0.025% full scale	Yes
Pressure module	Hathaway/Beta XL5948P-6:0-150 psi	0.025% full scale	Yes

Certified by: Joe Smith Date Certified: 12/19/98

(Version 1.0 Apr 99)

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EXAMPLE

Final Control Element Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	

Tag No.	Actuator: Pneumatic: _____ Electric: _____
Description:	Positioner: Direct: _____ Reverse: _____
Manufacturer:	Positioner: Input: _____ Output: _____
Model No.	I/P Converter: Input: _____ Output: _____
Serial No.	Valve to _____ on air failure
	Valve to _____ on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%						
25%						
50%						
75%						
100%						

Specified I/P converter accuracy: _____ % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	TRAVEL	ERROR (% of full travel)	INPUT	TRAVEL	ERROR (% of full travel)
0%						
25%						
50%						
75%						
100%						

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by:_____ Date Certified:_____

(Version 1.0 Apr 99)

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Final Control Element Certification Sheet

Project Name:	BIG PROJECT	Owner's Project No. (if applicable):	
Project Owner:	ABC Company	Regulatory Agency Project No. (if applicable):	
HDR Project No.	10050-211-134	Date:	12/19/98
Control Loop No.:	056		

Tag No.	LCV-056A
Description:	Control Valve
Manufacturer:	ACE, Inc.
Model No.	XYZ-123
Serial No.	748569AP2

Actuator:	Pneumatic: X	Electric: _____
Positioner:	Direct: X	Reverse: _____
Positioner:	Input: 9-15 psi	Output: 0-100%
I/P Converter:	Input: 4-20 mA	Output: 3-15 psi
Valve to	Open	on air failure
Valve to	Open	on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%	4.00 mA	3.01 psi	0.08	4.00 mA	3.02 psi	0.17
25%	8.00 mA	6.04 psi	0.33	8.00 mA	6.05 psi	0.42
50%	12.00 mA	9.00 psi	0.00	12.00 mA	9.01 psi	0.08
75%	16.00 mA	11.97 psi	0.25	16.00 mA	12.03 psi	0.25
100%	20.00 mA	14.99 psi	0.08	20.00 mA	14.99 psi	0.08

Specified I/P converter accuracy: 0.50% % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	TRAVEL	ERROR (% of full travel)	INPUT	TRAVEL	ERROR (% of full travel)
0%	9.00 psi	0%	-	9.00 psi	0%	-
25%	10.50 psi	25%	-	10.50 psi	25%	-
50%	12.00 psi	50%	-	12.00 psi	50%	-
75%	13.50 psi	75%	-	13.50 psi	75%	-
100%	15.00 psi	100%	-	15.00 psi	100%	-

Remarks: LCV-056A is not furnished with position transmitter, so travel checks were visual.

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?
Multi-fct calibrator	Fluke-XL743B	0.01% Rdg + 0.015% FS	Yes
Pressure Module	Fluke-XL700POS (0-30")	0.05% FS	Yes

Certified by: Joe Smith Date Certified: 12/19/98

EXAMPLE

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SECTION 13441
CONTROL LOOP DESCRIPTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instrumentation control loops.

1.2 QUALITY ASSURANCE

A. See Specification Section 13440.

1.3 SYSTEM DESCRIPTION

A. The control loop descriptions provide the functional requirements of the control loops represented in the Contract Documents.
   1. Descriptions are provided for each loop.

B. The control loop descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the Drawings and other Specification Sections.
   1. The control loop descriptions shall not be considered equal to a bill of materials.

C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and shown on Drawings.

1.4 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. See Specification Section 13440.

C. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

D. Control Strategy for Record Documents:
   1. Obtain this Specification Section 13441 in electronic format (Microsoft Word) from Engineer at beginning of Project.
   2. Revise and update the file monthly during construction and start-up to reflect all changes that occur due to specific equipment and systems supplied on the Project.
      a. Show all revisions in 'track change' mode.
      b. Change Specification Section Title to read "Control Loop Descriptions - Contractor Record Document."
      c. Reference all changes by Request for Information (RFI) number or Change Proposal Request (CPR) number.
      d. Submit revised file monthly to Engineer for review.
   3. Deliver the revised and updated file as a final control loop description Record Document in the Operation and Maintenance Manual described in Specification Section 01340.
   4. Provide both paper copy and electronic copy (on CD-ROM) of the Record Document control loop descriptions in the Operation and Maintenance Manual described in Specification Section 01340.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 CONTROL LOOPS

A. General:
   1. All analog values to have a minimum of 3 configurable alarm or control points adjustable over full range of analog point.
   2. All analog outputs shall be capable of being forced from SCADA screen using screen slider.
   3. All digital outputs shall be capable of being forced from SCADA screen.
   4. Provide alarm SCADA screen showing all active alarms. Show 3 most current alarms on all SCADA screens.
   5. Provide SCADA screen showing run time for each drive and number of starts during past 24 hour period.
   6. Provide SCADA communication screen showing communication data for each PLC and current status of each PLC.
   7. Loss of power will cause all drives to shut down. Upon restoration of power drives in Auto shall start in sequence to state prior to power failure and then return to normal control.
   8. If a drive is called to start or valve to open and fails to start or open with in a preset time an alarm shall be generated and the next drive in sequence shall be started where applicable.
   9. If a drive is running in Auto and stops while still called, the next drive in sequence shall be started and an alarm generated.
   10. If a drive is called to stop or valve to close and fails to stop or close with in a preset time an alarm shall be generated.

B. Specific Loops:
   1. Raw sewage flow. Indicate and totalize each raw sewage flow and the sum of the flows.
   2. Screens:
      a. User can select the lead and lag screen and whether one or two are on line. If only one is on line it shall be the lead screen. If the differential level of total raw sewage flow exceeds a preset value or if the on line screen fails the lag screen shall be called to run, an alarm generated and both screens shall operate until changed by the operator.
      b. Screen control is based on differential level, upstream and downstream, time interval or manual initiate. Once initiated automatically on differential level or time the screens shall clean in sequence if both are on line or only one if only one is on line.
      c. Screenings washer/compactor and screenings conveyor control is initiated when either screen starts. Washer/compactor and conveyor shall run for timed period after both screens are off.
      d. Screens shall resume normal operation following a power failure.
      e. Screen channel gates, 12SLG101, 102, 201 and 202, can be manually opened and closed from SCADA.
   3. Influent pumping:
      a. There are 2 wetwells and 4 pumps. The operator can select which pumps are in service and which wetwell level transmitter is to be used for control. If the selected level transmitter fails (out of range) the other transmitter shall be used for control and an alarm generated. If both pumps in one wetwell are out of service (off) a discrepancy shall be initiated if the level transmitter for that wetwell is selected for control. The operator can place all four pumps in a sequence of operation and any pumps out of service (off) will be skipped in that sequence. The first in service pump in the sequence shall be the base pump and shall operate continuously. If an in service pump in the sequence is called but fails to start the next in service pump shall be called and a failure alarm generated.
      b. The base pump shall operate on proportional only level speed control. If the flow exceeds the capacity of the on line pump(s) the level shall rise to a setpoint level above

the top of the control band and after a preset delay shall call the next pump in sequence. All on line pumps shall operate at the same speed. If the called for pump speed falls below a preset minimum (indicating too many pumps on line) the last pump on shall be stopped after a preset time delay. If a pump fails to start or stop when called a fail alarm shall be generated and the next pump in sequence shall be started or stopped as applicable.

c. The operator can change the pump sequence at any time by pressing a "change sequence" software button which shall bring up a screen showing the existing sequence and a set of blanks for filling in a new sequence and level transmitter selection. The old sequence shall continue in automatic operation. Once the new selections are made the operator can select the new sequence or cancel. If the new sequence is selected the transition shall be made by first starting any new pump(s) that should be in operation and then stopping any pumps that are out of the new sequence. In case of power failure the pumps will stop. When power is restored the pumps shall restart in sequence with the preset start delay until the same pumps are back on line that were running before the power failure and the sequence shall return to automatic proportional only control.

d. High and low level alarms can be set for each wetwell based on the analog level signal.

e. If the wetwell reaches the high level float switch all operating pumps in that wetwell are started outside the PLC, will generate an alarm, pump down to the low level float, then stop and will continue this pumping cycle until the automatic PLC controls resume. See pump control diagram, CD-13.

4. Grit removal:

a. The vortex grit removal system shall operate based on manufacturer's sequence. The grit unit shall operate continuously. The grit system shall call for the grit pump to operate and when either grit pump is called the grit cyclone and classifier shall run. When both grit pumps are stopped the classifier shall continue to run for a timed period and stop. The grit system shall resume normal operation following a power failure.

5. Primary clarifier bypass control:

a. Normally all degritted sewage shall flow to the primary clarifiers through the primary clarifier bypass structure over a straight weir with the water level (flow) over the weir measured by 22LIT001.

b. If the bypass control is in automatic and an adjustable setpoint flow is reached, normally 12 mgd, which is a water surface of 9.5 IN above the top of the weir or water surface elevation of 119.54, the bypass control shall commence to maintain the 119.54 water surface elevation maximum.

c. The bypass shall function by positioning downward opening weir gate 13SLG203 to maintain the setpoint flow to the primary clarifiers (water surface elevation 119.54 maximum) and bypass the rest over this weir gate either automatically or manually. This control shall be a deadband type since it is a somewhat slow action and is not precise. The user shall be able to set a flow deadband between 0 and 50 percent (normally 20 percent), time between gate position changes of 0 to 120 seconds, normally 30 seconds and amount of gate change of 0 to 10 percent, normally 2 percent. When the flow to the primary clarifiers exceeds the maximum setpoint the control shall change the gate position according to the control settings to maintain the primary clarifier flow within setpoint plus or minus the deadband setting.

6. Primary clarification:

a. Primary clarifier bypass can be operated manually or will automatically bypass excessive flows around the primary clarification. Overflow shall trigger a bypass alarm.

b. Normally the primary flow will be split between the primary clarifiers that are on line at the flow split structure. The on line primary clarifiers are started manually either locally or from SCADA and will run continuously. On restoration of power after a power failure the selected primary clarifiers will restart.

c. An alarm is generated on high torque and the clarifier is alarmed and shut down on high-high torque.

d. Primary effluent is normally split between the two aeration basins unless a basin is manually taken out of service or manually set to another mode.
e. Primary scum. Primary scum along with the solids gravity thickener scum is pumped to the digesters. Scum from primary clarifiers 1 and 2 flows to scum pit 1 and is pumped by the scum pump based on preset high and low level setpoints for scum pump start and stop (automatic) or can be operated manually by the operator at the scum pit. Scum pump shall shut down and alarm on high discharge pressure or high pump stator temperature. High and low scum pit level alarms can be set. Scum pumping shall resume after a power failure.
f. Scum from primary clarifier 3 flows to scum pit 2 and the scum pump control is the same as for scum pit 1. Scum pumping shall resume after a power failure.
g. Primary sludge pumping. Normally one primary sludge pump shall run for each primary clarifier; primary sludge pump 1 for primary 1, pump sludge pump 2 for primary 2 and either pump 3 or 4 for primary 3. Each selected primary sludge pump runs continuously at fixed speed (hand) or on a timed on-off cycle from the PLC and discharges to the gravity thickener. After a power failure and upon restoration of power the selected primary sludge pumps shall restart.

7. Biological treatment:
   a. Biological treatment can run in biological nitrogen removal (BNR) mode or contact stabilization (CS) mode as manually selected by the operator or automatically switched from BNR to CS mode at a setpoint high total raw sewage flow. Once switched to CS mode it must be switched back to BNR manually. Selection of one or the other modes operates RAS motor actuated valves and motor actuated gates at the aeration basins as follows:
      1) BNR mode: Close gate 31G113, open gate 31G112, open valve 32FV001 and close valves 32FV002, 003; similar for AB2.
      2) CS mode: Close gate 31G112, open gate 31G113, open valves 32FV002, 003 and close valve 32FV001; similar for AB2.
   b. The aeration basin mixers and AB recirculation pumps are selected to run manually by the operator and the AB recirculation pump speed can be set manually or flow paced by total raw sewage flow. Upon restoration of power after a power failure the mixers and pump(s) shall resume selected operation.
   c. Aeration basin air and DO control is controlled by the aeration blower system master control panel, see specification Section 11081.
8. Secondary clarifiers:
   a. The mixed liquor (ML) flow is split by weirs to the secondary clarifiers in service which are selected and started by the operator either locally or from SCADA. The secondary clarifiers run continuously and restart when power is restored after a power failure.
   b. The operator selects a lead and lag return activated sludge RAS pump for each secondary clarifier. The lead pump shall run when the corresponding secondary clarifier is running. If a lead RAS pump fails to start or fails while called the lag pump shall be started and an alarm generated. The operator can manually set the speed for each RAS pump or the speed can be automatically paced to total raw sewage flow. The pump speed shall be paced proportional to 0 – 100 percent of total raw sewage flow over a preselected range of pump speed; settable between 100 and 50 percent of pump speed typically 100 – 70 percent. If the RAS flow for clarifiers 1 or 2 exceeds 1.2 MGD the second RAS pump shall be started, if available, and an alarm generated in either case. Both pumps shall run until a pump is manually stopped. The control is the same for clarifiers 3, 4 and 5 except second pump shall be started at 1.0 MGD RAS flow. Upon restoration of power after a power failure the RAS pumping shall return to the original selected operation.
   c. Operator can select a lead and lag waste activated sludge WAS pump. If the lead WAS pump fails the lag pump shall start and an alarm shall be generated. The lead WAS pump shall run continuously. The user can manually select the destination of the WAS; normally to the gravity thickener and can select the WAS flow meter and control valve

in use from SCADA; either 43FE007and 43FCV009 or 43FE008 and 43FCV010. The user can set a setpoint WAS flow and the respective meter and flow control valve shall maintain that rate. WAS can be manually selected to discharge to the headworks through the plant drain if desired by the operator. Upon restoration of power after a power failure the WAS pumping shall return to the original selected operation.

9. Gravity sludge thickening:
   a. Gravity sludge thickener can be manually started locally or at SCADA and shall run continuously. Thickener shall restart after a power failure when power is restored.
   b. Thickener scum pump shall run on-off based on preset wetwell level on-off setpoints (automatic) or can be operated manually by the operator at the scum pit. Provide high and low level alarms. Scum pumping shall resume after a power failure.
   c. Gravity thickened sludge pumping. Operator can select lead and lag pump, manually select speed and must start pumping. If lead pump fails to start or fails in operation the lag pump shall start and a failure alarm generated. Operator must restart pumping after a power failure.
10. Rotary drum sludge thickeners:
    a. The thickeners are controlled by the respective LCP and are started and stopped manually by the operator.
11. Centrifuge sludge dewatering:
    a. The centrifuges are controlled by the respective LCP, are started and stopped manually by the operator and only one selected centrifuge can run at a time because of the sizing of the electrical feeder.
12. Thickening and dewatering polymer systems:
    a. These systems are started and stopped manually by the operator or automatically by the respective LCP. The thickened and dewatered polymer feed can be paced automatically to thickened or dewatered sludge flow respectively or set manually by operator.
13. Chlorine feed:
    a. The chlorine feed system is set up and started and stopped manually by the operator and shall restart upon restoration of power. Each chlorine feeder pump can be selectively paced by total raw sewage flow, effluent pumping flow or manually. Feeder pump 4 can be also paced by total RAS flow.
    b. Chlorine feed to the chlorine inductor is to be capable of 3 modes of operation selectable by operator; manual, flow paced or compound loop control (flow and chlorine residual). Chlorine residual control is a slow acting loop and is to be set up on a dead band type control with appropriate adjustable dead band parameters as proposed by the control integrator.
    c. Each feeder discharge pressure and flow is to be monitored while the respective pump is running. If the flow or discharge head drops below a preset setting the pump shall be stopped and an alarm generated. If there is a designated standby pump it shall be started.
    d. Operator shall be able to select which storage tank is to be used and the system will automatically switch to the other tank when the level in the selected tank falls to a preset level.
14. Number 3 water pumping:
    a. Operator can set lead and lag pump. The lead pump shall run continuously. If lead pump fails or the water pressure falls below a preset value the lag pump shall start, run until stopped by the operator and initiate a fail alarm. Operator shall be able to set low pressure alarm point. Pump(s) will restart operation after a power failure.
15. Sodium bisulfite feed:
    a. The sodium bisulfite feed system is set up and started and stopped manually by the operator and can be paced manually or automatically by contact basin effluent flow, 71FIT008. The feed system shall restart after a power failure upon restoration of power. Each feeder pump is capable of 3 modes of operation selectable by operator; manual, flow paced to chlorine contact basin flow or compound loop control (flow and chlorine contact basin effluent chlorine residual feed forward). Feed forward control

shall be the contact basin effluent chlorine residual times a constant times the flow as a percent of full scale. The constant shall be adjustable over a range of 1.0 to 5.0 so that it is possible to slightly over feed bisulfite.

b. Feeder pumps 2 and 3 can be selected to feed to the effluent pump station and can be run manually or automatically paced to effluent pump flow.

c. Each feeder discharge pressure and flow is to be monitored while the respective pump is running. If the flow or discharge head drops below a preset setting the pump shall be stopped and an alarm generated. If there is a standby pump it shall be started.

d. The dilution water solenoid valve shall be energized anytime the feeder is running.

16. Ferric chloride feed:
    a. The ferric chloride feed shall be set up manually by the operator and can be paced manually or automatically by total raw sewage flow. The feed system shall restart after a power failure upon restoration of power.
    b. Each feeder discharge pressure and flow is to be monitored while the respective pump is running. If the flow or discharge head drops below a preset setting the pump shall be stopped and an alarm generated. If there is a standby pump it shall be started.
17. Sodium hydroxide feed:
    a. Sodium hydroxide feed shall be set up manually by the operator and the feed rate set manually or paced automatically by total raw sewage flow. The feed system shall restart after a power failure upon restoration of power.
18. Emergency outfall structure monitoring:
    a. Chlorine residual, bisulfite residual, pH wastewater temperature are to be monitored in the emergency outfall structure. The pH analog signal shall be dampened by adjustable dampening in the PLC or SCADA to remove any short term spikes.
19. Chlorine residual:
    a. Measure chlorine residual as shown on the P&ID's.
    b. If chlorine residual in the emergency outfall structure shows a reading above zero, start the sodium bisulfite feed to the effluent pump station and initiate an alarm.
20. Digester gas flare:
    a. Digester gas flare is set up by the operator and is controlled by the LCP.
21. Effluent pumping:
    a. The effluent pumping control is set up similar to the plant influent pumping with operator selectable pump sequence and a proportional only control, but with only a single level transmitter for control.
    b. Provide adjustable time delay between successive pump starts with a minimum range of 30 to 180 seconds.
    c. Surge tank shall be controlled by the system LCP.
    d. In auto no more than 2 pumps can be called to run at a time.
    e. Provide adjustable ramp time of 30 seconds to 60 seconds from zero to full speed and adjustable time of 30 to 60 seconds for time between pump starts and stops.
    f. Proportional level control shall be applied to the Effluent Pump Station with the following modifications required by the wetwell and pumps:
        1) The flow range into the wetwell will be from approximately 700 gpm up to 14 mgd.
        2) Minimum wetwell level is 102.2 (to meet pump manufacturer minimum submergence requirements).
        3) Maximum wetwell level is 104.25 to avoid sending water to the emergency outfall prematurely.
        4) The proportional level control band shall be adjustable, but will be approximately from elevation 102 to 103.5 for 100 to 60 percent speed.
        5) One pump will normally run at variable speed between a setpoint maximum speed of about 95 (settable from 80 to 95 percent) and 60 percent speed (not less than 1000 gpm) over the proportional level control band. One pump operation will be limited to the setpoint maximum speed due to NPSH issues and must not be operated above that speed.

6) The lag (2nd pump) will be started if the wetwell level rises to a "start 2nd" pump setpoint level above the top of the control band at about elevation 104.0 and both pumps will run at the same speed within the control band.
7) Two pumps shall run between 100 and 80 percent speed (field settable) within the same proportional level control band.
8) If the pump speed drops to a setpoint of about 80 percent with both pumps running, one pump will be taken off line and the control will revert to one pump operation.
9) Three pumps can never run together to avoid over pressuring the forcemain.
10) One pump can not go below a setpoint speed adjustable from 50 to 80 percent (set to limit the minimum flow to about 1000 gpm) and if the speed drops to this setpoint speed with one pump running the control will revert to on-off operation between preset adjustable setpoints of about elevation 103.5 (ON) and 102.0 (OFF) in the wetwell and the pump will run at an adjustable setpoint constant speed. If the wetwell level rises to the preset "start 2nd pump" level the control will switch back to proportion speed control.
11) There are 2 wetwell level transmitters installed and operator can select from SCADA which is to be used for control. If the selected transmitter falls out of range the control shall revert to the other transmitter unless it is out of range and a failure alarm shall be initiated. If both transmitters are out of range the operation of the effluent pumping shall be stopped.
12) If the effluent header pressure rises to a setpoint high pressure (normally 100 psi) for a setpoint time (0 to 10 seconds) the effluent pumping shall be stopped and an alarm generated.

g. Provide high and low wetwell alarms at elevation 104.3 (high) and 101.5 (low).
h. Pumping system is to restart in sequence after a power failure.

22. Site lighting:
    a. The control modes are on (initiated from SCADA screen), off and PLC. When in PLC the site lights are to be controlled on and off based on the photo electric cell input to the PLC in RTU-2.
    b. The user shall be able to input a daily time range and mode selection on the SCADA screen if the user does not want the lights on all night.
    c. Each RTU shall output an output contact closure to be used by the site light control at each RTU.

END OF SECTION

SECTION 13442
PRIMARY ELEMENTS AND TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Flow components.
   2. Pressure components.
   3. Level components.
   4. Analytical components.
   5. Pipe, tubing and fittings.
   6. Instrument valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Gas Association (AGA):
      a. Gas Measurement Committee Report #3.
   2. American Iron and Steel Institute (AISI).
   3. American National Standards Institute (ANSI).
   4. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings.
      b. B31.1, Power Piping.
      c. PTC 19.3, Instruments and Apparatus, Part 3 Temperature Measurement.
      d. PTC 19.5, Application of Fluid Meters, Part 2.
      e. Section II, Part A SA-182, Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      f. Section II, Part A SA-479, Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   5. ASTM International (ASTM):
      a. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A182, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      d. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      e. A276, Standard Specification for Stainless Steel Bars and Shapes.
      f. A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
      g. B16, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
      h. B75, Standard Specification for Seamless Copper Tube.
      i. B124, Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes.
      j. B283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed).
      k. B453, Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod, Bar, and Shapes.
   6. Federal Communications Commission (FCC):
      a. 47 CFR 15, Radio Frequency Devices.

7. Instrumentation, Systems, and Automation Society (ISA):
    a. MC96.1, Temperature Measurement Thermocouples.
8. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
9. US Department of Interior Bureau of Reclamation (USDIBR):
    a. Water Measurement Manual.

1.3 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "I" series Drawings.
    1. These instruments are integrated with other control system components to produce the functional control defined in the Contract Documents.

1.4 SUBMITTALS

A. Shop Drawings:
    1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
    2. See Specification Section 13440.

B. Operation and Maintenance Manuals:
    1. See Specification Section 01340 for requirements for:
        a. The mechanics and administration of the submittal process.
        b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 FLOW COMPONENTS

A. Magnetic Flow Meters:
    1. Acceptable manufacturers:
        a. ABB.
        b. Rosemount.
        c. Krohne.
        d. Endress + Hauser.
        e. Seimens.
        f. Or approved equal.
    2. Design and fabrication:
        a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
        b. High input impedance pre-amplifiers.
            1) Minimum impedance: 10^{10} ohms.
        c. Provide flanged end connections per ASME B16.5 rated for piping system operating and test conditions.
        d. Operating pressure: 100 psi.
        e. Operating temperature: 100 DegF.
        f. Grounding requirements:
            1) Nonmetallic or lined pipe:
                a) Inlet and outlet grounding rings of same material as electrode.

2) Conductive piping:
a) Conductive path between the meter and the piping flanges.

g. Provide cable between magnetic flow meter and transmitter.
h. Pulsed DC magnetic field excitation.
i. Automatic zero.
j. Adjustable low flow cutoff.
k. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
l. Inaccuracy:
1) Above 10 percent of range: +/-1.0 percent of rate.
2) Below 10 percent of range: +/-0.1 percent of range setting.
3) Add +0.1 percent of range to above inaccuracies for analog outputs.
m. 4-20 mA DC isolated output into maximum 800 ohms.
n. Power supply: 117 V +/-10 percent, 60 Hz.
o. Indication of flow rate and totalized flow at transmitter.
p. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.
q. Transmitter electronics shall use microprocessor based architecture and be configured using parameters.
r. Liner: Hard rubber or Teflon.
s. Electrode: 316 stainless steel.

3. Schedule:

TAG NUMBER	SERVICE	FLOW RANGE	METER SIZE (IN)	INTEGRAL, FIELD OR PANEL-MOUNTED TRANSMITTER
32 FE/FIT 111	RAS	0 – 5 MGD	12	Integral with sunshade
32 FE/FIT 211	RAS	0 – 5 MGD	12	Integral with sunshade
42 FE/FIT 005	RAS	0 – 4 MGD	12	RTU – 7
42 FE/FIT 006	RAS	0 – 4 MGD	12	RTU - 7
61 FE/FIT 020	Pri Sludge	0 - 300 GPM	6	Integral
61 FE/FIT 021	WAS	0 - 200 GPM	6	Integral
64 FE/AIT 027	Thickened Sludge to RDT	0 - 500 GPM	6	Integral
61 FE/FIT 028	Thickened Sludge from RDT	0 - 300 GPM	6	Integral
62 FE/FIT 001	Centrifuge Feed	0 - 300 GPM	6	Integral
72 FE/FIT 007	#3 Water	0 - 300 GPM	6	Integral with Sunshade
91 FE/FIT 011	Eff P.S.	0 – 20 MGD	24	RTU-8
91 FE/FIT 004	#3/#4 Water	0 – 500 GPM	6	RTU-8

B. Flow Switch:
1. Acceptance manufacturers:
a. McDonnell & Miller FS 6-W1.
b. Or approved equal.
2. Material:
a. Wetted parts corrosion resistant brass, bronze, stainless steel.
3. Design and fabrication:
a. Sealed switch compartment.
b. NEMA 4X housing.
c. Adjustable trip point.
d. SPDT switch.

4. Schedule:

TAG NUMBER	SERVICE	PIPE SIZE (IN)
71 FSL 013	Water	3/4
71 FSL 014	Water	3/4
71 FSL 015	Water	3/4
71 FSL 016	Water	3/4
71 FSL 017	Water	3/4
71 FSL 018	Water	3/4

C. Rotameters:
1. Acceptable manufacturers:
   a. Brooks.
   b. Fischer and Porter.
   c. Or approved equal.
2. Materials:
   a. Tube: Borosilicate glass.
   b. Floats and fittings: 316 stainless steel.
   c. Gaskets and packing: Teflon.
   d. Side plates and bezels: 300 series stainless steel.
3. Design and fabrication:
   a. Variable area flow meter.
   b. Provide acrylic plastic safety enclosure where operating pressures may exceed 50 psig.
   c. Meter end fittings fully rotatable through 360 degrees.
   d. Provide frost shield to maintain dry dead air space between metering tube and atmosphere.
   e. Fabricate metal scale calibrated to read directly in units of flow with range of twice design flow.
   f. Tube length: 10 IN.
   g. Process fluid: Water, unless otherwise noted.
   h. Accuracy: +/-2 percent of full scale over a 10:1 turndown ratio.
   i. Unit shall be straight-through construction with vertical NPT end connections.

2.3 PRESSURE COMPONENTS

A. Pressure Transmitters:
1. Acceptable manufacturers:
   a. Rosemount, Model 3051.
   b. Foxboro, I/A series.
   c. Honeywell 100e.
   d. Or approved equal.
2. Materials:
   a. Isolating diaphragm: 316 stainless steel.
   b. Process flanges and adapters: 316 stainless steel.
   c. Housing: Aluminum.
   d. Vent/drain valve: 316 stainless steel.
   e. Fill fluid:
      1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
         a) Agents include but are not limited to: Cl2, KMN04, FeCl, Na0H, and Na0Cl.
      2) Utilize manufacturer's standard fill for other applications.
         a) Ensure fill is suitable for application temperatures.

3. Design and fabrication:
   a. Smart transmitters utilizing microprocessor based electronics.
   b. Output: 4-20 mA DC proportional to pressure.
   c. Nonvolatile EEPROM memory.
   d. Power supply: 24 Vdc.
   e. Adjustable zero and span.
   f. Temperature limits: -20 to 180 DegF.
      1) -4 to 175 DegF for LCD indicators.
   g. Overpressure limits: Withstand 150 percent of stated maximum service pressure without damage.
   h. Humidity limits: 0 to 100 percent relative humidity.
   i. Damping: Adjustable between 0 and 32 seconds.
   j. Inaccuracy (includes effects of linearity, repeatability and hysteresis): +/-0.10 percent of calibrated span for 15:1 rangeability.
   k. Stability: +/-0.2 percent of upper range limit for 12 months.
   l. Temperature effect:
      1) Total effect including span and zero errors: +/-0.2 percent of upper range limit per 100 DegF for minimum 15:1 rangeability.
   m. Minimum 1/2 IN pressure connection.
   n. Equip with test jacks or accessible terminals for testing output.
   o. Equip with isolation valve and test connections with isolation valves and/or plugs.
4. Schedule:

TAG NUMBER	SERVICE	SPAN	FLUID DENSITY
51 PIT 005	LP Air	0 – 15 PSI	-
72 PIT 006	#3 Water	0 – 100 PSI	1.0
75 LIT 005	Sodium Hypochlorite	0 – 12 FT	1.0
75 LIT 006	Sodium Hypochlorite	0 – 12 FT	1.0
75 LIT 105	Sodium Bisulfite	0 – 12 FT	1.33
75 LIT 106	Sodium Bisulfite	0 – 12 FT	1.33
76 LIT 004	Ferric Chloride	0 – 12 FT	1.40
77 LIT 104	Sodium Hydroxide	0 – 12 FT	1.52
91 PIT 019	Effluent	0 – 200 PSI	1.0

B. Pressure Switches:
1. Acceptable manufacturers:
   a. Ashcroft.
   b. Automatic Switch Company.
   c. United Electric.
   d. Or approved equal.
2. Materials:
   a. Wetted switch elements: 316 stainless steel.
   b. Diaphragm seal housing: 316 stainless steel.
   c. Pressure snubber:
      1) Filter disc: 316 stainless steel or Monel.
      2) Housing: Brass or 316 stainless steel.
3. Accessories:
   a. Provide ball valve to isolate pressure switch from source.
   b. Utilize pressure snubbers with porous metal discs to provide pulsation dampening on pressure switch as shown on schedule.
   c. On applications where a pressure switch and a pressure gage are used at the same location, it is permissible to utilize one (1) pulsation dampener and diaphragm seal to isolate both elements from the process fluid.

4. Design and fabrication:
    a. Utilize hermetically sealed mercury contact switches.
    b. Two (2) SPDT contacts rated:
        1) 1 amp inductive at 125 Vdc.
        2) 5 amp inductive at 120 Vac.
    c. Switch set points:
        1) Above 1,000 psi:
            a) Between 30 and 35 percent of switch rated working range.
            b) Operating pressure range not to exceed 35 percent of switch rated working pressure.
        2) Below 1,000 psi:
            a) Set points between 30 and 70 percent of switch rated working range.
            b) Operating pressure not to exceed 75 percent of switch rated working range.
    d. Accuracy: Better than 1 percent of full scale.
    e. Process connection: Minimum of 1/4 IN.
5. Schedule:

TAG NUMBER	SERVICE	LOW SETTING	HIGH SETTING	PROTECTOR REQUIREMENTS
23 PSH 008	Sludge		40 PSI	Yes
61 PSH 004	Sludge		60 PSI	Yes
61 PSH 014	Sludge		60 PSI	Yes
61 PSL 006	Water	30 PSI		No
64 PSH 023	Sludge		60 PSI	Yes
64 PSH 026	Sludge		60 PSI	Yes

C. Pressure Gage:
1. Acceptable manufacturers:
    a. Ashcroft.
    b. Ametek.
    c. Or approved equal.
2. Materials:
    a. Bourdon tube, socket, connecting tube: 316 stainless steel.
    b. Case: Phenolic.
    c. Pressure snubber:
        1) Filter disc: 316 stainless steel or Monel.
        2) Housing: Brass or 316 stainless steel.
3. Accessories:
    a. Provide valve at point of connection to equipment and at panel if panel mounted.
    b. Utilize pressure snubbers with porous metal discs to provide pulsation dampening on all gage applications.
    c. Provide 1/2 IN stainless steel antisiphon pigtail inlet connection for hot water and steam applications.
4. Design and fabrication:
    a. All components suitable for service at:
        1) 250 DegF.
        2) The maximum process temperature to which the gage is to be exposed.
    b. Provide viewer protection from element rupture.
    c. Calibrate gages at jobsite for pressure and temperature in accordance with manufacturer's instructions.
    d. Unless otherwise required by codes, provide stem mounted or flush mounted, as required, with dial diameter as follows:

PIPE SIZE	DIAL SIZE	GAGE CONNECTION
1-1/2 IN or less	2-1/2 IN	1/4 IN
Larger than 1-1/2 IN	4-1/2 IN	1/2 IN

e. Equip with 4 IN dials, white faces, black numerals and black pointers.
f. Gage tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment.
   1) Gage to be readable from an accessible standing position.
g. Gage accuracy: 1 percent of full range.
h. Select gage range so that:
   1) The normal operating value is in the middle third of the dial.
   2) Maximum operating pressure does not exceed 75 percent of the full scale range.

D. Schedule:

TAG NUMBER	APPLICATION	PRESSURE RANGE (PSI)	PROTECTOR REQUIREMENTS
23 PI 008	Primary Scum	0 – 60	Yes
23 PI 009	Primary Scum	0 – 60	Yes
25 PI 007	Primary Scum	0 – 60	Yes
25 PI 008	Primary Scum	0 – 60	Yes
25 PI 009	Primary Sludge	0 – 60	Yes
25 PI 010	Primary Sludge	0 – 60	Yes
42 PI 008	RAS	0 - 60	Yes
42 PI 009	RAS	0 – 60	Yes
42 PI 010	RAS	0 – 60	Yes
42 PI 011	RAS	0 – 60	Yes
43 PI 005	WAS	0 – 60	Yes
43 PI 006	WAS	0 – 60	Yes
51 PI 005	LP Air	0 – 15	No
61 PI 004	Sludge	0 – 100	Yes
61 PI 006	Water	0 – 100	No
61 PI 014	Sludge	0 – 100	Yes
64 PI 023	Sludge	0 - 100	Yes
64 PI 026	Sludge	0 – 100	Yes
72 PI 004	#3 Water	0 – 100	No
72 PI 005	#3 Water	0 – 100	No
91 PI 004	Effluent	0 – 200	No
91 PI 005	Effluent	0 – 200	No
91 PI 006	Effluent	0 - 200	No
92 PI 001	Effluent	0 – 100	No
92 PI 002	Effluent	0 – 100	No

E. Diaphragm Seal:
   1. Acceptable manufacturers:
      a. Ashcroft.
      b. Ametek.
      c. Or approved equal.
   2. Materials:
      a. Lower housing: 316 stainless steel.
      b. Diaphragm material: 316 stainless steel.

3. Design and fabrication:
    a. Isolates instrument from process fluids which are corrosive or contain solids.
    b. Upper housing with bleed screw.
    c. Lower housing with flushing connection.
    d. Fill fluid:
        1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl2, KMNO4, FeCl, NaOH, and NaOCl.
        2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
    e. Process connections:
        1) Instrument: 1/2 IN NPT
        2) Process: 0.5 IN female NPT.
        3) PVC pipe applications: Use a socket weld connection.
4. Installed where specified or shown on Drawings.

F. In-Line Isolation Sleeve (Annular Seal):
1. Acceptable manufacturers:
    a. Ametek.
    b. Red Valve.
    c. Or approved equal.
2. Materials:
    a. Body: 316 stainless steel.
    b. Flexible liner: Buna-N.
3. Design and fabrication:
    a. Provide full 360 degree annular pressure sensor with flexible in-line sleeve.
    b. Sensor shall not restrict the process flow (non-intrusive).
    c. Seal shall be wafer type.
        1) Line size as shown on the Drawings.
    d. Instrument connection: 0.25 IN female NPT.
    e. Fill fluid:
        1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl2, KMNO4, FeCl, NaOH, and NaOCl.
        2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
    f. Pressure rating: To meet requirements of schedule.

2.4 LEVEL ELEMENTS

A. Submersible Level Sensor/Transmitter:
1. Acceptable manufacturers:
    a. Keller Nonfouling Level Rat.
    b. Or approved equal.
2. Select range closest to measured span.
3. Cable length to reach terminal connection panel (Contractor to confirm).
    a. Transmitter to be self supporting from cable.
    b. Cable to be suitable for wet location.
    c. Cable to include transmitter venting.
4. 4-20 mA output, loop powered, 24 VDC.
5. Accessories:
    a. Cable venting/desiccant unit for mounting in control panel.
    b. Surge protector for mounting in control panel.
    c. Kellum grip type cable hanger.
    d. Cable weight.

6. Schedule:

TAG NUMBER	RANGE	SERVICE
12 LT 004	0 – 12 FT	Raw Sewage
12 LT 005	0 – 12 FT	Screened Sewage
12 LT 310	0 – 16 FT	Screened Sewage
12 LT 312	0 – 16 FT	Screened Sewage
23 LT 005	0 – 10 FT	Scum
23 LT 006	0 – 15 FT	Scum
61 LT 029	0 – 15 FT	Scum
71 LT 007A	0 – 10 FT	Final Effluent
71 LT 007B	0 – 10 FT	Final Effluent

B. Float-Tilt Type Level Switches:
   1. Acceptable manufacturers:
      a. Anchor Scientific Inc.
      b. Consolidated Electric.
      c. Or approved equal.
   2. Materials:
      a. Float material: Polypropylene or Teflon coated type 316 stainless steel.
      b. Cable jacket: PVC, neoprene.
      c. Cable clamp: Polypropylene or 316 stainless steel.
   3. Design and fabrication:
      a. Sealed switch in float.
      b. Provide switch complete with flexible electrical cables.
      c. SPDT contact rated at 4.5 amp at 120 Vac.
      d. Direct acting float switch:
         1) Switch actuates on rising level.
         2) Switch deactuates when liquid falls 1 IN below actuation level.
      e. Terminate cables in junction box.
      f. Process temperature: 100 DegF.
      g. Install floats per Drawing details.
   4. Schedule:

TAG NUMBER	SERVICE	MOUNTING ELEVATION
12 LSH 311	Screened Sewage	103.00
12 LSL 311		
12 LSH 313	Screened Sewage	103.00
12 LSL 313		

C. Ultrasonic Level Sensor and Transmitter:
   1. Acceptable manufacturers:
      a. Siemens.
      b. Endress + Hauser.
      c. Magnetrol.
      d. Or approved equal.
   2. Materials:
      a. Sensor wetted parts: PVC, polypropylene, KYNAR or polyvinylidene fluoride (PVDF).
   3. Design and fabrication:
      a. Sensor:
         1) Emits ultrasonic sound.

2) Detects return echo reflected from surface and converts it to electrical energy proportional to level.

b. Temperature compensated.

c. Capable of being configured to ignore false targets.

d. Operating temperature: -4 to 140 DegF.

e. Humidity: 95 percent non-condensing.

f. Transmitter:

1) Capable of producing output signal proportional to level of 4-20 mA DC into 500 ohm load.

2) Power supply: 120 Vac (+/-10 percent), 60 Hz.

3) Inaccuracy: 0.25 percent of range or 0.24 IN, whichever is greater.

4) Resolution: 0.1 percent of span or 0.08 IN, whichever is greater.

5) Display: Four-digit LED or LCD scalable to engineering units with selectable decimal point.

6) Temperature: -5 to 122 DegF.

7) Humidity: 95 percent noncondensing.

8) Memory: EEPROM (non-volitile).

9) Keypad programmer.

4. Schedule:

TAG NUMBER	SERVICE	RANGE	SUNSHADE
11 FIT 001	Raw Sewage	0 – 12 IN (0 – 10 MGD)	Yes
11 FIT 002	Raw Sewage	0 – 12 IN(0 – 10 MGD)	Yes
22 LIT 001	Screened Sewage	0 – 12 IN (0 – 16 MGD)	Yes
61 LIT 005	Thickened Sludge	0 – 5 FT	
61 LIT 015	Thickened Sludge	0 – 5 FT	
71 FIT 008	Water	0 – 1 FT (0 – 20 MGD)	Yes

D. Level Sensing Probes:

1. Acceptable manufacturers:

a. Warrick.

b. Or approved equal.

2. Materials:

a. Probe holder:

1) Series 3E.

2) Cast iron.

3) 2 probes.

4) Wall mount stainless steel bracket for those indicated as wall mount, use 24 IN long 316 stainless steel probes.

b. Controller:

1) Series 16M.

2) 120 VAC.

3) Wall mount NEMA 4X enclosure.

3. Schedule:

TAG NUMBER	SERVICE	MOUNTING ELEVATION
75 LSH 007	Sodium Hypochlorite	Wall Mount High Level
75 LSH 107	Sodium Bisulfite	Wall Mount High Level
76 LSH 005	Ferric Chloride	Wall Mount High Level
77 LSH 105	Sodium Hydroxide	Wall Mount High Level

2.5 ANALYTICAL ELEMENTS

A. Dissolved Oxygen Sensor and Analyzer/Transmitter:
   1. Acceptable manufacturers:
      a. Hach Company, model LDO® sensor and model series sc transmitter.
      b. Or approved equal.
   2. Materials:
      a. Sensor wetted parts: Noryl, Teflon, 316 stainless steel, PVC, polypropylene, PBT (thermoplastic polyesters based on polybutylene terephthalate), or PC (polycarbonate).
      b. Sensor membrane: Polybutyl methoacrolate or Teflon.
      c. If amperometric type sensor:
         1) Anode: Silver.
         2) Cathode: Gold.
   3. Design and fabrication:
      a. Sensor:
         1) Temperature compensated.
         2) Inaccuracy:
            a) Dissolved oxygen: +/-0.2 ppm or +/-0.2 percent of span at calibrating temperature.
            b) Temperature: +/-0.5 DegC.
         3) Response time: 95 percent in 60 seconds.
         4) Internal calibration standard.
         5) Mounting: Guardrail clamp arm.
         6) Operating temperature: 32 to 122 DegF.
         7) Spares:
            a) Luminescent type sensors: One (1) replacement sensor cap per sensor installed.
            b) Electrochemical type sensors: One (1) replacement sensor per each two (2) (or fraction thereof) sensors installed.
      b. Analyzer/transmitter:
         1) Minimum 2-1/2 digit local LED or backlit LCD display.
            a) 0.1 ppm resolution.
            b) 0.1 DegF resolution.
            c) Menu driven.
            d) Indication of sensor fault condition.
         2) Power supply: 120 Vac +10 percent, 60 Hz.
         3) Output signals:
            a) Isolated 4-20 mA DC, dissolved oxygen, into 500 ohms.
         4) Operating temperature: -4 to 140 DegF.
         5) Relative humidity: 95 percent.
         6) NEMA 4X enclosure.
   4. Schedule:

TAG NUMBER	SERVICE	MEASUREMENT RANGE	SUNSHADE
31 AE/AIT 106	Mixed Liquor	0 – 20 percent	Yes
31 AE/AIT 107	Mixed Liquor	0 – 20 percent	Yes
31 AE/AIT 108	Mixed Liquor	0 – 20 percent	Yes
31 AE/AIT 206	Mixed Liquor	0 – 20 percent	Yes
31 AE/AIT 207	Mixed Liquor	0 – 20 percent	Yes
31 AE/AIT 208	Mixed Liquor	0 – 20 percent	Yes

B. pH/Temperature Sensor and Transmitter:
   1. Acceptable manufacturers:
      a. Rosemount Analytical.

b. Hach Company.
c. Leeds and Northrup.
d. Or approved equal.

2. Materials:
   a. Body, cover: Polyethersulfone (PES), KYNAR, (polyvinylidene fluoride (PVDF)), liquid crystal polymer, epoxy (less than 140F).
   b. O-rings: VITON.
3. Design and fabrication:
   a. Sensor:
      1) Integral pre-amplifier to convert high impedance pH into stable, noise-free signal (if not furnished with integral transmitter).
      2) Automatic temperature compensation.
      3) Shielded cable, 40 FT minimum.
      4) Submersible.
      5) Sensitivity: 0.01 pH.
      6) Range: 0-14 pH.
      7) Mounting: Guardrail clamp arm.
   b. Transmitter:
      1) Local digital display.
         a) LCD or LED.
         b) Minimum 3-1/2 digit.
      2) Current output: Isolated 4-20 mA DC.
      3) Power supply: 120 Vac, +10 percent, 60 Hz or 24 Vdc for 2-wire transmitter.
      4) Ambient temperature: -4 to 122 DegF.
      5) Ambient humidity: 0-95 percent.
      6) Accuracy: +0.01 pH.
      7) Repeatability: +0.1 pH.
      8) Temperature compensated: 32 to 212 DegF.
      9) Temperature coefficient:
         a) Input: +0.0017 pH/DegF.
         b) Output: +0.0033 pH/DegF.
      10) NEMA 4X enclosure.
      11) Cable, 40 FT minimum.
      12) 2 channel, pH and temperature.
4. Schedule:

TAG NUMBER	SERVICE	RANGE	SUNSHADE
31 AIT 110	Mixed Liquor	0 – 14, 0 – 100 DegF	Yes
31 AIT 210	Mixed Liquor	0 – 14, 0 - 100 DegF	Yes
71 AIT 011	Effluent	0 – 14, 0 – 100 DegF	Yes

C. Total Chlorine Residual:
1. Hatch CL17 or approved equal.
2. 120 VAC power supply with cord and grounding plug.
3. Output 4–20 mA.
4. Initial supply of chemicals.
5. Schedule:

TAG NUMBER	SERVICE	SPAN
71 AE/AIT 003A	Effluent	0 – 20 mg/l
71 AE/AIT 003B	Effluent	0 – 20 mg/l
71 AE/AIT 009	Effluent	0 – 5 mg/l
71 AE/AIT 010	Effluent	0 – 5 mg/l
91 AE/AIT 013	Effluent	0 – 5 mg/l

D. Sulfite Residual:
   1. ATI Model Q46S/66 or approved equal.
   2. 120 VAC power supply with cord and grounding plug.
   3. Output 4-20 mA.
   4. NEMA 4X enclosure.
   5. Complete unit including chemistry module and electronic monitor with interconnecting cable.
   6. Panel mounting bracket kit.
   7. Schedule:

TAG NUMBER	SERVICE	SPAN
71 AE/AIT 012	Effluent	0 – 5 mg/l
91 AE/AIT 014	Effluent	0 – 5 mg/l

E. Nitrate (NO3) / Ammonium (NH4) Sensor:
   1. Acceptable manufacturer:
      a. Hach Instruments, Model AN-ISC SC Combination Sensor System.
      b. Or approved equal.
   2. Design and fabrication:
      a. Submersible up to 10 FT.
      b. Minimum of 30 FT of cable.
      c. Accuracy; 5 percent measured value $\pm$ 0.2 mg/l.
      d. Calibrated sensor cartridge.
      e. 4-20 mA outputs.
      f. Complete with Hach SC-200 transmitter, or equal with cord and grounding plug.
      g. Guardrail clamp arm.
   3. Schedule:

TAG NUMBER	RANGE	SUNSHADE
31 AE/AIT 111	0 – 20 mg/l (NO3), 0 - 10 mg/l (NH4)	Yes
31 AE/AIT 211	0 – 20 mg/l (NO3), 0 – 10 mg/l (NH4)	Yes

2.6 PIPE, TUBING, AND FITTINGS

A. Acceptable Manufacturers:
   1. Tube fittings:
      a. Parker CPI.
      b. Swagelok.
      c. Or approved equal.

B. Instrument Tubing and Fittings:
   1. Material:
      a. Tubing: ASTM A269, Grade TP 316 stainless steel.
      b. Straight fittings: 316 stainless steel per ASME SA-479 or ASTM A276.
      c. Shaped bodies: ASME SA-182 F316 stainless steel.
   2. Design and fabrication:
      a. Tubing:
         1) Seamless.
         2) Fully annealed.
         3) Maximum hardness: 80 Rb.
         4) Free from surface scratches and imperfections.
         5) Diameter: 1/2 IN OD unless specified otherwise.

6) Wall thickness:
a) Meet requirements of ASME B31.1, Paragraph 122.3.
b) Minimum 0.049 IN for 1/2 IN OD tubing.
b. Fittings:
1) Flareless.
2) Compression type.

C. Instrument Piping:
1. For applications where the instrument is supported solely by the sensing line, (e.g., pressure gauge directly mounted to process line) utilize piping as specified below.
a. Diameter: 1/2 IN unless specified otherwise.
b. Schedule 80.
c. 316 stainless steel.

2.7 INSTRUMENT VALVES

A. Process instrument multi-valve manifolds, isolation, vent and blow-down valves:
1. Acceptable manufacturers:
a. Whitey Co.
b. Anderson-Greenwood USA, Inc.
c. Or approved equal.
2. Materials:
a. Packing:
1) 450 DegF and above: Graphite.
2) Below 450 DegF: Graphite or Teflon.
b. Body: 316 stainless steel per ASTM A479.
c. Stem: 316 stainless steel per ASTM A276.
d. Ball: 316 stainless steel per ASTM A276.
e. Support rings: 316 stainless steel per ASTM A276.
f. Seats:
1) Metal:
a) 316 stainless steel per ASTM A276.
2) Soft:
a) Teflon, Delrin.
b) Only utilized on applications where manufacturer's temperature and pressure ratings exceed process design conditions.
3. Design and fabrication:
a. Either of the following:
1) Ball valve with 1/4 turn activation.
2) Free-swiveling ball stem.
b. Provide body wall thickness sufficient for process design conditions per ASME B31.1.
c. Temperature: Manufacturer's temperature rating for all components shall exceed process design conditions.

2.8 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
1. Materials, unless otherwise specified, shall be as follows:
a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
b. Mounting brackets: 316 stainless steel.
c. Mounting plates, angles: 316 stainless steel.
d. Instrument pipe stands:
1) Standard: Hot-dip galvanized 2 IN schedule 40, ASTM A106, Grade B carbon steel.
2) Wet or corrosive areas: 316 stainless steel.

B. Tubing Support Angles and Brackets:
   1. Any of the following materials are acceptable:
      a. Aluminum support with dielectric material between support and tubing.
      b. Type 316 stainless steel.
      c. Fiberglass.

C. Tubing Tray or Channel:
   1. Aluminum.
   2. Provide dielectric material between tray or channel and tubing.

D. Provide handheld communicator compatible with all intelligent transmitters furnished.
   1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
   2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.

E. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Instrument Valves:
   1. Orient stems for proper operation.
   2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
   3. Provide a minimum of 2 IN clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
   4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
      a. When cool, reassemble the valves.
   5. Support each valve individually.
      a. The tubing system does not qualify as support for the valve.

D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

E. Keep foreign matter out of the system.

F. Remove all oil on piping and tubing with solvent before piping and tubing installation.

G. Plug all open ends and connections to keep out contaminants.

H. Tubing Installation:
   1. General:
      a. Install such that tube shows no sign of crumpling, bends of too short a radius, or flattening, etc.
      b. Make tube runs straight and parallel or perpendicular to the floor, equipment and piping runs.
      c. For liquid and steam applications, slope continuously from the process to the instrument with a minimum slope of 0.50 IN per foot.
      d. For gas and air applications, slope continuously from the instrument to the process with a minimum slope of 0.50 IN per foot.
      e. If the sensing line cannot be continuously sloped, install high point vents and low point drains.

f. Keep instrument tubing clean during all phases of work.
g. Blow out with clean, dry, oil-free air immediately before final assembly.
h. Cut by sawing only and debur.

2. Bending:
   a. Make each bend with tube bender of the correct size for the tube.
   b. Make all bends smooth and continuous.
   c. Rebending is not permitted.
   d. Make bends true to angle and radius.
   e. Maintain a true circular cross section of tubing without buckling or undue stretch of tube wall.
   f. Allowable tolerance for flattening out of tubing bends: Maximum of 8 percent of the OD for stainless steel tubing.
   g. Minimum bending radius for stainless steel tubing:

TUBE OD, INCHES	MINIMUM BENDING RADIUS, INCHES
1/4	9/16
3/8	15/16
1/2	1-1/2

   h. Minimum bending radius for type L, hard (drawn) copper:

TUBE OD, INCHES	MINIMUM BENDING RADIUS, INCHES
3/8	1-3/4
1/2	2-1/2

3. Tubing support:
   a. Intermittently support by clamping to support angle.
   b. Install supports to be self-draining, supported by hangers, or cantilevered from walls or structural beams.
   c. Support at 5 FT-0 IN maximum spans for horizontal or vertical runs.
   d. Use tubing trays in areas where spans between supports are greater than 5 FT and for all signal tubing support.
   e. Support each tubing tray at 10 FT maximum spans.
   f. Align tubing in orderly rows and retain in the tray by bolted clips.
      1) The use of spring or speed clips is not acceptable.
   g. Maintain order of the tubing throughout the length of the tray.
   h. Locate angle, channel and tray installation to protect tubing from spills and mechanical damage.
   i. Locate support members to clear all piping, conduit, equipment, hatchways, monorails, and personnel access ways and allow access for equipment operation and maintenance.
   j. Support trays to prevent torsion, sway or sag.
   k. Permanently attach supports to building steel or other permanent structural members.
   l. Arrange supports and trays so that they do not become a trough or trap.
4. Routing and orientation:
   a. Route to maintain a minimum headroom clearance of 8 FT.
   b. Locate and orient valves and specialties so that they are accessible for operation and maintenance from the operating floor.
      1) Do not route through or over equipment removal areas, below monorails or cranes nor above or below hatches.
5. Expansion and vibration provisions:
   a. Provide horizontal expansion loops at the process connections.
   b. Route tubing parallel to relative motion through sleeved supports that allow linear tube movement.

c. Cold springing of tubing to compensate for thermal expansion is prohibited.
d. Utilize flexible hoses to connect pneumatic tubing to air users which may move or vibrate.

I. Threaded Connection Seals:
1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

J. Capillary Tubing:
1. Route capillary tubing in tubing tray.
2. Install capillary tubing with a 2 IN minimum bend radius which does not kink or pinch the capillaries.
3. Do not cut or disconnect at any point.
4. Coil excess capillary tubing and secure at the instrument.

K. Temperature Elements:
1. Assemble in the following sequence:
a. Remove temperature sensor sheaths and terminal blocks from the head and nipple assembly.
b. Connect nipple and head to thermowell installed in the pipe.
c. Insert sheath and terminal block until it seats in the thermowell.
d. Connect to the head.

L. Instrument Mounting:
1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
a. Protection from heat, shock, and vibrations.
b. Accessibility for maintenance.
c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01650.

END OF SECTION

SECTION 13446
CONTROL AUXILIARIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Signal modules.
   2. Pilot devices:
      a. Selector switches.
      b. Pushbuttons.
      c. Indicating lights.
   3. Relays/timers:
      a. Percentage timers.
      b. Reset timers.
      c. Control relay.
      d. Time delay relays.
   4. Termination equipment:
      a. Terminal blocks.
      b. Fuse holders.
   5. Power supplies:
      a. DC power supplies.
   6. Voltage surge protection devices.
   7. Running time indicator.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Instrumentation, Systems, and Automation Society (ISA):
      a. S18.1, Annunciator Sequences and Specifications.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   3. Underwriters Laboratories, Inc. (UL).

B. Miscellaneous:
   1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.

C. Submit request for substitution in accordance with Specification Section 01640.

2.2 SIGNAL MODULE

A. Acceptable Manufacturers:
   1. AGM Electronics.
   2. Moore Industries.
   3. Or approved equal.

B. Design and Fabrication:
   1. Solid state electronics.
   2. Transmit analog output signal directly proportional to measured input signal.
   3. Power source: 24 Vdc.
   4. Analog input: 4-20 mA DC or 1-5 Vdc.
   5. Output signal: 4-20 mA DC into 1400 ohms.
   6. Impedance:
      a. Voltage input: 10 Meg.
      b. Current input: 50 ohms.
      c. Voltage output: 1 ohm.
      d. Current output: 1650 ohms.
   7. Accuracy: Better than ± 0.10 percent of span.
   8. Isolation: Up to 500 V rms (input, output and case).
   9. Temperature effect: ±0.0025 percent of span per DegF.
   10. Ambient temperature range: 0-140 DegF.
   11. Factory calibrated.

2.3 PILOT DEVICES

A. Selector Switches:
   1. Acceptable manufacturers:
      a. Eaton.
      b. Allen-Bradley.
      c. Or approved equal.
   2. Design and fabrication:
      a. Heavy-duty type.
      b. Oiltight.
      c. Rotary cam units conforming to NEMA ICS 2-216.22.
      d. Mounting hole: 30.5 mm.
      e. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified.
      f. UL listed.
      g. Maintained contact type.
      h. Knob type operators.
      i. Black colored operators.
      j. Designed with cam and contact block with approximate area of 2 IN SQ.
      k. Legend plate marked per Contract Documents.

l. Contact block requirements:
    1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
    2) Wet or outside locations: Hermetically sealed contact blocks.

B. Pushbuttons:
1. Acceptable manufacturers:
    a. Eaton.
    b. Allen-Bradley.
    c. Or approved equal.
2. Materials:
    a. Backing diaphragm: Buna-N.
3. Design and fabrication:
    a. Heavy-duty type.
    b. Oiltight.
    c. Conforming to NEMA ICS 2-216.22.
    d. Mounting hole: 30.5 mm.
    e. Diaphragm backed.
    f. UL listed.
    g. Emergency stop pushbuttons to have mushroom head operator and maintained contact.
    h. Non-illuminated type:
        1) Momentary contact with necessary contact blocks.
        2) Molded, solid color melamine buttons.
        3) Standard flush operators with full shroud.
        4) Green colored buttons for START or ON and red color for STOP or OFF.
        5) Appropriate contact blocks to fulfill functions shown or specified.
    i. Contact block requirements:
        1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
        2) Wet or outside locations: Hermetically sealed contact blocks.
        3) Legend plate marked per Contract Documents.
    j. Illuminating type:
        1) Momentary contact with necessary contact blocks.
        2) Serves as both pushbutton control and indicating light.
        3) Green colored lenses for start or on and red for STOP or OFF.
        4) LED-type full voltage light unit with lens and panel gasket.
        5) Legend plate marked per Contract Documents.
        6) Appropriate contact blocks to fulfill functions shown or specified.

C. Indicating Lights:
1. Acceptable manufacturers:
    a. Eaton.
    b. Allen-Bradley.
    c. Or approved equal.
2. Design and fabrication:
    a. Heavy duty type.
    b. Oiltight.
    c. Type allowing replacement of bulb without removal from control panel.
    d. LED.
    e. UL listed.
    f. Legends marked per Contract Documents.
    g. Nominal 2 IN SQ face.
    h. Mounting hole: 30.5 mm.
    i. Push-to-test indicating lights.
    j. Glass lens.
    k. Color code lights as follows:
        1) Green: ON or running; valve open.

2) Amber: Standby; auto mode; ready.
3) Red: OFF or stopped; valve closed.

l. Legend plate engraved for each light.

2.4 RELAYS/TIMERS

A. Percentage Timer:
1. Acceptable manufacturer:
a. Eagle Signal Controls.
b. Or approved equal.
2. Design and fabrication:
a. Dial setting made by turning a knob located in the center of dial.
b. Dial calibrated with 100 divisions and a pointer to indicate percentage of each total cycle that the contact is closed.
c. Set accuracy: 1 percent.
d. Repeat accuracy: 1/2 percent of full scale.
e. Percentage timer shall allow 0 to 100 percent time selector of the specified time range time setting of 24 HR timer control.
f. Automatic repeat cycle-type timer.
g. Switch rating: 25 amps at 120 Vac.
h. Current input: 120 V, 1 PH, 60 HZ.
i. Time range of percentage timer equal to 15 minutes.

B. Reset Timer:
1. Acceptable manufacturer:
a. Eagle Signal Controls.
b. Or approved equal.
2. Design and fabrication:
a. Heavy duty.
b. Consisting of adjustable time delay with automatic reset feature when period is timed out.
c. Auxiliary relays as required to perform functions specified or shown on Drawings.
d. Operate on 117 Vac (+10 percent) power source.
e. Nominal dimensions: 4 x 4 IN.
f. Switch rating: 10 amps.
g. Dial range: 60 minutes.

C. Control Relays:
1. Acceptable manufacturers:
a. Idec.
b. Potter & Brumsfield.
c. Allen-Bradley.
d. Or approved equal.
2. Design and fabrication:
a. Plug-in general purpose relay.
b. Blade connector type.
c. Switching capacity: 10 A.
d. Contact material: Silver cadmium oxide.
e. Provide relays with a minimum of 3 SPDT contacts.
f. Coil voltage: 120 Vac or 24 Vdc.
g. Relay sockets are DIN rail mounted.
h. Internal neon or LED indicator is lit when coil is energized.
i. Clear polycarbonate dust cover with clip fastener.
j. Check button.
k. Temperature rise:
1) Coil: 85 DegF max.
2) Contact: 65 DegF max.

l. Insulation resistance: 100 Meg min.
m. Frequency response: 1800 operations/hour.
n. Operating temperature: -20 to +150 DegF.
o. Life expectancy:
1) Electrical: 500,000 operations or more.
2) Mechanical: 50,000,000 operations or more.
p. UL listed or recognized.

D. Time Delay Relays:
1. Acceptable manufacturers:
a. Eagle Signal Controls.
b. Idec.
c. Or approved equal.
2. Design and fabrication:
a. Melt design test and performance requirements of NEMA ICS 2-218.
b. Heavy-duty.
c. Solid-state construction.
d. External adjusting dial.
e. Auxiliary relays as required to perform functions specified or shown on Drawings.
f. Operates on 117 Vac (±10 percent) power source.
g. Contact rating: A150 per NEMA ICS 2-125.
h. Furnish with "on" and "timing out" indicators.

2.5 TERMINATION EQUIPMENT

A. Terminal Blocks:
1. Acceptable manufacturers:
a. Phoenix Contact.
b. Allen-Bradley.
c. Or approved equal.
2. Design and fabrication:
a. Modular type with screw compression clamp.
b. Screws: Stainless steel.
c. Current bar: Nickel-plated copper allow.
d. Thermoplastic insulation rated for -40 to +90 DegC.
e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
f. Install end sections and end stops at each end of terminal strip.
g. Install machine-printed terminal markers on both sides of block.
h. Spacing: 6 mm.
i. Wire size: 22-12 AWG.
j. Rated voltage: 600 V.
k. Din rail mounting.
l. UL listed.
3. Standard-type block:
a. Rated current: 30 A.
b. Color: Gray body.
4. Bladed-type block:
a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
b. Rated current: 10 A.
c. Color:
1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
2) Foreign voltage entering enclosure: Orange body, orange switch.
5. Grounded-type block:
a. Electrically grounded to mounting rail.
b. Use to terminal ground wires and analog cable shields.
c. Color: Green and yellow body.

B. Fuse Holders:
   1. Acceptable manufacturers:
      a. Phoenix Contact.
      b. Allen-Bradley.
      c. Or approved equal.
   2. Design and fabrication:
      a. Modular-type with screw compression clamp.
      b. Screws: Stainless steel.
      c. Current bar: Nickel-plated copper alloy.
      d. Thermoplastic insulation rated for -40 to +105 DegC.
      e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
      f. Blocks can be ganged for multi-pole operation.
      g. Install end sections and end stops at each end of terminal strip.
      h. Install machine-printed terminal markers on both sides of block.
      i. Spacing: 9.1 mm.
      j. Wire size: 30-12 AWG.
      k. Rated voltage: 300 V.
      l. Rated current: 12 A.
      m. Fuse size: 1/4 x 1-1/4.
      n. Blown fuse indication.
      o. DIN rail mounting.
      p. UL listed.

2.6 POWER SUPPLIES

A. DC Power Supplies:
   1. Acceptable manufacturers:
      a. Sola Hevi-Duty.
      b. Phoenix Contact.
      c. Rockwell Automation.
      d. Or approved equal.
   2. Design and fabrication:
      a. Converts 120 Vac input to DC power at required voltage.
      b. DIN rail mount with enclosure (i.e., not open frame).
      c. Switching type.
      d. AC input: 120 Vac +/-15 percent, nominal 60 Hz.
      e. Efficiency: Minimum 86 percent.
      f. Rated mean time between failure (MTBF): 500,000 HRS.
      g. Voltage regulation:
         1) Static: Less than 1.0 percent V_{out}.
         2) Dynamic: +/-2 percent V_{out} overall.
      h. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
      i. Overload, short circuit and open circuit protection.
      j. Temperature rating: 0 to 60 DegC full rated, derated linearly to 50 percent at 70 DegC.
      k. Humidity rating: Up to 90 percent, non-condensing.
      l. LED status indication for DC power.

2.7 VOLTAGE SURGE PROTECTION DEVICES

A. See Specification Section 16491.

2.8 RUNNING TIME INDICATORS

A. Acceptable Manufacturer:
   1. Eagle Signal Controls.
   2. Cramer.
   3. Or approved equal.

B. Design and Fabrication:
   1. Six-digit wheels including a 1/10 digit.
   2. Non-reset type.
   3. Time range in hours.
   4. Automatic recycle at zero.
   5. Accuracy: 1 percent.
   6. Sealed against dirt and moisture.
   7. Tamperproof.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount terminal strips, relays, signal modules, etc. on separate subpanel in control panel.

END OF SECTION

SECTION 13448
CONTROL PANELS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for control panels and enclosures utilized as follows:
      a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in Division 13.

B. This Specification Section is only applicable to panels furnished with Division 11 equipment packages when so stated in the applicable Division 11 Specification Section.

C. This Section is only applicable to panels housing Division 16 specified equipment (e.g., motor starters, lighting controls, etc.) when so stated in the applicable Division 16 Specification Section.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. B75, Standard Specification for Seamless Copper Tube.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 409, Industrial Control Panels.
   5. Underwriters Laboratories, Inc. (UL):
      a. 508A, Standard for Safety Industrial Control Panels.

B. Miscellaneous:
   1. Approved supplier of Industrial Control Panels under provisions of UL 508A.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
      b. Control panel(s) without an affixed UL 508A label will be rejected.

1.3 DEFINITIONS

A. The term "panel" refers to control panels or enclosures listed in the schedule included in this Specification Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe:
   1. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.
   2. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.

D. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

E. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad), and is used for the transmission of low current or low voltage signals.

F. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.

G. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.

H. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using telemetry such as radio, dial-up telephone, or leased lines.

I. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PLC or RTU.

J. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.

K. Highway Addressable Remote Transducer (HART): An open, master-slave protocol for bus addressable field instruments.

L. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, RTUs, etc.

M. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.

N. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20ma DC analog signals.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Section 13440.
   3. Prepared with computer aided design (CAD) software.
   4. Printed on 11 by 17 IN sheets.
   5. Drawings shall include a title block containing the following:
      a. Plant or facility name where panel(s) are to be installed.
      b. Drawing title.
      c. Drawing number.
      d. Revision list with revision number and date
      e. Drawing date.
      f. Drawing scale.
      g. Manufacturer name, address, and telephone number.
   6. Cover sheet for each drawing set shall indicate the following:
      a. Plant or facility name.
      b. Project name.
      c. Submittal description.
      d. Revision number.
      e. Issue date.
   7. Table of contents sheet(s) shall indicate the following for each drawing in the set:
      a. Drawing number.

b. Drawing title.
c. Sheet number.

8. Legend and abbreviation sheet shall indicate the following:
   a. Description of symbols and abbreviations used.
   b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
   c. Confirmation that the panel(s) are to be affixed with a UL 508A label prior to shipment from the factory.
9. Bill of Material for each panel shall include the following component information:
   a. Instrument tag number.
   b. Quantity.
   c. Functional name or description.
   d. Manufacturer.
   e. Complete model number.
   f. Size or rating.
10. Panel exterior layout drawings to scale and shall indicate the following:
    a. Panel materials of construction, dimensions, and total assembled weight.
    b. Panel access openings.
    c. Conduit access locations.
    d. Front panel device layout.
    e. Nameplate schedule:
       1) Nameplate location.
       2) Legend which indicates text, letter height and color, and background color.
11. Panel interior layout drawings shall be drawn to scale and shall indicate the following:
    a. Sub-panel or mounting pan dimensions.
    b. Interior device layouts.
    c. PLC/RTU general arrangement layouts.
    d. Wire-way locations, purpose, and dimensions.
    e. Terminal strip designations.
    f. Location of external wiring and/or piping connections.
    g. Location of lighting fixtures, switches and receptacles.
12. Wiring diagrams shall consist of the following:
    a. Panel power distribution diagrams.
    b. Control and instrumentation wiring diagrams.
    c. PLC/RTU I/O information:
       1) Model number of I/O module.
       2) Description of I/O module type and function.
       3) Rack and slot number.
       4) Terminal number on module.
       5) Point or channel number.
       6) Programmed point addresses.
       7) Signal function and type.
    d. Wiring diagrams shall identify each wire as it is to be labeled.

B. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

C. Electrical load calculations for each panel:
   1. Total connected load.
   2. Peak electrical demand for each panel.

D. Climate control calculations for each panel.
   1. Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.

E. Miscellaneous:
   1. Record Drawings:
      a. Updated panel drawings delivered with the panel(s) from the Contractor's factory.
      b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

F. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. See Section 13440.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Enclosures:
      a. Hoffman Engineering Co.
      b. Rittal.
      c. Hammond Manufacturing.
      d. Millbank Mfg. Co.
      e. Or approved equal.
   2. Panel heaters:
      a. Hoffman Enclosures, Inc.
      b. Rittal.
      c. Hammond Manufacturing.
      d. Or approved equal.
   3. Heat exchangers and air conditioners:
      a. Hoffman Enclosures, Inc.
      b. Rittal.
      c. Hammond Manufacturing.
      d. Or approved equal.
   4. Cooling fans and exhaust packages:
      a. Hoffman Enclosures, Inc.
      b. Rittal.
      c. Or approved equal.
   5. Internal corrosion inhibitors:
      a. Hoffman Enclosures, Inc.; Model A-HCI.
      b. Northern Technologies International Corporation (NTIC); Model Zerust VC.
      c. Cortec Corporation; Model VpCl Emitting Systems.
      d. Or approved equal.

2.2 ACCESSORIES

A. Panel Nameplates and Identification:
   1. See Section 10400.

2.3 FABRICATION

A. General:
   1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.
   2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.

3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.
    a. Devices that cannot be obtained with an adequate NEMA rating shall be installed behind a transparent viewing window.
    b. The window shall maintain the required NEMA rating of the enclosure.
4. Panel(s) shall be completely assembled at the Contractor's factory.
    a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.
5. Painting:
    a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.
        1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.
        2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.
        3) Utilize solvent or chemical methods to clean panel surfaces.
        4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.
        5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.
        6) Bake powder coating at high temperatures to bond coating to enclosure surface.
            a) Panel interior shall be white with semi-gloss finish.
            b) Panel exterior shall be ANSI #61 gray with flat finish.
        7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.
    b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.
6. Finish opening edges of panel cutouts to smooth and true surface conditions.
    a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.
7. Panel shall meet all requirements of UL 508A.
    a. If more than one (1) disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one (1) disconnect switch required to de-energize the equipment before servicing."
8. Provide control panel in accordance with NFPA 70, Article 409.
    a. In the event of any conflict between NFPA 70, Article 409 and UL 508A, the more stringent requirement shall apply.

B. Free-Standing Panels:
    1. Welded construction.
    2. Completely enclosed, self-supporting, and gasketed dusttight.
    3. Rolled lip around all sides of enclosure door opening.
    4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
    5. Full height, fully gasketed flush pan doors.
    6. Full length piano hinges rated for 1.5 times door plus instrument weight.
    7. Doors with keyed alike locking handles and three-point catch.
    8. Appropriate conduit, wiring, and instrument openings shall be provided.
    9. Lifting eyebolts to allow simple, safe rigging and lifting of panel during installation.

C. Wall Mounted Panels:
    1. Seams continuously welded and ground smooth.
    2. Rolled lip around all sides of enclosure door opening.
    3. Gasketed dust tight.
    4. Door clamps and hasp/staple for padlocking.
    5. Key doors alike.
    6. Continuous heavy GA hinge pin on doors.
        a. Hinges rated for 1.5 times door plus instrument weight.
    7. Front full opening door.

8. Brackets for wall mounting.

D. Internal Panel Wiring:
1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.
   a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.
   b. Follow wire-duct manufacturer's recommended fill limits.
   c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.
   d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.
2. Wiring shall be installed such that if wires are removed from one (1) device, source of power will not be disrupted to other devices.
3. Splicing and tapping of wires permitted only at terminal blocks.
4. Wire bunches to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.
   a. Protect bend area with sleeve.
5. Arrange wiring neatly, cut to proper length, with surplus wire removed.
   a. Arrange wiring with sufficient clearance.
   b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.
6. AC circuits shall be routed separate from analog signal cables and digital signal cables.
   a. Separate by at least 6 IN, except at unavoidable crossover points and at device terminations.
7. Provide at least 6 IN of separation between intrinsically safe devices and circuits and non-intrinsically safe devices and circuits.
8. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.
9. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 DegC.
   a. Conductor size shall be as required for load and 16 AWG minimum.
   b. Internal panel wiring color code:
      1) AC circuits:
         a) Power wiring: Black.
         b) Control interconnections: Yellow.
         c) Neutral: White.
         d) Ground: Green.
      2) Low voltage DC circuits:
         a) Power wiring: Blue.
         b) Control interconnections: Violet.
      3) Foreign voltage circuits: Pink.
      4) Annunciator circuits: Red.
      5) Intrinsically safe circuits: Orange.
10. Analog signal cables shall be of 600 V insulation, stranded copper, twisted-shielded pairs.
    a. Conductor size: 18 AWG minimum.
    b. Terminate shield drain conductors to ground only at one (1) end of the cable.
11. High precision 250 ohm resistors with 0.25 percent accuracy shall be used where 4-20 mA DC analog signals are converted to 1-5 Vdc signals.
    a. Resistors located at terminal strips.
    b. Resistors terminated using individual terminal blocks and with no other conductors.
    c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.

12. Analog signals for devices in separate enclosures shall not be wired in series.
    a. Loop isolators shall be used where analog signals are transmitted between control enclosures.
13. Wire and cable identification:
    a. Wire and cables numbered and tagged at each termination.
    b. Wire tags:
        1) Slip-on, PVC wire sleeves with legible, machine-printed markings.
        2) Adhesive, snap-on, or adhesive type labels are not acceptable.
    c. Markings as identified in the Shop Drawings.

E. Grounding Requirements:
1. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.
2. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.
3. Bond electrical racks, chassis and machine elements to a central ground bus.
    a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.
4. Bond the enclosure to the ground bus.
    a. It is imperative that good electrical connections are made at the point of contact between the ground bus and enclosure.
5. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.
6. Sub-panels and doors shall be bonded to ground.

F. Termination Requirements:
1. Wiring to circuits external to the panel connected to interposing terminal blocks.
2. Terminal blocks rigidly mounted on DIN rail mounting channels.
3. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
4. One (1) side of each strip of terminal blocks reserved exclusively for the termination of field conductors.
5. Terminal block markings:
    a. Marking shall be the same as associated wire marking.
    b. Legible, machine-printed markings.
    c. Markings as identified in the shop drawings.
6. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
7. Terminal blocks with continuous marking strips.
    a. Each terminal block shall be identified with machine printed labels.
8. Terminals shall facilitate wire sizes as follows:
    a. 120 Vac applications: Conductor size 12 AWG minimum.
    b. Other: Conductor size 14 AWG minimum..
9. Analog signal cable shield drain conductors shall be individually terminated.
10. Install minimum of 20 percent spare terminals.
11. Bladed, knife switch, isolating type terminal blocks where control voltages enter or leave the panel.
12. Fused terminal blocks shall be used in the following circuits:
    a. Control voltage is used to energize a solenoid valve.
    b. DC power is connected to 2-wire, loop-powered instruments.
13. Fused terminal blocks shall be provided with blown fuse indicators.
14. When control circuits require more than one (1) field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one (1) field conductor per terminal block.
15. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.

16. Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.

G. Component Mounting and Placement:
1. Components shall be installed per manufacturer instructions.
2. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.
3. Front panel devices shall be mounted within a range of 40 to 70 IN above the finished floor, unless otherwise shown in the Contract Documents.
4. PLC/RTU and I/O rack installation:
   a. Located such that the LED indicators and switches are readily visible with the panel door open.
   b. Located such that repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.
5. Locate power supplies with sufficient spacing for circulation of air.
6. Where components such as magnetic starters, contactors, relays, and other electromagnetic devices are installed within the same enclosure as the PLC/RTU system components, provide a barrier of at least 6 IN of separation between the “power area containing the electromagnetic devices” and the “control area”.
7. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.
   a. Fastening devices shall not project through the outer surface of the panel enclosure.
8. Excess mounting space of at least 20 percent for component types listed below to facilitate future expansion:
   a. Fuse holders.
   b. Circuit breakers.
   c. Control relays.
   d. Time delay relays.
   e. Intrinsically safe barriers and relays.
9. Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 IN.
   a. Minimum of 2 IN separation between terminal strips and wire ducts.

H. Power Distribution:
1. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.
   a. Limit load to maximum of 80 percent of circuit breaker rating.
2. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:
   a. PLC/RTU power supply modules.
   b. Single-loop controllers.
   c. Recorders.
   d. Alarm annunciators.
3. Each control panel with PLC/RTU components shall be furnished with power protection in the form of a double conversion UPS.
4. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 percent spare capacity.
5. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.

I. Internal Panel Lighting and Service Receptacles:
1. Panels less than or equal to 4 FT wide:
   a. One (1) electrical GFCI duplex receptacle.
   b. One (1) compact fluorescent light fixture with manual switch(es).
2. Panels or panel faces greater than 4 FT wide:
   a. One (1) duplex electrical GFCI receptacle per 6 FT of length.
   b. Continuous fluorescent lighting strip with manual switches.

J. Environmental Controls:
   1. Indoor panels located in a designated electrical room or control room:
      a. Thermostat controlled cooling fans with exhaust louvers if required to maintain temperature inside panel(s) below the maximum operating temperature rating of the internal components.
      b. Internal corrosion inhibitors.
   2. Indoor panels not located within a designated electrical room or control room:
      a. Thermostat controlled heaters to maintain temperature approximately 10 DegF above ambient for condensation prevention inside the panels.
      b. Automatically controlled, closed-loop heat exchangers or closed-loop air conditioners where required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel(s).
      c. Internal corrosion inhibitors.
   3. Outdoor panels:
      a. Outdoor temperature range of 0 DegF through 120 DegF.
      b. Thermostat controlled heaters to maintain temperature approximately 10 DegF above ambient for condensation prevention inside the panels.
      c. Outdoor temperature range of 0 DegF through 120 DegF.
      d. Thermostat controlled closed-loop heat exchangers or closed-loop air conditioners if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel.
      e. Internal corrosion inhibitors.
   4. Environmental control components:
      a. Panel heaters:
         1) Thermostat controlled.
         2) Fan driven.
         3) Components mounted in an anodized aluminum housing.
         4) Designed for sub-panel mounting.
         5) Powered from 120 Vac and protected with a dedicated circuit breaker.
      b. Cooling fans and exhaust packages:
         1) Cooling fan with louver or grill and replaceable filter.
         2) Designed to be mounted within a panel cutout to provide positive airflow through the panel.
         3) Cooling fan and exhaust louvers shall be designed and listed to maintain a NEMA 12 enclosure rating.
         4) Fitted with replaceable, high-density foam or synthetic fiber.
         5) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.
         6) Powered from 120 Vac and protected with a dedicated circuit breaker.
      c. Heat exchangers and air conditioners:
         1) Dual-loop design to isolate panel interior air from exterior air.
         2) Thermostat controlled.
         3) Operate from 120 Vac and protected with a dedicated circuit breaker.
      d. Internal corrosion inhibitors:
         1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.
         2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.
         3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

2.4 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Quantity of 10 percent replacement lamps for each type installed (minimum of 5 of each type).
   2. Minimum 12 replacement filters for each type installed.

3. One (1) quart of exterior finish touch-up paint.
4. One (1) complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Scope: Inspect and test entire panel assembly to verify readiness for shipment.

B. Location: Contractor's factory.

C. Factory Tests:
1. Tests shall be fully documented and signed by the Contractor's factory supervisor.
2. The panel shop shall fully test the control panel for correct wiring.
   a. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.
3. Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 HRS.
4. A PLC Central Processing Unit (CPU) shall be obtained and connected to the panel(s) if necessary for testing purposes.
5. Testing equipment (such as digital multi-meters, analog loop calibrators, and laptop computers with PLC programming software) shall be used as required for testing.
6. The following functions shall be tested as a minimum:
   a. Demonstrate functions of the panel(s) required by the Contract Documents.
   b. Correctness of wiring from all panel field terminals to all I/O points and to all panel components.
   c. Simulate and test each discrete signal at the field terminal strips.
   d. Simulate and test each analog signal using loop calibrators.
   e. Correct operation of communications between PLC system Central Processing Units (CPUs) and Remote I/O bases.
   f. Correct operation of single-loop controllers (including digital communication to microprocessor based devices).
   g. Correct operation of all digital communication devices.
   h. Demonstrate online and offline diagnostic tests and procedures.
   i. The Contractor shall notify the Engineer in writing a minimum of 15 calendar days prior to the Factory Tests.
      1) Engineer has the option to witness all required tests.
7. Make following documentation available to the Engineer at test site during the tests:
   a. Contract Documents.
   b. Factory Demonstration Testing procedures.
   c. List of equipment to be testing including make, model, and serial number.
   d. Shop Drawing submittal data for equipment being tested.
8. Deficiencies shall be corrected prior to shipment from the Contractor's factory.

3.2 INSTALLATION

A. Install free-standing panels on 4 IN high concrete housekeeping pads.

B. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.

C. Obtain approved panel layouts prior to installation of conduits.

D. Install products in accordance with manufacturer's instructions.

3.3 SCHEDULE

A. Schedule:
1. Blower building site lighting control panel:
   a. NEMA 12 wall mounting enclosure, see CD-11 on Drawings.

b. Front panel devices:
   1) Nameplate.
   2) Control switch and nameplates.
   3) Circuit breaker operating handle.
   4) Arc flash label.
   5) Voltage warning label.
c. Rear panel devices:
   1) External connection terminal blocks.
   2) Lighting contactor.
   3) Wiring.
   4) Label and cover all 480 volt wiring.
   5) Control power transformer and fuses.
   6) 480V power in circuit breaker disconnect with cover mounded operating handle.

2. Secondary area VFD panel:
   a. NEMA 4X free standing panel with air conditioning.
   b. Front panel devices:
      1) Nameplates.
      2) VFD operator interfaces.
      3) Duplex GFCI outlet.
      4) Arc flash label on each door.
      5) Voltage warning label on each door.
   c. Rear panel devices:
      1) Interior light.
      2) Duplex GFCI outlet.
      3) VFD's.
      4) Input/output reactors.
      5) Submersible pump protection modules (Mini CAS) and relays.
      6) External connection terminals.
      7) Other required appurtenances.
3. RTU-2, electrical building:
   a. NEMA 12 free standing.
   b. Front panel devices:
      1) Nameplates.
      2) Arc flash label.
   c. Rear panel devices:
      1) Interior light.
      2) Duplex GFCI outlet.
      3) External connection terminal strips.
      4) 2-PLC's.
      5) Ethernet switch.
      6) Power supplies including loop power supply.
      7) UPS.
      8) Relays, timers and control auxiliaries.
      9) 120 VAC power connection, disconnect and conditioning.
      10) Fiber optic cable WIC and auxiliaries.
4. RTU-8, effluent pumping station:
   a. NEMA 12 free standing or wall mount.
   b. Front panel devices:
      1) Nameplates.
      2) Arc flash label.
      3) HMI (SCADA).
   c. Rear panel devices:
      1) Interior light.
      2) Duplex GFCI outlet.
      3) External connection terminal strips.
      4) PLC.

5) Ethernet switch..
6) Power supplies including loop power supply.
7) UPS.
8) Relays, timers and control auxiliaries.
9) 120 VAC power connection, disconnect and conditioning.
10) Space for 91 FIT 011, 92 FIT 004.
11) Fiber optic cable WIC and auxiliaries.

5. RTU-3, provided under specification Section 11081.
6. RTU-4, dewatering:
   a. NEMA 4X free standing or wall mount.
   b. Front panel devices:
      1) Nameplates.
      2) Arc flash label.
      3) HMI (SCADA).
   c. Rear panel devices:
      1) Interior light.
      2) Duplex GFCI outlet.
      3) External connection terminal strips.
      4) PLC.
      5) Ethernet switch.
      6) Power supplies including loop power supply.
      7) UPS.
      8) Relays, timers and control auxiliaries.
      9) 120 VAC power connection, disconnect and conditioning.
      10) Fiber optic cable WIC and accessories.
7. RTU-7, secondary:
   a. NEMA 4X free standing with air conditioning and sun/rain shield over top.
   b. Front panel devices:
      1) Nameplates.
      2) Arc flash label.
   c. Rear panel devices:
      1) Interior light.
      2) Duplex GFCI outlet.
      3) External connection terminal strips.
      4) PLC.
      5) Ethernet switch.
      6) Power supplies including loop power supply.
      7) UPS.
      8) Relays, timers and control auxiliaries.
      9) 120 VAC power connection, disconnect and conditioning.
      10) Space for 32FIT111, 32FIT211.
      11) Fiber optic cable VIC and accessories.
8. RTU-9, chlorine contact/effluent quality:
   a. Add provisions for fiber optic cable including WIC and Ethernet switch/FO transceiver to existing RTU.

END OF SECTION

SECTION 13500

PROGRAMMABLE LOGIC CONTROLLER (PLC) CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Programmable logic controller (PLC) control system(s), including software, programming, and training.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.90.2, Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
      b. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. ICS 1, General Standards for Industrial Control and Systems.

B. Qualifications:
   1. Installation supervisor shall have had experience in overseeing installation and startup of at least three (3) similar installations.
   2. Programmer(s) shall have had experience in programming PLCs for at least two (2) projects of similar size and complexity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Section 13440.
   3. Product technical data including:
      a. Annotated hard copies of PLC software programs.
         1) Submit program for logic in ladder diagram format as used for the specific PLC system.
         2) Annotate program listing to include the following:
            a) Written description of each rung's function.
            b) Reference to control loop number for each rung where applicable.
            c) Reference to instrumentation tag number of I/O devices for each rung where applicable.
         3) Provide written descriptions completely defining all function blocks used in program.
         4) Provide list of all addresses referenced in logic diagram with description of data associated with each address.
      b. Results of factory testing procedures.
      c. Drawings containing the following information to be submitted as part of Section 13448 submittals:
         1) Arrangement drawings for PLC system components.
         2) Panel and enclosure plans, sections and details.
         3) Access opening locations and required clearances for each panel and enclosure.
         4) Enclosure internal wiring and terminal blocks.
      d. Catalog cut sheets containing information on PLC components to be submitted as part of this Specification Section submittals.
   4. Certifications:
      a. Qualifications of installation supervisor.

b. Qualifications of programmer(s).

B. Operation and Maintenance Manuals:
1. See Specification Section 01340 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.
2. Submit maintenance procedures available to Owner.
a. Include the location and phone numbers of service centers (including 24 HR "hot lines").
b. Provide specific information including operation and maintenance requirements, programming assistance, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturer is acceptable to match existing equipment:
1. Automation Direct Productivity 3000 PLC as applicable for the I/O point count.
2. C-More EA9-T12CL HMI.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Section 13440.

B. The PLC system shall accomplish the control requirements of the loop descriptions, Drawings, and Specifications.

C. PLC programming shall be documented and factory tested.

D. The PLC system shall operate in ambient conditions of 32 to 140 DegF temperature and 5 to 95 percent relative humidity without the need for purging or air conditioning.

E. Environmental Controls:
1. Furnish circulation fans in solid state control system enclosures.
2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
3. Air conditioning applications shall include means of preventing moisture condensation.

F. Where the PLC is utilized to control multiple trains of equipment and where the equipment in each train operates as a unit relatively independent of other equipment trains (e.g., facility with multiple boiler units or filter trains), the PLC components (I/O modules, power supplies, etc.) shall be assigned so that the failure of any one (1) component does not affect equipment on all trains.
1. I/O modules shall be segregated on a train basis unless required otherwise for safety reasons.
2. Where several equipment units operate in parallel, but are not considered assigned to a particular equipment train (e.g., multiple raw water pumps or chemical feed pumps all discharging into a common system), the PLC I/O modules associated with each equipment unit shall be assigned so that the failure of any one (1) I/O module does not affect all of the parallel operating equipment units.

G. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.

H. Incorporate the following minimum safety measures:
1. Watchdog function to monitor:
a. Internal processor clock failure.
b. Processor memory failure.
c. Loss of communication between processor and I/O modules.

d. Processor ceases to execute logic program.

2. Safety function wiring: Emergency shutdown switches shall not be wired into the controller.
3. Safe wiring:
   a. Unless otherwise specified, activation of alarms and stopping of equipment shall result from the de-energization of control circuits, rather than the energization of control circuits.
   b. Low voltage control signal wires:
      1) Place in conduit segregated for that purpose only.
      2) Twisted shielded wire pair.
      3) Not located in the same conduit or bundle with power wiring.
4. Initial safety conditions:
   a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
   b. Utilize program each time PLC is re-initiated and the control program activated.
5. Monitoring of internal faults and display:
   a. Internal PLC system status and faults shall be monitored and displayed.
      1) Monitored items shall include:
         a) Memory ok/loss of memory.
         b) Processor ok/processor fault.
         c) Scan time overrun.
6. Control of programs: Protect access to PLC program loading with password protection or with locked, key operated selector switches.
7. Design PLC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
8. Operator intervention:
   a. Logic system failure shall not preclude proper operator intervention.
   b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

2.3 COMPONENTS

A. PLC System Central Processor Unit (CPU):
   1. CPU shall provide communications with other control systems and man-machine interfaces as specified.
   2. Memory:
      a. Battery-backed RAM.
      b. EEPROM program back-up:
         1) Automatically download to RAM in the event RAM is corrupted.
   3. Memory battery backup shall be capable of 60 days memory retention with fresh battery.
      a. Provide visual indication of battery status and alarm low battery voltage.
      b. Memory battery backup shall be capable of 14 days memory retention after the "Battery Low" indicating LED is on.
   4. Plug-in card design to allow quick field replacement of faulty devices.
      a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
   5. 20 percent minimum spare useable memory capacity after all required programming is in place and operating.
   6. Capable of executing all control functions required by the Specifications and Drawings.
   7. Built-in three-mode (proportional-integral-derivative) control capabilities.
      a. As directly selectable algorithms requiring no user knowledge of programming languages.
   8. On-line reconfigurable.
   9. Lighted status indicators for "RUN" and "FAILURE."

10. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy.
    a. Transfer shall be bumpless and balanceless.

B. Input/output (I/O) Modules:
1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
2. Provide I/O system with:
    a. I/O solid state boards with status lights indicating I/O status.
    b. Electric isolation between logic and field device.
    c. Capability of withstanding low energy common mode transient to 1000 V without failure.
    d. Incorporate noise suppression design.
    e. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
    f. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
    g. Install 20 percent spare I/O points.
3. Input/output connection requirements:
    a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
    b. Prewire I/O modules to terminal blocks.
    c. Provide terminal blocks with continuous marking strip.
    d. Size terminals to accommodate all active data base points and spares.
    e. Provide terminals for individual termination of each signal shield.
    f. Field wiring shall not be disturbed when removing or replacing an I/O module.
4. Discrete input modules:
    a. Interface to ON/OFF devices.
    b. Status indicator on module front.
    c. Input modules to be 24 VDC for isolated contact inputs.
5. Discrete outputs shall be fused relay outputs rated 5 amps at 120 VAC:
    a. Provide one (1) fuse per common or per isolated output.
    b. Provide blown fuse indication.
    c. External fusing shall be provided if output module does not possess internal fusing.
    d. Fuses provided external to output model shall:
        1) Be in accordance with module manufacturer's specifications.
        2) Be installed at terminal block.
    e. Status indicator.
6. Analog I/O modules:
    a. Input modules to accept signals indicated on Drawings or Specifications.
    b. Minimum 12 bit resolution.
    c. I/O chassis supplied power for powering connected field devices.
    d. Differential inputs and outputs.
    e. User configurable for desired fault-response state.
    f. Provide output signals as indicated on Drawings and Specifications.
    g. Individual D/A converter for each output module.
    h. Individual A/D converter for each input module.
    i. Provide I/I isolator for each analog input and output point.

C. Power Supply Units:
1. Provide regulated power units:
    a. Designed to operate with PLC system and shall provide power to:
        1) All components of PLC system.
        2) All two-wire field instruments.
        3) Other devices as indicated on Drawings or Specifications.
    b. Capable of supplying PLC system when all of the specified spare capacity is utilized.

c. Each power supply shall be sized such that it will carry no more than 75 percent of capacity under normal loads.

2. Electrical service to PLC system is 105 to 125 V, 60 Hz, +1 percent, 1 PH power.
3. Separate AC circuit breakers shall be provided for each power supply.
4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room for power supply modification in the PLC system enclosure.
5. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
6. Power distribution:
   a. Immune to transients and surges resultant from noisy environment.
   b. Shall provide constant voltage level DC distribution to all devices.
7. Provide uninterruptible power supply (UPS) to sustain full power to UPS powered loads listed below for a minimum of 30 minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
   a. UPS powered loads:
      1) All rack mounted PLC components.
      2) Local operator consoles.
      3) All power supplies furnished with the PLC and associated loads.
   b. Input:
      1) 120 Vac +10 percent.
      2) 60 Hz.
      3) Line fuse protection.
   c. Output:
      1) 120 Vac (5 percent.
      2) 60 Hz.
      3) Short circuit protected.
      4) Instantaneous transfer time.
   d. IEEE C62.41 Class A voltage surges of 6000 V attenuated to less than 50 V on the output.
   e. Battery: Maintenance free lead acid.

D. PLC System Enclosure:
1. In accordance with Section 13448.
2. Component placement:
   a. Mount all controller components vertically within the enclosure to allow maximum convection cooling.
   b. Either install power supplies above all other equipment with at least 10 IN of clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.
   c. Do not place I/O racks directly above the CPU or power supply.
   d. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
   e. If items such as magnetic starters, contactors, relays, and other electromagnetic devices must be located within the same enclosure as the PLC system components, place a barrier with at least 6 IN of separation between the magnetic area and the control area.
   f. Place circulating fans close to major heat generating devices.
   g. Segregate input/output modules into groups of identical type.
3. Wiring and grounding to be in accordance with Section 13448.
4. Termination requirements:
   a. In accordance with Section 13448.
   b. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.
   c. Prewire I/O modules to terminal blocks.
   d. Size terminals to accommodate all active database points and spares.
   e. Provide terminals for individual termination of each signal shield.

f. Field wiring shall not be disturbed when removing or replacing an I/O module.

E. PLC System Software and Programming:
1. Provide all hardware and programming required to provide communication between the PLC and the man-machine interface.
2. Provide programming to accomplish all control and monitoring requirements of the Drawings and Specifications.
3. Provide two (2) copies of control logic program on 3-1/2 IN disks or on CD.
4. IBM compatible software.
5. Full documentation capability.
   a. Provide description for each rung.
6. On/off line programming.
7. Offline simulation prior to download.
8. Two-step commands requiring operator verification prior to deletion of any programming.

2.4 ACCESSORIES

A. Provide all accessories required to furnish a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

2.5 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment.
1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
2. Conduct testing with dummy I/Os to verify each control loop operation.
3. Allow for Owner and Engineer representatives to witness testing program.
   a. Provide minimum of 15 days notice prior to testing.
4. Do not ship prior to successful completion of this testing program.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
1. Inspect equipment covered by these Specifications.
2. Supervise adjustments and installation checks.
3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
   a. All commissioning functions may be witnessed by the Engineer.
   b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
4. Conduct startup of equipment and perform operational checks.
5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.3 DEMONSTRATION

A. Demonstrate system in accordance with Section 01650.

B. On-Site Training:
1. Provide employee of the manufacturer or certified representative to provide one (1) week of operating and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.
   a. As a minimum, training shall cover:
      1) Hardware overview.
      2) Software overview.
      3) Maintenance.

4) Trouble shooting.
5) Operation, e.g., changing set points, passwords, etc.

3.4 SCHEDULE OF INPUT/OUTPUT

A. RTU-1, (NOT USED).

B. RTU-2, Headworks/Influent Pump Station/Primary Treatment.
1. PLC-2A:
a. Digital Input:
1) Screen 1, 12 LCP 101, Auto.
2) Screen 1, 12 LCP 101, Fail.
3) Screen 2, 12 LCP 201, Auto.
4) Screen 2, 12 LCP 201, Fail.
5) Screenings Conveyor, 12 CVR 003, Auto.
6) Screenings Conveyor, 12 CVR 003, Fail.
7) Screenings Washer/Compactor, 12 WC 006, Auto.
8) Screenings Washer/Compactor, 12 WC 006, Fail.
9) Influent Pumping Wetwell 1A, 12 LSH 311, High Level.
10) Influent Pumping Wetwell 1B, 12 LSH 313, High Level.
11) Influent Pumping Wetwell 1A, 12LSL311, Low Level.
12) Influent Pumping Wetwell 1B, 12LSL313, Low Level.
13) Influent Pump 1, 12 PMP 301, Run.
14) Influent Pump 1, 12 PMP 301, Auto.
15) Influent Pump 1, 12 PMP 301, Fail.
16) Influent Pump 2, 12 PMP 302, Run.
17) Influent Pump 2, 12 PMP 302, Auto.
18) Influent Pump 2, 12 PMP 302, Fail.
19) Influent Pump 3, 12 PMP 303, Run.
20) Influent Pump 3, 12 PMP 303, Auto.
21) Influent Pump 3, 12 PMP 303, Fail.
22) Influent Pump 4, 12 PMP 304, Run.
23) Influent Pump 4, 12 PMP 304, Auto.
24) Influent Pump 4, 12 PMP 304, Fail.
25) Influent Pump High Level Control, Off.
26) Influent Pump High Level Control, Wetwell 1.
27) Influent Pump High Level Control, Wetwell 2.
28) Vortex Grit Removal, 13 VGR 003, Run.
29) Vortex Grit Removal, 13 VGR 003, Auto.
30) Vortex Grit Removal, 13 VGR 003, Fail.
31) Grit Pump 1, 13 PMP 001, Run.
32) Grit Pump 1, 13 PMP 001, Auto.
33) Grit Pump 1, 13 PMP 001, Fail.
34) Grit Pump 2, 13 PMP 002, Run.
35) Grit Pump 2, 13 PMP 002, Auto.
36) Grit Pump 2, 13 PMP 002, Fail.
37) Grit Cyclone/Classifier, 13 GRC 001, Auto.
38) Grit Cyclone/Classifier, 13 GRC 001, Fail.
39) Primary Clarifier 1, 21 C 001, Run.
40) Primary Clarifier 1, 21 C 001, Fail.
41) Primary Clarifier 1, 21 C 001, Remote.
42) Primary Clarifier 2, 21 C 002, Run.
43) Primary Clarifier 2, 21 C 002, Fail.
44) Primary Clarifier 2, 21 C 002, Remote.
45) Primary Clarifier 3, 21 C 003, Run.
46) Primary Clarifier 3, 21 C 003, Fail.
47) Primary Clarifier 3, 21 C 003, Remote.

48) Primary Scum Pump 1, 23 PMP 001, Run.
49) Primary Scum Pump 1, 23 PMP 001, Auto.
50) Primary Scum Pump 1, 23 PMP 001, Fail.
51) Primary Scum Pump 2, 23 PMP 002, Run.
52) Primary Scum Pump 2, 23 PMP 002, Auto.
53) Primary Scum Pump 2, 23 PMP 002, Fail.
54) Primary Sludge Pump 1, 25 PMP 001, Run.
55) Primary Sludge Pump 1, 25 PMP 001, Auto.
56) Primary Sludge Pump 1, 25 PMP 001, Fail.
57) Primary Sludge Pump 2, 25 PMP 002, Run.
58) Primary Sludge Pump 2, 25 PMP 002, Auto.
59) Primary Sludge Pump 2, 25 PMP 002, Fail.
60) Primary Sludge Pump 3, 25 PMP 003, Run.
61) Primary Sludge Pump 3, 25 PMP 003, Auto.
62) Primary Sludge Pump 3, 25 PMP 003, Fail.
63) Primary Sludge Pump 4, 25 PMP 004, Run.
64) Primary Sludge Pump 4, 25 PMP 004, Auto.
65) Primary Sludge Pump 4, 25 PMP 004, Fail.
66) Standby Generator 3, Run.
67) Standby Generator 3, Auto.
68) Standby Generator 3, Fail.
69) Standby Generator 3, Fuel Low.
70) Standby Generator 3, Fuel Leak.
71) Automatic Transfer Switch 2, Utility.
72) Automatic Transfer Switch 2, Generator.
73) Photo Electric Cell.
74) Gate, 12 SLG 101, Open.
75) Gate, 12 SLG 101, Closed.
76) Gate, 12 SLG 101, Remote Mode.
77) Gate, 12 SLG 102, Open.
78) Gate, 12 SLG 102, Closed.
79) Gate, 12 SLG 102, Remote Mode.
80) Gate, 12 SLG 201, Open.
81) Gate, 12 SLG 201, Closed.
82) Gate, 12 SLG 201, Remote Mode.
83) Gate, 12 SLG 202, Open
84) Gate, 12 SLG 202, Closed.
85) Gate, 12 SLG 202, Remote Mode.
86) Gate, 12 SLG 103, Open
87) Gate, 12 SLG 103, Closed.
88) Gate, 12 SLG 203, Open.
89) Gate, 12 SLG 203, Closed.
90) Gate, 13 SLG 101, Open.
91) Gate, 13 SLG 101, Closed.
92) Gate, 13 SLG 102, Open.
93) Gate, 13 SLG 102, Closed.
94) Gate, 13 SLG 201, Open.
95) Gate, 13 SLG 201, Closed.
96) Gate, 13 SLG 202, Open.
97) Gate, 13 SLG 202, Closed.
98) Gate, 13 SLG 204, Remote Mode.
99) Odor Scrubber, 130S001, Run.
100) Odor Scrubber, 130S001, Fail.
101) Chlorine Inductor, 71 CI 006, Run.
102) Chlorine Inductor, 71 CI 006, Auto.
103) Chlorine Inductor, 71 CI 006, Fail.

104) Ferric Chloride Metering Pump 1, 76 PMP 001, Run.
105) Ferric Chloride Metering Pump 1, 76 PMP 001, Fail.
106) Ferric Chloride Metering Pump 2, 76 PMP 002, Run.
107) Ferric Chloride Metering Pump 2, 76 PMP 002, Fail.
108) Ferric Chloride Containment, 76 LSH 005, High Level.
109) Shower 77 FSH 106, Flow Active.
110) Shower 76 FSH 006, Flow Active.
111) Surge Tank, Low Air Pressure.
112) Sample Pump, 71 PMP 013, Low Flow.
113) Sample Pump, 71 PMP 014, Low Flow.
114) Sample Pump, 71 PMP 015, Low Flow.
115) Sample Pump, 71 PMP 016, Low Flow.
116) Sample Pump, 71 PMP 017, Low Flow.
117) Sample Pump, 71 PMP 018, Low Flow.

b. Digital Output:
1) Influent Pump 1, 12 PMP 301, Start/Stop CMD.
2) Influent Pump 2, 12 PMP 302, Start/Stop CMD.
3) Influent Pump 3, 12 PMP 303, Start/Stop CMD.
4) Influent Pump 4, 12 PMP 304, Start/Stop CMD.
5) Grit Pump 1, 13 PMP 001, Start/Stop CMD.
6) Grit Pump 2, 13 PMP 002, Start/Stop CMD.
7) Primary Clarifier 1, 21 C 001, Start/Stop CMD.
8) Primary Clarifier 2, 21 C 002, Start/Stop CMD.
9) Primary Clarifier 3, 21 C 003, Start/Stop CMD.
10) Primary Scum Pump 1, 23 PMP 001, Start Cycle.
11) Primary Scum Pump 2, 23 PMP 002, Start Cycle.
12) Primary Sludge Pump 1, 25 PMP 001, Start/Stop CMD.
13) Primary Sludge Pump 2, 25 PMP 002, Start/Stop CMD.
14) Primary Sludge Pump 3, 25 PMP 003, Start/Stop CMD.
15) Primary Sludge Pump 4, 25 PMP 004, Start/Stop CMD.
16) Chlorine Inductor, 71 CI 006, Start/Stop CMD.
17) Site Light Control, On/Off CMD.
18) Gate, 12 SLG 101, Open/Close CMD.
19) Gate, 12 SLG 102, Open/Close CMD.
20) Gate, 12 SLG 201, Open/Close CMD.
21) Gate, 12 SLG 202, Open/Close CMD.
22) Ferric Chloride Metering Pump 1, 76 PMP 001, Start/Stop CMD.
23) Ferric Chloride Metering Pump 2, 76 PMP 002, Start/Stop CMD.

c. Analog Input:
1) Raw Sewage Flow, 11 FIT 001, Pinole.
2) Raw Sewage Flow, 11 FIT 002, Hercules.
3) Influent Pumping Wetwell 1A, 12 LT 310, Level.
4) Influent Pumping Wetwell 1B, 12 LT 312, Level.
5) Influent Pump 1, 12 PMP 301, Speed.
6) Influent Pump 2, 12 PMP 302, Speed.
7) Influent Pump 3, 12 PMP 303, Speed.
8) Influent Pump 4, 12 PMP 304, Speed.
9) Gate, 13SLG204, Position.
10) Primary Clarifier bypass Chamber, 22 LIT001, Flow.
11) Primary Scum Pit 1, 23 LT 005, Level.
12) Primary Scum Pit 2, 23 LT 006, Level.
13) Chlorine Contact Basin Effluent, 71 FIT 008, Flow.
14) Ferric Chloride Metering Pump 1, 76 PMP 001, Pressure.
15) Ferric Chloride Metering Pump 1, 76 PMP 001, Flow.
16) Ferric Chloride Metering Pump 2, 76 PMP 002, Pressure.
17) Ferric Chloride Metering Pump 2, 76 PMP 002, Flow.

18) Ferric Chloride Storage Tank, 76 LIT 004, Level.

d. Analog Output:
   1) Influent Pump 1, 12 PMP 301, Speed CMD.
   2) Influent Pump 2, 12 PMP 302, Speed CMD.
   3) Influent Pump 3, 12 PMP 303, Speed CMD.
   4) Influent Pump 4, 12 PMP 304, Speed CMD.
   5) Gate, 13SLG204, Position CMD.
   6) Ferric Chloride Metering Pump 1, 76 PMP 001, Pacing.
   7) Ferric Chloride Metering Pump 2, 76 PMP 002, Pacing.
   8) Sampler, 11CS005, Pacing.
   9) Sampler, 71CS019, Pacing.

e. Data Link:
   1) Power Monitor 2.

2. PLC-2B:

a. Digital Input:
   1) #3 Water Pump 1, 72 PMP 001, Run.
   2) #3 Water Pump 1, 72 PMP 001, Auto.
   3) #3 Water Pump 1, 72 PMP 002, Run.
   4) #3 Water Pump 1, 72 PMP 002, Auto.
   5) #3 Water Strainer, 72 STR 008, Auto.
   6) #3 Water Strainer, 72 STR 008, Fail.
   7) Effluent Pump 1, 91 PMP 001, Run.
   8) Effluent Pump 1, 91 PMP 001, Auto.
   9) Effluent Pump 1, 91 PMP 001, Fail.
   10) Effluent Pump 1, 91 PMP 001, Bearing Temperature.
   11) Effluent Pump 1, 91 PMP 001, Winding Temperature.
   12) Effluent Pump 2, 91 PMP 002, Run.
   13) Effluent Pump 2, 91 PMP 002, Auto.
   14) Effluent Pump 2, 91 PMP 002, Fail.
   15) Effluent Pump 2, 91 PMP 002, Bearing Temperature.
   16) Effluent Pump 2, 91 PMP 002, Winding Temperature.
   17) Effluent Pump 3, 91 PMP 003, Run.
   18) Effluent Pump 3, 91 PMP 003, Auto.
   19) Effluent Pump 3, 91 PMP 003, Fail.
   20) Effluent Pump 3, 91 PMP 003, Bearing Temperature.
   21) Effluent Pump 3, 91 PMP 003, Winding Temperature.
   22) Sodium Hydroxide Metering Pump 1 77 PMP 101, Run.
   23) Sodium Hydroxide Metering Pump 1 77 PMP 101, Fail.
   24) Sodium Hydroxide Metering Pump 2 77 PMP 102, Run.
   25) Sodium Hydroxide Metering Pump 2 77 PMP 102, Fail.
   26) Sodium Hydroxide Containment, 77 LSH 105, High Level.

b. Digital Output:
   1) #3 Water Pump, 72 PMP 001, Start/Stop CMD.
   2) #3 Water Pump, 72 PMP 002, Start/Stop CMD.
   3) Effluent Pump 1, 91 PMP 001, Start/Stop CMD.
   4) Effluent Pump 2, 91 PMP 002, Start/Stop CMD.
   5) Effluent Pump 3, 91 PMP 003, Start/Stop CMD.
   6) Sodium Hydroxide, Water Solenoid, Open/Close CMD.
   7) Sodium Hydroxide Metering Pump 1, 77 PMP 101, Start/Stop CMD.
   8) Sodium Hydroxide Metering Pump 2, 77 PMP 102, Start/Stop CMD.

c. Analog Input:
   1) #3 Water, 72 FIT 007, Flow.
   2) #3 Water, 72 PIT 006, Pressure.
   3) Effluent Pump 1, 91 PMP 001, Speed.
   4) Effluent Pump 2, 91 PMP 002, Speed.
   5) Effluent Pump 3, 91 PMP 003, Speed.

6) Sodium Hydroxide Metering Pump 1, 77 PMP 101, Pressure.
7) Sodium Hydroxide Metering Pump 1, 77 PMP 101, Flow.
8) Sodium Hydroxide Metering Pump 2, 77 PMP 102, Pressure.
9) Sodium Hydroxide Metering Pump 2, 77 PMP 102, Flow.
10) Sodium Hydroxide Storage Tank, 77 LIT 104, Level.

d. Analog Output:
1) Effluent Pump 1, 91 PMP 001, Speed CMD.
2) Effluent Pump 2, 91 PMP 002, Speed CMD.
3) Effluent Pump 3, 91 PMP 003, Speed CMD.
4) Sodium Hydroxide Metering Pump 1, 77 PMP 101, Pacing.
5) Sodium Hydroxide Metering Pump 2, 77 PMP 102, Pacing.

C. RTU-8, Effluent P.S. Building:
1. Digital Input:
a. Sodium Hypochlorite Metering Pump 1, 75 PMP 001, Run.
b. Sodium Hypochlorite Metering Pump 1, 75 PMP 001, Fail.
c. Sodium Hypochlorite Metering Pump 2, 75 PMP 002, Run.
d. Sodium Hypochlorite Metering Pump 2, 75 PMP 002, Fail.
e. Sodium Hypochlorite Metering Pump 3, 75 PMP 003, Run.
f. Sodium Hypochlorite Metering Pump 3, 75 PMP 003, Fail.
g. Sodium Hypochlorite Metering Pump 4, 75 PMP 001, Run.
h. Sodium Hypochlorite Metering Pump 4, 75 PMP004, Fail.
i. Sodium Bisulfite Metering Pump 1, 75 PMP 101, Run.
j. Sodium Bisulfite Metering Pump 1, 75 PMP 101, Fail.
k. Sodium Bisulfite Metering Pump 2, 75 PMP 102, Run.
l. Sodium Bisulfite Metering Pump 2, 75 PMP 102, Fail.
m. Sodium Bisulfite Metering Pump 3, 75 PMP 103, Run.
n. Sodium Bisulfite Metering Pump 3, 75 PMP 103, Fail.
o. Sodium Hypochlorite Storage Containment, 75 LSH 007, High Level.
p. Sodium Bisulfite Storage Containment, 75 LSH 107, High Level.
q. Shower 75 FSH 008, Flow Active.
r. Shower 75 FSH 009, Flow Active.
s. Standby Generator 2, Run.
t. Standby Generator 2, Auto.
u. Standby Generator 2, Fail.
v. Surge Tank System, 91 ST 013, Fail.
w. Sodium Hypochlorite Storage Tank 1, Shutoff Valve, 75 FCV 010, Open.
x. Sodium Hypochlorite Storage Tank 1, Shutoff Valve, 75 FCV 010, Closed.
y. Sodium Hypochlorite Storage Tank 1, Shutoff Valve, 75 FCV 010, Remote Mode.
z. Sodium Hypochlorite Storage Tank 2, Shutoff Valve, 75 FCV 011, Open.
aa. Sodium Hypochlorite Storage Tank 2, Shutoff Valve, 75 FCV 011, Closed.
bb. Sodium Hypochlorite Storage Tank 2, Shutoff Valve, 75 FCV 011, Remote Mode.
cc. Sodium Bisulfite Storage Tank 1, Shutoff Valve, 75 FCV 111, Open.
dd. Sodium Bisulfite Storage Tank 1, Shutoff Valve, 75 FCV 111, Closed.
ee. Sodium Bisulfite Storage Tank 1, Shutoff Valve, 75 FCV 111, Remove Mode.
ff. Sodium Bisulfite Storage Tank 2, Shutoff Valve, 75 FCV 112, Open.
gg. Sodium Bisulfite Storage Tank 2, Shutoff Valve, 75 FCV 112, Closed.
hh. Sodium Bisulfite Storage Tank 2, Shutoff Valve, 75 FCV 112, Remove Mode.
2. Digital Output:
a. Sodium Hypochlorite Metering Pump 1, 75 PMP 001, Start/Stop CMD.
b. Sodium Hypochlorite Metering Pump 2, 75 PMP 002, Start/Stop CMD.
c. Sodium Hypochlorite Metering Pump 3, 75 PMP 003, Start/Stop CMD.
d. Sodium Hypochlorite Metering Pump 4, 75 PMP 004, Start/Stop CMD.
e. Sodium Bisulfite Metering Pump 1, 75 PMP 101, Start/Stop CMD.
f. Sodium Bisulfite Metering Pump 2, 75 PMP 102, Start/Stop CMD.
g. Sodium Bisulfite Metering Pump 3, 75 PMP 103, Start/Stop CMD.

h. Sodium Hypochlorite Storage Tank 1, Shutoff Valve 75 FCV 010, Open/Close CMD.
i. Sodium Hypochlorite Storage Tank 2, Shutoff Valve 75 FCV 011, Open/Close CMD.
j. Sodium Bisulfite Storage Tank 1, Shutoff Valve 75 FCV 111, Open/Close CMD.
k. Sodium Bisulfite Storage Tank 2, Shutoff Valve 75 FCV 112, Open/Close CMD.
l. Sodium Bisulfite, Water Solenoid 1, Open/Close CMD.
m. Sodium Bisulfite, Water Solenoid 2, Open/Close CMD.

3. Analog Input:
   a. Sodium Hypochlorite Storage Tank 1, 75 LIT 005, Level.
   b. Sodium Hypochlorite Storage Tank 2, 75 LIT 006, Level.
   c. Sodium Bisulfite Storage Tank 1, 75 LIT 105, Level.
   d. Sodium Bisulfite Storage Tank 2, 75 LIT 106, Level.
   e. Effluent Pumping, 91 FIT 011, Flow.
   f. Effluent Pumping Wetwell, 91 LT 007A, Level.
   g. Effluent Pumping Wetwell, 91 LT 007B, Level.
   h. Chlorine Contact Basin Inlet, 71 AIT 003, Chlorine Residual.
   i. Effluent Pumping Wetwell, 91 AIT 013, Chlorine Residual.
   j. Emergency Outfall Structure, 71 AIT 010, Chlorine Residual.
   k. Emergency Outfall Structure, 71 AIT 011, pH.
   l. Emergency Outfall Structure, 71 AIT 011, Temperature.
   m. Emergency Outfall Structure, 71 AIT 012, Sodium Bisulfite Residual.
   n. Effluent Pump Station, 71 AIT 014, Sodium Bisulfite Residual.
   o. Sodium Hypochlorite Metering Pump 1, 75 PMP 001, Pressure.
   p. Sodium Hypochlorite Metering Pump 1, 75 PMP 001, Flow.
   q. Sodium Hypochlorite Metering Pump 2, 75 PMP 002, Pressure.
   r. Sodium Hypochlorite Metering Pump 2, 75 PMP 002, Flow.
   s. Sodium Hypochlorite Metering Pump 3, 75 PMP 003, Pressure.
   t. Sodium Hypochlorite Metering Pump 3, 75 PMP 003, Flow.
   u. Sodium Hypochlorite Metering Pump 4, 75 PMP 004, Pressure.
   v. Sodium Hypochlorite Metering Pump 4, 75 PMP 004, Flow.
   w. Sodium Bisulfite Metering Pump 1, 75 PMP 101, Pressure.
   x. Sodium Bisulfite Metering Pump 1, 75 PMP 101, Flow.
   y. Sodium Bisulfite Metering Pump 2, 75 PMP 102, Pressure.
   z. Sodium Bisulfite Metering Pump 2, 75 PMP 102, Flow.
   aa. Sodium Bisulfite Metering Pump 3, 75 PMP 103, Pressure.
   bb. Sodium Bisulfite Metering Pump 3, 75 PMP 103, Flow.
   cc. #3/4 Water, 92 FIT 004, Flow.
   dd. Effluent, 91 PIT 019, Pressure.
4. Analog Output:
   a. Sodium Hypochlorite Metering Pump 1, 75 PMP 001, Pacing.
   b. Sodium Hypochlorite Metering Pump 2, 75 PMP 002, Pacing.
   c. Sodium Hypochlorite Metering Pump 3, 75 PMP 003, Pacing.
   d. Sodium Hypochlorite Metering Pump 4, 75 PMP 004, Pacing.
   e. Sodium Bisulfite Metering Pump 1, 75 PMP 101, Pacing.
   f. Sodium Bisulfite Metering Pump 2, 75 PMP 102, Pacing.
   g. Sodium Bisulfite Metering Pump 3, 75 PMP 103, Pacing.
   h. Sampler, 91 CS 016, Pacing.

D. RTU-3, Blower Building:
1. Digital Input:
   a. Standby Generator 1, Run.
   b. Standby Generator 1, Auto.
   c. Standby Generator 1, Fail.
   d. Automatic Transfer Switch 1, Utility.
   e. Automatic Transfer Switch 1, Generator.
   f. DO Control Valve, 31 FV 103, Remote Mode.
   g. DO Control Valve, 31 FV 104, Remote Mode.

h. DO Control Valve, 31 FV 105, Remote Mode.
i. DO Control Valve, 31 FV 203, Remote Mode.
j. DO Control Valve, 31 FV 204, Remote Mode.
k. DO Control Valve, 31 FV 205, Remote Mode.

2. Digital Output:
   a. Site Light Control, On/Off CMD.
3. Analog Input:
   a. Low Pressure Air, 51 PIT 005, Header Pressure.
   b. DO Analyzer, 31 AIT 106, DO.
   c. DO Analyzer, 31 AIT 107, DO.
   d. DO Analyzer, 31 AIT 108, DO.
   e. DO Analyzer, 31 AIT 206, DO.
   f. DO Analyzer, 31 AIT 207, DO.
   g. DO Analyzer, 31 AIT 208, DO.
   h. DO Control Valve, 31 FV 103, Position.
   i. DO Control Valve, 31 FV 104, Position.
   j. DO Control Valve, 31 FV 105, Position.
   k. DO Control Valve, 31 FV 203, Position.
   l. DO Control Valve, 31 FV 204, Position.
   m. DO Control Valve, 31 FV 205, Position.
4. Analog Output:
   a. DO Control Valve, 31 FB 103, Position CMD.
   b. DO Control Valve, 31 FV 104, Position CMD.
   c. DO Control Valve, 31 FV 105, Position CMD.
   d. DO Control Valve, 31 FB 203, Position CMD.
   e. DO Control Valve, 31 FV 204, Position CMD.
   f. DO Control Valve, 31 FV 205, Position CMD.
5. Data Link:
   a. Blower 1 LCP.
   b. Blower 2 LCP.
   c. Blower 3 LCP.
   d. Power Monitor 1.

E. RTU-4, Dewatering:
1. Digital Input:
   a. Gravity Thickener, 61 GT 022, Run.
   b. Gravity Thickener, 61 GT 022, Fail.
   c. Gravity Thickener, 61 GT 022, Remote.
   d. Gravity Thickener Scum Pump, 61 PMP 030, Run.
   e. Gravity Thickener Scum Pump, 61 PMP 030, Auto.
   f. Gravity Thickener Scum Pump, 61 PMP 030, Fail.
   g. Gravity Thickened Sludge Pump 1, 61 PMP 024, Run.
   h. Gravity Thickened Sludge Pump 1, 61 PMP 024, Auto.
   i. Gravity Thickened Sludge Pump 1, 61 PMP 024, Fail.
   j. Gravity Thickened Sludge Pump 2, 61 PMP 025, Run.
   k. Gravity Thickened Sludge Pump 2, 61 PMP 025, Auto.
   l. Gravity Thickened Sludge Pump 2, 61 PMP 025, Fail.
   m. Centrifuge 1, 62 CG 001, Run.
   n. Centrifuge 1, 62 CG 001, Fail.
   o. Eyewash, 65 FSH 007, Flow Active.
   p. Thickener Polymer System 1, 65 PBS 001, Run.
   q. Thickener Polymer System 1, 65 PBS 001, Auto.
   r. Thickener Polymer System 1, 65 PBS 001, Fail.
   s. Thickener Polymer System 2, 65 PBS 002, Run.
   t. Thickener Polymer System 2, 65 PBS 002, Auto.
   u. Thickener Polymer System 2, 65 PBS 002, Fail.

v. Centrifuge Polymer System 1, 65 PBS 003, Run.
w. Centrifuge Polymer System 1, 65 PBS 003, Auto.
x. Centrifuge Polymer System 1, 65 PBS 003, Fail.
y. Centrifuge Polymer System 2, 65 PBS 004, Run.
z. Centrifuge Polymer System 2, 65 PBS 004, Auto.
aa. Centrifuge Polymer System 2, 65 PBS 004, Fail.
bb. Odor Scrubber, 610S007, Run.
cc. Odor Scrubber, 610S007, Fail.

2. Digital Output:
   a. Gravity Thickener, 61 GT 022, Start/Stop CMD.
   b. Gravity Thickener Scum Pump, 61 PMP 030, Start Cycle.
   c. Gravity Thickened Sludge Pump 1, 61 PMP 024, Start/Stop CMD.
   d. Gravity Thickened Sludge Pump 2, 61 PMP 025, Start/Stop CMD.
   e. Site Light Control, On/Off CMD.
3. Analog Input:
   a. Aeration Basin Scum, 61 FIT 019, Flow.
   b. Primary Sludge, 61 FIT 020, Flow.
   c. WAS, 61 FIT 021, Flow.
   d. Gravity Thickened Sludge Pump 1, 61 PMP 024, Speed.
   e. Gravity Thickened Sludge Pump 2, 61 PMP 025, Speed.
   f. Gravity Thickened Sludge, 61 FIT 027, Flow.
   g. Thickened Sludge, 61 FIT 028, Flow.
   h. Centrifuge Sludge Feed, 62 FIT 001, Flow.
   i. Thickener Scum Pump Wetwell, 61 LT 029, Level.
4. Analog Output:
   a. Gravity Thickened Sludge Pump 1, 61 PMP 024, Speed CMD.
   b. Gravity Thickened Sludge Pump 2, 61 PMP 025, Speed CMD.
   c. Sampler, 11 CS 003, Pacing.
   d. Sampler, 11 CS 004, Pacing.
   e. Thickener 1 Polymer System, 65 PBS 001, Pacing.
   f. Thickener 2 Polymer System, 65 PBS 002, Pacing.
   g. Centrifuge 1 Polymer System, 65 PBS 003, Pacing.
   h. Centrifuge 2 Polymer System, 65 PBS 004, Pacing.
5. Data Link:
   a. Rotating Drum thickener 1.
   b. Rotating Drum thickener 2.
   c. Centrifuge 2, 62 CG 002.

F. RTU-5, Cogeneration (No change).

G. RTU-6, Digesters (No change).

H. RTU-7, Secondary Treatment:
1. Digital Input:
   a. Secondary Clarifier 1, 41 C 001, Run.
   b. Secondary Clarifier 1, 41 C 001, Fail.
   c. Secondary Clarifier 1, 41 C 001, Remote.
   d. Secondary Clarifier 2, 41 C 002, Run.
   e. Secondary Clarifier 2, 41 C 002, Fail.
   f. Secondary Clarifier 2, 41 C 002, Remote.
   g. Secondary Clarifier 3, 41 C 003, Run.
   h. Secondary Clarifier 3, 41 C 003, Fail.
   i. Secondary Clarifier 3, 41 C 003, Remote.
   j. Secondary Clarifier 4, 41 C 004, Run.
   k. Secondary Clarifier 4, 41 C 004, Fail.
   l. Secondary Clarifier 4, 41 C 004, Remote.
   m. Secondary Clarifier 5, 41 C 005, Run.

n. Secondary Clarifier 5, 41 C 005, Fail.
o. Secondary Clarifier 5, 41 C 005, Remote.
p. RAS Pump 1, 42 PMP 001, Run.
q. RAS Pump 1, 42 PMP 001, Auto.
r. RAS Pump 1, 42 PMP 001, Fail.
s. RAS Pump 2, 42 PMP 002, Run.
t. RAS Pump 2, 42 PMP 002, Auto.
u. RAS Pump 2, 42 PMP 002, Fail.
v. RAS Pump 3, 42 PMP 003, Run.
w. RAS Pump 3, 42 PMP 003, Auto.
x. RAS Pump 3, 42 PMP 003, Fail.
y. RAS Pump 4, 42 PMP 004, Run.
z. RAS Pump 4, 42 PMP 004, Auto.
aa. RAS Pump 4, 42 PMP 004, Fail.
bb. RAS Pump 5, 42 PMP 011, Run.
cc. RAS Pump 5, 42 PMP 011, Auto.
dd. RAS Pump 5, 42 PMP 011, Fail.
ee. RAS Pump 6, 42 PMP 012, Run.
ff. RAS Pump 6, 42 PMP 012, Auto.
gg. RAS Pump 6, 42 PMP 012, Fail.
hh. RAS Pump 7, 42 PMP 013, Run.
ii. RAS Pump 7, 42 PMP 013, Auto.
jj. RAS Pump 7, 42 PMP 013, Fail.
kk. RAS Pump 8, 42 PMP 014, Run.
ll. RAS Pump 8, 42 PMP 014, Auto.
mm. RAS Pump 8, 42 PMP 014, Fail.
nn. RAS Pump 9, 42 PMP 031, Run.
oo. RAS Pump 9, 42 PMP 031, Auto.
pp. RAS Pump 9, 42 PMP 031, Fail.
qq. RAS Pump 10, 42 PMP 032, Run.
rr. RAS Pump 10, 42 PMP 032, Auto.
ss. RAS Pump 10, 42 PMP 032, Fail.
tt. WAS Pump 1, 043 PMP 001, Run.
uu. WAS Pump 1, 043 PMP 001, Auto.
vv. WAS Pump 2, 043 PMP 002, Run.
ww. WAS Pump 2, 043 PMP 002, Auto.
xx. WAS Valve, 43 FCV 008, Open.
yy. WAS Valve, 43 FCV 009, Remote Mode.
zz. WAS Valve, 43 FCV 010, Remote Mode.
aaa. RAS Valve, 32 FV 001, Open.
bbb. RAS Valve, 32 FV 001, Closed.
ccc. RAS Valve, 32 FV 001, Remote Mode.
ddd. RAS Valve, 32 FV 002, Open.
eee. RAS Valve, 32 FV 002, Closed.
fff. RAS Valve, 32 FV 002, Remote Mode.
ggg. RAS Valve, 32 FV 003, Open.
hhh. RAS Valve, 32 FV 003, Closed.
iii. RAS Valve, 32 FV 003, Remote Mode.
jjj. Gate, 31 G 112, Open.
kkk. Gate, 31 G 112, Closed.
lll. Gate, 31 G 112, Remote Mode.
mmm. Gate, 31 G 113, Open.
nnn. Gate, 31 G 113, Closed.
ooo. Gate, 31 G 113, Remote Mode.
ppp. Gate, 31 G 212, Open.
qqq. Gate, 31 G 212, Closed.

rrr. Gate, 31 G 212, Remote Mode.
sss. Gate 31 G 213, Open.
ttt. Gate 31 G 213, Closed.
uuu. Gate 31 G 213, Remote Mode.
vvv. Mixer, 31 MX 101, Run.
www. Mixer, 31 MX 101, Fail.
xxx. Mixer, 31 MX 101, Auto.
yyy. Mixer, 31 MX 102, Run.
zzz. Mixer, 31 MX 102, Fail.
aaaa. Mixer, 31 MX 102, Auto.
bbbb. Mixer, 31 MX 201, Run.
cccc. Mixer, 31 MX 201, Fail.
dddd. Mixer, 31 MX 201, Auto.
eeee. Mixer, 31 MX 202, Run.
ffff. Mixer, 31 MX 202, Fail.
gggg. Mixer, 31 MX 202, Auto.
hhhh. ML Pump, 31 PMP 103, Run.
iiii. ML Pump, 31 PMP 103, Fail.
jjjj. ML Pump, 31 PMP 103, Auto.
kkkk. ML Pump, 31 PMP 203, Run.
llll. ML Pump, 31 PMP 203, Fail.
mmmm. ML Pump, 31 PMP 203, Auto.
nnnn. Channel Aeration Blower, 31 B 001, Run.
oooo. Channel Aeration Blower, 31 B 001, Auto.
pppp. Channel Aeration Blower, 31 B 001, Fail.

2. Digital Output:
   a. RAS Pump 1, 42 PMP 001, Start/Stop CMD.
   b. RAS Pump 2, 42 PMP 002, Start/Stop CMD.
   c. RAS Pump 3, 42 PMP 003, Start/Stop CMD.
   d. RAS Pump 4, 42 PMP 004, Start/Stop CMD.
   e. RAS Pump 5, 42 PMP 011, Start/Stop CMD.
   f. RAS Pump 6, 42 PMP 012, Start/Stop CMD.
   g. RAS Pump 7, 42 PMP 013, Start/Stop CMD.
   h. RAS Pump 8, 42 PMP 014, Start/Stop CMD.
   i. RAS Pump 9, 42 PMP 031, Start/Stop CMD.
   j. RAS Pump 10, 42 PMP 032, Start/Stop CMD.
   k. WAS Pump 11, 43 PMP 001, Start/Stop CMD.
   l. WAS Pump 12, 43 PMP 002, Start/Stop CMD.
   m. RAS Valve, 32 FV 001, Open/Close CMD.
   n. RAS Valve, 32 FV 002, Open/Close CMD.
   o. RAS Valve, 32 FV 003, Open/Close CMD.
   p. Gate, 31 G 112, Open/Close CMD.
   q. Gate, 31 G 113, Open/Close CMD.
   r. Gate, 31 G 212, Open/Close CMD.
   s. Gate, 31 G 213, Open/Close CMD.
   t. Mixer, 31 MX 101, Start/Stop CMD.
   u. Mixer, 31 MX 102, Start/Stop CMD.
   v. Mixer, 31 MX 201, Start/Stop CMD.
   w. Mixer, 31 MX 202, Start/Stop CMD.
   x. ML Pump, 31 PMP 103, Start/Stop CMD.
   y. ML Pump, 31 PMP 203, Start/Stop CMD.
   z. Secondary Clarifier 1, 41 C 001, Start/Stop CMD.
   aa. Secondary Clarifier 2, 41 C 002, Start/Stop CMD.
   bb. Secondary Clarifier 3, 41 C 003, Start/Stop CMD.
   cc. Secondary Clarifier 4, 41 C 004, Start/Stop CMD.
   dd. Secondary Clarifier 5, 41 C 005, Start/Stop CMD.

ee. Site Light Control, On/Off CMD.
ff. Channel Aeration Blower, 31 B 001, Start/Stop CMD.

3. Analog Input:
   a. RAS Pump 1, 42 PMP 001, Speed.
   b. RAS Pump 2, 42 PMP 002, Speed.
   c. RAS Pump 3, 42 PMP 003, Speed.
   d. RAS Pump 4, 42 PMP 004, Speed.
   e. RAS Pump 5, 42 PMP 011, Speed.
   f. RAS Pump 6, 42 PMP 012, Speed.
   g. RAS Pump 7, 42 PMP 013, Speed.
   h. RAS Pump 8, 42 PMP 014, Speed.
   i. RAS Pump 9, 42 PMP 031, Speed.
   j. RAS Pump 10, 42 PMP 032, Speed.
   k. WAS Valve, 43 FCV 009, Position.
   l. WAS Valve, 43 FCV 010, Position.
   m. WAS, 43 FIT 007, Flow.
   n. WAS, 43 FIT 008, Flow.
   o. RAS, 42 FIT 005, Flow.
   p. RAS, 42 FIT 006, Flow.
   q. RAS, 42 FIT 015, Flow.
   r. RAS, 42 FIT 016, Flow.
   s. RAS, 42 FIT 033, Flow.
   t. RAS to Aeration Basin 1, 32 FIT 111, Flow.
   u. RAS to Aeration Basin 2, 32 FIT 211, Flow.
   v. ML Pump, 31 PMP 103, Speed.
   w. ML Pump, 31 PMP 203, Speed.
   x. ML Drain/Recycle Wetwell, 31 LT 115, Level.
   y. ML Drain/Recycle Wetwell, 31 LT 215, Level.
   z. pH Analyzer, 31 AIt 110, pH.
   aa. pH Analyzer, 31 AIT 110, Temperature.
   bb. pH Analyzer, 31 AIT 210, pH.
   cc. pH Analyzer, 31 AIT 210, Temperature.
   dd. NO3 Analyzer, 31 AIT 111, Nitrate.
   ee. NO3 Analyzer, 31 AIT 211, Nitrate.
   ff. NH4 Analyzer, 31 AIT 111, Ammonium.
   gg. NH4 Analyzer, 31 AIT 211, Ammonium.
4. Analog Output:
   a. RAS Pump 1, 42 PMP 001, Speed CMD.
   b. RAS Pump 2, 42 PMP 002, Speed CMD.
   c. RAS Pump 3, 42 PMP 003, Speed CMD.
   d. RAS Pump 4, 42 PMP 004, Speed CMD.
   e. RAS Pump 5, 42 PMP 011, Speed CMD.
   f. RAS Pump 6, 42 PMP 012, Speed CMD.
   g. RAS Pump 7, 42 PMP 013, Speed CMD.
   h. RAS Pump 8, 42 PMP 014, Speed CMD.
   i. RAS Pump 9, 42 PMP 031, Speed CMD.
   j. RAS Pump 10, 42 PMP 032, Speed CMD.
   k. WAS Valve, 43 FCV 009, Position CMD.
   l. WAS Valve, 43 FCV 010, Position CMD.
   m. ML Pump, 31 PMP 103, Speed CMD.
   n. ML Pump, 31 PMP 203, Speed CMD.

o. Sampler, 21 CS 004, Pacing.
p. Sampler, 41 CS 006, Pacing.

I. RTU-9 Chlorine Contact.

END OF SECTION

SECTION 13502

COMPUTER NETWORK AND HUMAN MACHINE INTERFACE (HMI) SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Computer network and HMI hardware requirements which includes but is not necessarily limited to:
      a. LCD flat panel type monitors.
      b. HMI computer workstations.
      c. Ethernet switches.
      d. Printers.
      e. Software.
      f. Accessories and maintenance materials.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 802.3, Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
         1) 802.3u: IEEE Standards for Local and Metropolitan Area Networks: Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100 Mb/s Operation, Type 100BASE-T.
         2) 802.3x: IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation.

1.3 DEFINITIONS

A. HMI: Human Machine Interface.

B. LCD: Liquid Crystal Display.

C. OPC: “OLE for Process Control”, a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.

D. PC: Personal Computer.

E. RAID: Redundant Array of Independent Disks, a method of storing the same data in different places on multiple hard disks.

F. RAM: Random Access Memory.

G. SCSI: Short for Small Computer System Interface, a parallel interface standard used for attaching peripheral devices to computers.

H. SDRAM: Synchronous Dynamic RAM.

I. SNMP: Simple Network Management Protocol, a set of protocols for managing complex networks.

J. TFT: Thin-Film Transistor, a technology for building LCD screens.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed within the following Articles are acceptable.

2.2 LCD FLAT PANEL TYPE MONITORS

A. Acceptable Manufacturers:
   1. Dell.
   2. NEC.
   3. Samsung.
   4. Hewlett-Packard.
   5. Or approved equal.

B. Design Requirements:
   1. Type of display: Color TFT active matrix LCD.
   2. Native Resolution:
      a. 20 IN: 1600 x 1200.
      b. 17 IN: 1280 x 1024.
   3. Aspect ratio: 4:3.
   4. Image brightness: Minimum 300 cd/m2.
   5. Display image contrast ratio: 800:1 or higher.
   6. Maximum sync rate (vertical scan rate x horizontal scan rate): At least 75 Hz x 80 KHz.
   7. Viewing angle: 170 degrees both vertical and horizontal.
   8. Adjustable tilt and swivel.
   9. Anti-glare flat screen.
   10. DVI or HDMI video connection.
   11. Power input: 120 Vac.
   12. Speakers: display mounted soundbar.
   13. Provide monitor for each workstation.

2.3 HMI COMPUTER WORKSTATIONS

A. Acceptable Manufacturers:
   1. Dell.
   2. HP/Compaq.
   3. Or approved equal.

B. PCs shall be in accordance with the following minimum requirements:
   1. Minimum 3.4 GHz processing speed and 3 MB cache.
   2. Minimum 4 GB RAM, expandable up to 16 GB.
   3. Minimum 500 GB hard drive.
   4. Chip: Quad-core.

5. DVD-RW drive.
    a. Read speed:
        1) 40x CD.
        2) 16x DVD.
6. Communication ports as listed below:
    a. All communication ports as required by functional requirements of Contract Documents.
    b. Minimum four (4) USB 2.0.
    c. Ethernet 10/100 MB/s 1 GB/s.
7. Ethernet networking cards for LAN communication.
8. Case style: Tower.

C. Keyboards:
1. Incorporate Standard IBM-QWERTY design with numeric keypad and assigned function keys.
2. Sculptured keys.
3. Tactile feedback.
4. Hardwired USB.

D. High performance mouse with laser sensor and tilt wheel; hardwired USB.

E. See Drawings for workstations required.

2.4 SERVER/EQUIPMENT RACKS

A. Acceptable Manufactures:
1. Hoffman.
2. Dell.
3. Rittal.
4. Or approved equal.

B. Design and fabrication:
1. Width: As required.
2. Depth: Minimum 30 IN.
3. Height: As required.
4. Open rack to enable air movement. Plexiglass doors with minimum 1 mm thick steel enclosure panels on the bottom and both sides, and louvered steel top cover. Steel side covers which are removable via quarter-turn fasteners.
5. Material: Aluminum or steel with powder coat finish.
6. Leveling feet and rollers.
7. Sliding shelves.
8. Anti-tip stabilizer feet.
9. Sliding tray to hold portable computer/keyboard.
10. Rack mounted power strips and cable management.

2.5 ETHERNET SWITCHES

A. Acceptable Manufacturers:
1. Hirschmann.
2. N-TRON.
3. Or approved equal.

B. Managed Ethernet Switches:
1. Design and fabrication:
    a. Support Ethernet 100 MBit/s.
    b. Backbone ports for connection to multimode fiber via type ST connectors.
        1) Quantity as required for communication with devices as depicted in the Contract Documents.
    c. 10/100 MBit/s twisted pair ports (RJ45) and fiber optic ports as required for communication with devices as depicted in the Contract Documents.

1) Unless otherwise noted, provide at least two (2) spare 10/100 MBit/s port (twisted pair) at each Ethernet switch.

d. Check all received data for validity.
   1) Discard invalid and defective frames or fragments.

e. Monitor connected TP/TX line segments for short-circuit or interrupt using regular link test pulses in accordance with IEEE 802.3.

f. Monitor attached fiber optic lines for open circuit conditions in accordance with IEEE 802.3.

g. As applicable, meet requirements of IEEE 802.3.

h. Power switch with 24 Vdc power input.

i. Provide LED status lights to indicate:
   1) Power: Supply voltage present.
   2) Fault.
   3) Port status.

j. Environmental rating:
   1) Operating temperature: 32 Deg F to 122 Deg F.
   2) Humidity: 95 percent relative humidity, non-condensing.

2.6 WALL OR PANEL MOUNTED FIBER OPTIC CABLE PATCH PANELS

A. Industrial grade multi fiber cable termination/patch panel for wall or panel mounting.
   1. Corning ITC.
   2. Hubbel Premise.
   3. Or approved equal.

2.7 PRINTERS

A. Monochrome Laser Printers:
   1. Acceptable manufacturers:
      a. Dell.
      b. Hewlett Packard.
      c. Oki Data.
      d. Xerox.
      e. Or approved equal.
   2. Rated engine speed: 22 pages per minute.
   3. Printer engine resolution: Up to 1200 x 600 dpi.
   4. Minimum input paper tray capacity: 500 sheets.
   5. Capable of printing on standard bond paper.
   6. Memory: Minimum 64 MB.
   7. Interfaces:
      a. Ethernet.
      b. USB.
   8. Capable of printing:
      a. Letter size paper.
      b. Legal size paper.
   9. Minimum toner or cartridge capacity: 10,000 pages based on 5 percent coverage.
   10. Operating temperature: 50 to 90 DegF.
   11. Operating humidity: 20 to 80 percent (non-condensing).

B. Color Laser Printers:
   1. Acceptable manufacturers:
      a. Dell.
      b. Hewlett Packard.
      c. Lexmark.
      d. Oki Data.
      e. Or approved equal.
   2. Rated engine speed:
      a. Monochrome: 24 pages per minute.

b. Color: 16 pages per minute.
3. Printer engine resolution: Up to 1200 x 1200 dpi.
4. Minimum input paper tray capacity: 500 sheets.
5. Capable of printing on standard bond paper, glossy paper, and transparency film.
6. Capable of printing:
   a. Letter size paper.
   b. Legal size paper.
7. Memory: Minimum 64 MB.
8. Integral interfaces:
   a. Ethernet.
   b. USB.
9. Minimum toner or cartridge capacity: 10,000 pages based on 5 percent coverage.
10. Operating temperature: 50 to 90 DegF.
11. Operating humidity: 20 to 80 percent (non-condensing).

2.8 SOFTWARE

A. Provide all software and associated programming/configuration required to meet performance requirements of the Contract Documents.
   1. At substantial completion of the Project:
      a. Turn current licenses for all software over to the Owner in the Owner's name and install the latest version, upgrade or service pack for all software.
      b. Provide the respective software supplier's Comprehensive Support Contract for all software covering a full one (1) year warranty period following substantial completion which shall provide no cost software upgrades, service packs and tech support from the software supplier.

B. HMI Software:
   1. Subject to compliance with the Contract Documents, the following HMI software packages are acceptable:
      a. Schneider Electric Citect, no substitution.
   2. Runtime HMI software:
      a. Provide licensed software with capability for all HMIs to be active simultaneously.
   3. Development software:
      a. Install development software on engineering workstation.
   4. Data Historian software:
      a. Provide data historian software compatible with HMI software package.
   5. Tag name quantity requirements:
      a. As required to meet performance requirements of the Contract Documents.
      b. Capable of handling an additional 20 percent more tags (future expansion) without impacting the license.
   6. Provide digital alarm notification software equal to Wonderware SCADAlarm.

C. Ethernet Network Management Software:
   1. Software to include an OPC Server, capable of integrating real-time SNMP tag data into OPC client enabled HMI software databases.
   2. Software shall allow control of polling rate for SNMP requests, as well as limit access to write SNMP data on each SNMP tag.
   3. Software shall have pre-developed tag databases for several manufacturer’s Ethernet network devices, as well as generic MIB (Management Information Base) tag databases.
   4. Software shall have integrated OPC client data viewer software, so that SNMP data may be viewed without having to create HMI tags.

D. Provide each PC with the latest edition of the following software:
   1. Operating system: Microsoft Windows.
   2. Microsoft Office Professional.

E. All software must be latest edition and licensed to the Owner.

2.9 ACCESSORIES AND MAINTENANCE MATERIALS

A. Provide all accessories required to furnish a complete computer-based network for the control system to accomplish the requirements of the Drawings and Specifications.

B. Furnish Owner with the following extra materials:
   1. One (1) spare Ethernet switch of each type utilized.
   2. One (1) spare toner cartridge per laser printer provided.

PART 3 - EXECUTION

3.1 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01650.

3.2 INSTALLATION AND CHECKOUT

A. Provide installation and checkout in accordance with Specification Section 13440.

END OF SECTION

SECTION 13504

CONFIGURATION REQUIREMENTS: HUMAN MACHINE INTERFACE (HMI) AND REPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Configuration requirements for HMI and reports which includes but is not necessarily limited to.
      a. Specific software functional descriptions.
      b. Graphics requirements.
      c. HMI functionality requirements.
      d. Plant overview screens.
      e. Process detail displays.
      f. Trend displays.
      g. PLC hardware/HMI status screen.
      h. Alarm monitoring.
      i. Report generation.
      j. Configuration standards and conventions.
      k. Screen configuration review meetings.
      l. Report configuration review meetings.
      m. Coordination.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Programmer(s) shall have had experience in software configuration and installation for at least two (2) projects of similar size and complexity.

1.3 DEFINITIONS

A. HMI: Human Machine Interface.

B. I/O: Input/Output.

C. OLE: Object Linking and Embedding, a document standard developed by Microsoft that enables the creation of an object with one application and the linking or embedding of the object in a second application.

D. OPC: "OLE for Process Control"; a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.

E. PC: Personal Computer.

F. PLC: Programmable Logic Controller.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 13440.
   3. Software Configuration Standards and Conventions document.
   4. Graphic screen displays; provide in actual colors utilized.
   5. Sample reports.

6. Certifications:
    a. Qualifications of programmer(s).

B. Operation and Maintenance Manuals:
1. See Specification Section 01340 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. Software Configuration Standards and Conventions - final version.

C. Miscellaneous Submittals:
1. Results of factory testing procedures.
2. Proposed training agendas and schedule.

1.5 GENERAL FUNCTIONAL REQUIREMENTS

A. Software Functional Requirements:
1. General functional requirements for system configuration are indicated on the Drawings and described in the Specifications.
2. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system.
3. The Contractor is responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Owner.

B. Available Process Values:
1. All process alarm, equipment status, and process variable values shall be available at any HMI.
2. If communications to a particular I/O point has failed for any reason, then wherever that data is displayed, the software shall post a visual indication that the point is not valid.

C. Provide comprehensive on-line help for all development functions.

D. Manual Entry of Data:
1. All PC-based HMIs must allow manual entry of surrogate data and other variables, which must then be available for display and use in reports.
    a. Operator-entered commands from any of the operator workstations must be logged by the computer servers.

E. System Failure:
1. Failure of any PLC, remote I/O hardware, or network communication link must be individually alarmed at HMIs.
2. Unless otherwise specified, each alarm must be specific to a single point of failure.

F. Software licensing shall allow all plant HMIs to be active simultaneously.

G. All process related functions, calculations, timers, and numeric manipulations, shall be accomplished in the PLC hardware and not in the HMI.
1. The HMI shall function as a monitoring system, not as a process controller.
2. The HMI shall transfer data to the PLC system and the PLC system shall perform all control algorithms.

1.6 SECURITY

A. Fully integrate security into the SCADA system to allow only users with appropriate security levels access to individual parts of the system.

PART 2 - PRODUCTS

2.1 SPECIFIC SOFTWARE FUNCTIONAL DESCRIPTIONS

A. Specific functional requirements for various software control blocks within the computer system are as follows.

B. Descriptions are general and are not intended to fully indicate the complete functionality of the system.
   1. Monitoring of process values:
      a. Process values derived from analog process variable signals must be historically archived.
         1) Store all historical data with time and date of occurrence.
         2) Make values available for use in reports.
         3) Assign high and low alarms to process values as defined below and otherwise deemed appropriate.
      b. Provide capability for computer server(s) to retrieve real-time values from the PLC system at adjustable time periods.
      c. Alarm limits:
         1) Set per direction from the Owner.
         2) An operator having proper security authorization must be able to enable, disable, and adjust the setpoint of any individual alarm.

C. Utilize graphic screen displays at the HMI(s) to provide monitoring and control functionality.
   1. Hierarchy of HMI screens is in descending order as follows:
      a. Plant overview screen(s).
      b. Process screens.
      c. Pop-up/control screens.

D. HMI operator interface functionality shall include:
   1. Indication of process variables.
   2. Configuration of control loop parameters (e.g., setpoints, gains, etc.).
   3. Adjustment of controller output.
   4. Display of real time and historical process trends.
   5. Selector switch and pushbutton station controls.
   6. System and process status indicators.
   7. Graphic representation of plant operations with interactive status and measurement symbols.
   8. Annunciation.

E. Graphics:
   1. Utilize dynamic variables with unique tags per graphic.
   2. Dragging the mouse over designated process areas of screen shall allow the operator to select predetermined processes or equipment and drill down to site-specific detail screens.
   3. Critical "overview" information such as tank levels, flows and pressures shall be indicated through data fields or animation effects such as level fills or color change.
   4. All monitored and or controlled process equipment shall be animated or color-highlighted to indicate status changes.
      a. For example, a pump "running" condition shall be signified by the pump color changing to bright green.
   5. Tank and vessel levels shall be indicated with a tabular data field and by graphic "fill" simulating a rising or falling level within the tank or vessel.
   6. Provide the ability to "drill down" to detail screens or graphics.
      a. Clicking on a device or process area shall generate a detail graphic or pop-up window to access specific data or control functions.
      b. All operator adjustments (e.g., set point adjustment, mode selection) shall be accomplished via a pop-up display, and shall not be allowed on the process screen.

7. Standard symbol library:
    a. User defined.
    b. Must not require software programming.
8. Single keystroke access from graphic to group display or other custom graphic displays.
9. Capable of being edited by moving, copying, or grouping user defined areas of screen.
10. Utilize a navigation bar.
    a. Navigation bar utilized on every screen.
    b. Navigation bar to include navigation functions, active alarm notification, security functions, current date/time display, "PRINT SCREEN" pushbutton, and other functions as required and as agreed upon at the Screen Configuration Review Meetings.

F. Plant Process Overview Screens:
1. Plant liquid stream process showing major plant real time parameters.
2. Plant solids stream process showing major real time parameters.

G. Process Screens:
1. As a minimum, provide screens as shown on P&ID drawings; approximately 35 screens.
2. At a process overview screen, the operator shall be able to select a specific detail display for monitoring/control purposes.
    a. Monitoring and control functions available at the selected process screen include but are not limited to the following:
        1) Select individual equipment items for monitoring and control.
        2) Select a control loop or point for control action.
        3) Change control mode of loop selected (manual, automatic, cascade).
        4) Change setpoint.
        5) Issue commands to start/stop and open/close two-state equipment.
        6) For manual loading output stations, the operator shall be able to manipulate analog output values.
        7) Select a loop and initiate further display, such as the detail display, trend, or hourly averaging.
        8) Display and change ratio and bias values.
        9) Control field equipment such as motor-operated valves and switches.
3. Alarm summary sheet showing all active alarms.
4. Communications status sheet.
5. Flow summary sheet showing current flow and totalized flow.

H. Detail Display:
1. Provide separate display for each point.
    a. Representations of each analog and digital point shall be single user configured faceplate.
    b. Display shall include alphanumeric representations of all variables and parameters for single loops including but not limited to:
        1) Alarm points.
        2) Limits.
        3) Constants.
        4) Interconnections to other loops.
        5) Calculating functions.

I. Trend Displays:
1. Real time historical trend displays.
2. Real time on-line trend displays.
3. Capable of displaying multiple points per display.
4. Operator shall be able to select any desired sample time interval.
5. Provide flexibility and easy access to real time and historical trend information for any variable TAG defined within the SCADA application.
    a. As a minimum, provide the following:
        1) Provide capability for the user to define trend scenarios.

2) Provide a button to open a dialog window to select multiple variable TAGS and save them as a trend scenario for future use.
3) Provide a pull-down menu to allow the user to open saved trend scenarios.
4) Provide a button to allow the user to select real-time or historical trends.
5) Provide a button to save displayed trend info to a file for export to external software applications (such as Microsoft Excel).
6) Provide a Print Trend button to allow user to print current trend.

6. Utilize Historical Data Server(s) to collect and manage data.

J. PLC Hardware/HMI Status Screen:
1. Provide a status screen to depict status conditions and diagnostic information for all major networked equipment.
2. Depict communication status for all networked communicating devices, such as PLC processors, Ethernet switches, PCs, and radios.

K. Alarm Monitoring:
1. Provide standard alarm screen functionality to ensure flexibility and quick access to live alarms, alarm history and alarm grouping parameters.
   a. As a minimum, include the following features and functionality:
      1) An Alarm Screen header bar to head all alarm pages and reside below the Navigation Bar.
      2) Buttons to dynamically switch between Alarm Summary and Alarm History.
      3) A menu to allow user to select and open historical alarm archives.
         a) Utilize a time-date stamp file structure.
      4) Pull-down menu bar to select operator configured alarm groups.
      5) Capability to sort alarms by priority and to define priority for all system alarms.
      6) Capability to filter or group alarms.
2. Analog alarms:
   a. The SCADA software shall monitor analog and discrete variables and calculated conditions, and determine if the variable is in an alarm condition.
   b. For each Analog Tag, an alarm for each of the following conditions shall be assignable:
      1) Low-low.
      2) Low.
      3) High.
      4) High-high.
      5) Deviation low.
      6) Deviation high.
      7) Rate of change.
   c. Provide adjustable dead bands and delay timers for all analog alarms.
3. Present alarms in order of:
   a. Priority.
   b. Time of occurrence.
   c. Non-acknowledged presented ahead of acknowledged.
4. Utilize single keystroke or pushbutton to:
   a. Acknowledge alarms.
5. Alarm list presented to operator shall include:
   a. Time of occurrence.
   b. Time of acknowledgement.
   c. Description.
   d. Acknowledgement status.
6. Alarm list printed by either of the following:
   a. On command.
   b. Periodically.
7. Audible alarming capability for user selected alarms.

L. Report Generation:
1. Base bid on the generation of the following reports:

a. Minimum of 10 formatted reports.
   1) Report form and content shall be determined at the Report Configuration Review Meetings.
   2) Each report shall contain daily, weekly, and monthly average calculated values.
   3) Each report shall contain between 10 and 20 measured parameters.
b. List of all entries initiated by operator including the following:
   1) Console key changes.
   2) Beginning and final values of setpoint and output changes.
   3) Mode changes (i.e., auto to manual).
   4) Time change was made.
c. Event list:
   1) Description of selected events.
   2) Time of event.

2. Custom report capabilities:
   a. User configurable.
   b. Contain selected information from any log, event, or alarm list.
   c. Capable of producing custom log report for periodic and on-demand printing of a list of process or calculated variables.
   d. Reports shall not require software programming by the user to setup.
3. Control of programs:
   a. Protect access to configuration via password protection.

2.2 SOURCE QUALITY CONTROL

A. Include performance test of HMI software in supplier's shop with the overall RTU System test.
   1. Conduct a test where the system is operated continuously and checked for correct operation including loop controls, displays, printing, keyboard functions, alarm responses, and on/off sequencing control.
   2. Allow for Owner and Engineer representatives to witness testing program.
      a. Provide minimum of 15 days notice prior to testing.

PART 3 - EXECUTION

3.1 CONFIGURATION REQUIREMENTS

A. Provide all programming and configuration required for all HMIs furnished under this Contract:

3.2 CONFIGURATION STANDARDS AND CONVENTIONS

A. Prepare and submit a "Software Configuration Standards and Conventions."
   1. Submit for review and approval prior to commencing with software configuration.
   2. Describe and define such items as:
      a. Proposed graphic display process colors/representations.
      b. Color standards for "ON," "OFF," and "ALARM" conditions.
      c. Font type and size.
      d. Alarm handling conventions.
      e. Methods for navigation between displays.
      f. Address usage/naming conventions.
      g. Security setup.
   3. Prior to submitting the initial draft document, the Contractor must meet with the Owner to review any of the Owner's existing standards and conventions.
   4. In addition to submitting the initial document for review, submit an updated version of the document as part of the Operation and Maintenance Manuals.
      a. Revise this document to include any additional standards that are established throughout the configuration process.

B. It is the intent of these specifications to provide the end user with state-of-the-art functionality.
   1. Minimum standards are as follows:
      a. Depict the actual process equipment configuration as accurately as possible.
   2. All overview and site-specific screens shall incorporate a "navigational header bar" similar in function and appearance to *Microsoft Internet Explorer.*
      a. The intention of this Specification is to provide a familiar, user-friendly navigation throughout the graphical displays.

3.3 SCREEN CONFIGURATION REVIEW MEETINGS

A. Conduct a minimum of two configuration conferences with the Owner to review and discuss system configuration programming and related topics.
   1. The purpose of the conferences will be to discuss, in detail, how each I/O point will be handled and the types, quantities, hierarchies, and functioning of display screens.
   2. Review of the Owner's existing systems, standards, conventions, file and tag naming requirements, font type and size requirements, and reporting requirements must be part of each conference.
   3. Review the navigation bar to be utilized.
   4. Conferences will be held at a site designated by the Owner at Pinole, California.
   5. Each screen will be reviewed at each conference.
      a. If required, to review all screens, each conference will occur on multiple days.
   6. Submit 10 color copies of printed screens via shop drawing submittal process 10 calendar days before each conference.
   7. Bring equipment to project screens on wall or provide multiple monitors for viewing by attendees.

B. Proposed graphic screens and report formats must be reviewed with the Owner throughout the configuration process.

3.4 REPORT CONFIGURATION REVIEW MEETINGS

A. Conduct a configuration conference with the Owner to review and discuss the reports and report formats.
   1. Review of the Owner's existing systems, standards, conventions, and reporting requirements must be part of each conference.
   2. The conference will be held at a site designated by the Owner at Pinole, California.
   3. Each report will be reviewed at each conference.
      a. If required, to review all reports, each conference will occur on multiple days.
   4. Provide 10 copies of printed sample reports via shop drawing submittal process 10 calendar days before each conference.

B. Proposed report formats must be reviewed with the Owner throughout the configuration process.

3.5 COORDINATION

A. Coordinate as required with other contractors and vendors to seamlessly integrate all HMI monitoring and control functions.
   1. To the greatest extent possible, integrate graphics presentation for all systems into screens utilizing one common HMI software.

3.6 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise adjustments and installation checks.
   3. Maintain and submit an accurate daily or weekly log of all commissioning functions.
      a. All commissioning functions may be witnessed by the Engineer.
      b. All reports shall be cosigned by the Contractor and the Engineer if witnessed.
   4. Conduct startup of equipment and perform operational checks.

5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

3.7 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01650.

B. On-Site Training:
   1. Provide employee of the manufacturer or certified representative to provide 1 week of operating and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.
      a. As a minimum, training shall cover:
         1) Hardware overview.
         2) Software overview.
         3) Maintenance.
         4) Trouble shooting.
         5) Operation, e.g., changing set points, passwords, etc.

END OF SECTION

SECTION 13900

PACKAGED METERING MANHOLE

PART 1 - SUMMARY

1.1 DESCRIPTION

A. Section includes:
   1. Pinole influent metering manhole, Hercules influent metering manhole, and plant drain metering manhole.
      a. Totally integrated packaged metering manhole as designed to be installed to meter municipal wastewater from an existing sanitary sewer.
      b. Including manhole barrel, flume, ladder, grating, and accessories. The entire package shall be fully assembled, and designed specifically for operation immersed in municipal wastewater and exposed to corrosive gases such as hydrogen sulfide.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. ASTM D3753, Glass Fiber Reinforced Polyester Manholes
   2. 29 CFR Part 1910.17, Federal Register, Occupational Safety and Health Administration, General Industrial Standards, Part 1910.17 for Fixed Ladders

B. Manufacturer's Experience:
   1. Equipment furnished under this section shall be the product of a single manufacturer who shall be able to demonstrate not less than 3 years' continuous successful experience in not less than ten similar applications.
   2. If the Contractor proposes a manufacturer with less than the required experience, the proposal shall be accompanied by a cash bond or irrevocable letter of credit drawn on a financial institution insured by the United States government in the amount of not less than $40,000. The bond or irrevocable letter of credit shall have a term of two years, beginning with substantial completion of this portion of the project. The instrument shall be in a form satisfactory to the Owner and surrenderable to the Owner upon the failure of the equipment, in the sole opinion of the Owner, to demonstrate continuous, reliable operation in the intended application.

1.3 SUBMITTALS

A. See Section 01340 for requirements for the mechanics and administration of the submittal process.

B. Manufacturer's type designation and catalog data showing rated capacity, size, and type of flume furnished.

C. Cross-sectional views of the packaged materials manhole furnished.

D. Details of all appurtenances to be furnished.

E. Anchor bolt design calculations and details in accordance with Section 05505.

1.4 SHIPMENT AND STORAGE

A. Equipment shipment, protection, and storage shall conform to the requirements of Section 01600.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. The packaged metering manhole shall be as manufactured by Plasti-Fab, Inc., Warminster Fiberglass, or equal. The same manufacturer shall fabricate the barrel, flume, ladder, grating, and accessories as well as fully assemble the unit.

2.2 MATERIALS

A. General:
   1. Packaged metering manhole shall be a completely integral unit consisting of a corrosion resistant fiberglass reinforced plastic (FRP) manhole with sealed fiberglass bottom, fiberglass access ladder, metering flume, and accessories as required. Two neoprene boots with stainless steel clamps sized to connect inlet and outlet pipe stubs shall be supplied by the manhole manufacturer and the manhole will be equipped with hold-down brackets for anchoring the unit to the concrete slab. A 1/2 IN thick expanded polystyrene bead board shall be supplied for placement on the concrete slab under the manhole.
   2. Packaged metering manhole shall have a minimum 1/2 IN wall thickness and be designed and manufactured in accordance with ASTM D3753. Any portion of the flume or end adapters extending outside the manhole shall have a reinforced cover. The manhole sides, bottom, and external flume sections shall be designed to withstand a static load of 150 lb-ft per foot of depth with less than 1/4 IN deflection. There shall be no light duty angles of flanges protruding beyond the flume or manhole that can be damaged by shear or load forces. The fiberglass manhole shall be fabricated with polyester resin, in one integral piece that is structurally strong, lightweight, watertight, and corrosion resistant to salt water, groundwater, corrosive soil conditions, and many commonly encountered industrial chemicals.
   3. Packaged metering manhole concentric manway opening shall be designed to withstand a 16,000 lb vertical dynamic wheel load (H-20), plus lateral forces. The manhole opening shall be for use with a 36 IN cast iron cover, suitable for H-20 highway loading.

B. Manhole Barrel:
   1. Fiber glass barrel shall be 60 IN in diameter. The barrel shall have a minimum 1/2 IN thickness. The interior of the barrel shall have a 15 to 20 mil thick white gel coat.
   2. Barrel manufacturer shall be the same as that of the flume and the accessories.

C. Pipe Stubs:
   1. FRP manhole and flume shall be provided with pipe stubs for connection to 36 IN and 42 IN diameter primary effluent pipe.
   2. Flume end adapters shall allow a smooth flow transition from the pipe flow to flume flow.

D. Flume:
   1. Flume shall be a 18 IN Parshall flow measurement flume for the Hercules influent and Pinole influent manholes. Fume shall be a 12 IN Parshall flume measurement flume for the plant drain measurement manhole. Flume inside surface shall be smooth, isophthalic gelcoat of 10-20 mil thickness.
   2. Flume shall be constructed or orthophthalic polyester resin reinforced with fiberglass. The minimum glass content shall be 30 percent exclusive of gelcoat surfaces. Nominal wall thickness shall be a minimum of 1/4 IN for areas inside the barrel and 1/2 IN minimum for portions extending beyond the barrel.
   3. Flume shall be furnished with a project specific ultrasonic bracket and a temperature probe bracket. Note that manufacturer's standard ultrasonic bracket will not be acceptable.
   4. Flume shall be bonded into the manhole to form a totally integral flow measurement manhole package. The resultant structure will be watertight. Portions of the flume extending outside the manhole shall be covered with fiberglass to assure a watertight system. The fiberglass cover shall be reinforced and of sufficient strength to withstand soil loads up to 150 lb-ft per foot of depth when buried.

E. Internal Ladder:
   1. Packaged metering manhole shall be furnished with an internal fiberglass ladder to provide easy access. The ladder rungs shall have a non-slip traction surface and internal stainless steel safety bar. The ladder shall meet or exceed 29 CFR part 1910.17 for “Fixed Ladders”.

F. Utility Taps:
   1. Manhole barrel shall be fitted with two 1 IN FRP through-wall utility taps having both interior and exterior threaded connections to permit subgrade entrance of power, sample, or recording lines without damaging the watertight integrity of the manhole.

G. Flume Cover:
   1. An internal fiberglass grate shall be furnished to provide a walking surface and prevent debris from falling into flume channel. The grate shall be removable to allow cleaning of the flume.

PART 3 - EXECUTION

3.1 GENERAL

A. Packaged metering manhole shall be installed in accordance with installation instructions and recommendations of the manufacturer.

B. Contractor shall see that good construction and installation procedures are followed throughout handling, storage, and placement to ensure that the manhole is not damaged in any manner, and that maximum serviceable results are achieved.

3.2 HANDLING AND STORAGE

A. During loading, unloading, and storage, care shall be exercised to ensure that the manhole is not dropped or otherwise damaged through impacting with solid surfaces.

B. Manhole shall be stored on a smooth surface, free of sharp objects, and if laid horizontally, shall be placed in such a way as to avoid structural damage to the inlet and outlet channels.

C. Slinging will be accomplished using nylon or other fabric material. Under no circumstances shall cable or chain slings be used in direct contact with fiberglass surfaces.

3.3 SITE PREPARATION

A. Site shall be excavated wide enough to accommodate the manhole and to provide a safe working environment for workers.

B. Concrete foundation shall be positioned so that the invert of manhole piping matches that of the pipeline.

3.4 PLACEMENT AND INSTALLATION

A. Prior to manhole placement, the slab shall be cleaned of all sharp objects and debris, and the foam pad, supplied with unit, properly placed on slab.

B. Neoprene boots supplied with unit shall be placed onto existing pipes before lowering manhole onto concrete slab.

C. After placement on the foam pad, all anchor bolts shall be securely tightened to tie downs on packaged manhole, and the flume level shall be checked and adjusted as necessary.

D. All open spaces under the flume shall be filled with grout to provide adequate structural support.

3.5 BACKFILLING

A. Care shall be taken to avoid uneven backfill loads on the package manhole.

B. Groundwater or surface water runoff shall not be allowed to accumulate in the open excavation around a manhole which has not been complete backfilled.

C. Backfill materials shall be placed evenly around the package manhole in maximum 12 IN lifts.

3.6 FINISH TO REQUIRED ELEVATION

A. Finish to required elevation using precast concrete rings to construct chimney of required height.

B. Mortar bed and first grade ring shall be firmly supported on flat, bearing shoulder of package manhole.

END OF SECTION

SECTION 14301
HOISTS, TROLLEYS, AND MONORAILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hoists and trolleys.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Society of Mechanical Engineers (ASME):
      a. B30.11, Safety Code for Underhung Cranes and Monorail Systems.
      b. B30.16, Safety Code for Overhead Hoists.
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

B. Comply with ASME B30.11 and ASME B30.16.

1.3 DEFINITIONS

A. Hook Height: The minimum acceptable distance in feet from bottom of hook in full raised position to the nearest floor surface.

B. Lift Height: The distance in feet from the bottom of the hook in full raised position to the surface of the lowest floor from which items may be hoisted.

C. Total Trolley Capacity: The ultimate load-carrying capacity of the trolley based on the ultimate strength of the material used (with a 5:1 safety factor) and the bearing life.

D. Ultimate Load-Carrying Capacity: Live load, weights of all equipment and an allowance for impact.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
   4. Fabrication and/or layout drawings.
      a. Track layout including supports, splices, connections, switches, and end trucks.
   5. Test reports verifying strength of inserts and rail.
   6. Load test results.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Hoists:
      a. Yale.
      b. Acco.
      c. Robbins and Myers.
      d. Wright.
   2. Trolleys:
      a. Yale.
      b. Acco.
      c. Wright.

2.2 MANUFACTURED UNITS

A. Trolleys:
   1. Motor-driven.
   2. Completely compatible with hoists, cranes specified.
   3. Meet NEC standards according to classifications shown on Drawings.
   4. Capable of maneuvering curves without binding or scraping the track.
   5. Minimum ABMA L-10 bearing life of 5000 HRS based on 75 percent of the wheel load, excluding impact.
   6. Motor Driven:
      a. Operate at a single speed as scheduled.
      b. Enclose internal gears in oiltight housing.
      c. Design motors to operate with 460 V, 3 PH, 60 cycle power supply.
   7. Plain trolleys:
      a. Frame consisting of thick rolled steel sections extending beyond wheel flanges to protect wheels.
      b. Alloy steel hardened axles, ball-bearings and pressed steel wheels.
         1) Carburized and hardened ball tread wheels.
         2) Factory lubricated requiring no additional lubrication.

B. Hoists:
   1. Electric wire rope hoists:
      a. Low headroom models.
      b. Hoist frames of welded heavy steel plate construction.
      c. Oiltight gear casing for oil bath lubrication of gears.
      d. Construct rope drum and surrounding units to minimize abrading, crushing or jamming of the rope during usage.
      e. Drum diameter not less than 18 times the diameter of the rope used.
      f. Assure that two (2) complete wraps of rope remain on the drum after lowering the load hook through its rated lift distance, unless a lower limit device is provided, in which case provide a minimum of one (1) complete wrap.
      g. Double revving for hoists with total lift height greater than hook height.
      h. Sheave and drum grooves: Smooth and free from surface irregularities which could cause rope damage.
      i. Provide running sheaves with means for lubrication.
      j. Bearings:
         1) Antifriction type.
         2) Minimum ABMA L-10 life of 1250 HRS for Class H1, 2500 HRS for Class H2, and 5000 HRS for Class H3, based on full rated speed and mean effective load K of 0.65.
      k. Mechanical load brake.
      l. Lower limit switch to stop hoist when hook reaches its lower limit.

m. Motor:
    1) Motor brake.
        a) Internal disc magnetic type.
        b) Rated for 150 percent of motor torque.
    2) TENV motors operable on 460 V, 3 PH, 60 cycle power.
    3) Meet specified area classification.
    4) Permanently lubricate and seal motor ball-bearings.
    5) Provide an upper limit switch to stop the hoist motor and apply the holding brake when the hook reaches its upper limit.
n. Controls:
    1) Motor starters, electric conduit, control stations, magnetic reversing contactors and low-voltage transformer, necessary for a complete and totally functional conveying system.
o. Mark the hoist with the following information:
    1) Name and address of manufacturer.
    2) Manufacturer's unit identification number.
    3) Rated load.
    4) Voltage of AC or DC power supply and phase and frequency of AC power supply.
    5) Rated amperage.

2. For Class I, Division 1 or 2, Group D locations, provide spark and corrosion-resistant models with bronze hooks, stainless steel load chains, bronze or aluminum hand chain, and bronze trolley wheels.
3. Mark each hoist with the following information:
    a. Name and address of manufacturer.
    b. Manufacturer's unit identification number.
    c. Rated load.

2.3 ACCESSORIES

A. Trolley stops design to engage the trolley frame rather than trolley wheels.

B. Furnish chain containers for hand hoists.

C. Electrification and Controls:
1. Provide electrical power to the motor-driven hoists and trolleys using one (1) of the following methods as scheduled:
    a. Festoon tagline system:
        1) Equip with plastic wheels in areas with an NEC classification of Class I, Division 1 or 2, Group D.
        2) Include all components needed for a complete and operable system.
    b. Cable reel system:
        1) 360-degree swivel base.
        2) Full working length of cable plus 25 percent.
        3) Include all components needed for a complete and operable system.
2. Controls:
    a. Pendant pushbutton control stations with reversing type contactors for electric hoists and/or trolleys.
    b. Single station if hoist and trolley are both motor-driven.
    c. Suspend control stations from trolleys.
    d. Clearly mark function of each button.
    e. Suspend station in a manner that will protect the electrical conductors against strain.
    f. Control station: Operable from 115 V power supply.
    g. Ground control station to hoist.
    h. Provide control cable lengths of 1 FT less than distance to nearest floor.

3. Switches:
   a. Manual switches.
   b. Completely compatible with hoists, trolleys, and monorails specified.
   c. Provide switch chain to within 6 FT of floor.

PART 3 - EXECUTION

3.1 ERECTION

A. Support track as shown on Drawings.

B. Arrange supports for easy removal of track for repair or replacement.

C. Align track true and level.

D. Warning Signs:
   1. Affix to the hoist or the lower load block or the controls in a readable position a durable label or labels displaying the following information concerning safe operating procedures:
      a. The word WARNING or other legend designed to bring the label to the attention of an operator.
      b. Cautionary language against:
         1) Lifting more than rated load.
         2) Operating hoist when hook is not centered under hoist.
         3) Operating hoist with twisted, kinked or damaged rope or chain.
         4) Operating damaged or malfunctioning hoist.
         5) Operating hoist with a rope that is not properly seated in its groove (if applicable).
         6) Lifting people or lifting loads over people.
         7) Removing or obscuring warning label.

3.2 FIELD QUALITY CONTROL

A. Test each hoist, trolley, and monorail using 110 percent rated load.

B. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-start-up adjustments, installation checks and all field tests.
   3. Conduct initial start-up of equipment and perform operational checks.
   4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
   5. Instruct Owner's personnel for 4 HRS at jobsite on operation and maintenance of the hoist, trolley, and crane equipment.

3.3 SCHEDULE

A. Hoist and trolley systems include but are not necessarily limited to the following:

AREA	LOADING (TONS)	HOOK HEIGHT (FT)*	LIFTING HEIGHT (FT)*	HP	OPERATING SPEED FPM	HOIST	TROLLEY
Solids Handling	3	13	8	7.5	19	WR	E
Headworks	1.5	12	30	NA	19	C	HG

* Distances listed are approximate as they will vary depending on hoist and trolley selection.

C = Chain
E = Electric Operator
HG = Hand Geared
WR = Wire Rope
NA = Not Applicable

END OF SECTION

SECTION 14305
BRIDGE CRANES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electric, top running bridge cranes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. American Welding Society (AWS).
   4. Crane Manufacturers Association of America, Inc. (CMAA):
      a. 70, Standard Specifications for Electric Overhead Traveling Cranes.
      b. 74, Standard Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

B. Qualifications:
   1. Welding shall be done by certified welders and shall be in accordance with the AWS standards.

C. Coordinate installation to assure proper operation within the confines dictated by structural, equipment, mechanical and electrical installations.

D. Verify hook and lifting heights for each application to assure each system is completely operational over range intended.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005.
   3. Girder layout including supports, connections and appurtenances.
   4. Load test results.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Bridge cranes:
      a. Acco.
      b. P & H.

c. Or equal.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Performance and Configuration Requirements:
1. Solids Handling Building:
a. Duty cycle rating: Class A1.
b. Operating speed: 15 FT/min.
c. Type:
1) Bottom-running, single girder, dual-drive electric.
2) Direct drive end trucks.
d. Rated capacity: 3 tons.
e. Span: See Drawings.
f. Drive horsepower: 7.5 each drive.
g. Power source: 460 Vac, 3 PH, 60 Hz.
h. Crane overhead clearance: 3 IN minimum to nearest obstruction.

B. Design load carrying parts, except structural members and gears, so that the calculated stress in the material, based on rated load, shall not exceed 20 percent of the published average ultimate strength of the material.

C. Comply with CMAA #70 and CMAA #74.

D. Trolley and hoist (Section 14301) compatible with the specified bridge crane.

E. Runway Rails:
1. Straight, parallel and level.
2. Sufficient strength and rigidity to prevent detrimental lateral or vertical deflection.

F. Girder:
1. Structural steel from standard structural shapes.
2. Design girder to resist vertical, lateral and torsional forces and stresses as defined by CMAA #74.
3. The maximum vertical deflection of the girder produced by the dead load, weight of the trolley and hoist and the rated load shall not exceed 1/600 of the span.
4. Locate safety stops at each end of bridge girder to prevent overtravel of trolley hoist.

G. End Trucks:
1. Carry crane bridge on end trucks sized to carry the rated load when it is lifted at one (1) end of the crane bridge.
2. End truck wheelbase minimum of 1/8 of the crane span.
3. Construct from structural channels welded and bolted into a rigid box section.
4. Assure proper alignment of axles.
5. Design so that drop of truck is limited to 1 IN in case of axle or wheel failure.
6. Equip motorized top-running cranes with rail sweeps which extend below the top of the rail and project in front of the crane wheels.

H. Crane Wheels:
1. Top-running double flanged wheels of forged steel, cast-iron, cast carbon or alloy steel.
2. Support each wheel on roller bearings mounted on stationary axles suitable to take radial and thrust loads.
3. Factory lubricate and seal bearings.
4. Wheels may be heat treated.

I. Crane Drives:
1. Provide each end truck with a helical gear motor reducer.
2. Motors integral with fully-enclosed oil splash lubricated gear reducers.
3. Support gear reduction shaft by precision ball or roller bearings.
4. Design motors and drives to supply the crane speed specified.

5. Permanently lubricate and seal motor ball-bearings.

J. Bearings: 5000 HRS ABMA L-10.

K. Gearing:
1. All gearing except the final reduction at the wheels shall run in oil or be splash lubricated.
2. Comply with AGMA specifications for load ratings.
3. Gears not enclosed in gear boxes.
   a. Safety guards.
   b. Provisions for lubrication and inspection.

L. Bridge Brake:
1. Capable of stopping bridge within a distance in feet equal to 10 percent of full load speed (in fpm) when traveling at full speed with full load.

M. Bumpers and Stops:
1. Capable of stopping the crane at a rate of deceleration not to exceed 3 FT per second when traveling in either direction at 20 percent of rated speed.
2. Sufficient energy absorbing capacity to stop the crane when traveling at full speed with full load.
3. Stops designed to resist full load speed.
4. Locate stops at limit of bridge travel.
5. Runway stops shall not engage wheel treads.

N. Electrical:
1. Provide disconnect device mounted on crane with overcurrent protection for the controllers.

2.3 ACCESSORIES

A. Electrification and Controls:
1. Provide electrical power to the motor-driven hoists and trolleys using one (1) of the following methods as scheduled:
   a. Festoon tagline system:
      1) Equip with plastic wheels in areas with an NFPA 70 classification of Class I, Division 1 or 2, Group D.
      2) Include all components needed for a complete and operable system.
   b. Cable reel system:
      1) 360-degree swivel base.
      2) Full working length of cable plus 25 percent.
      3) Include all components needed for a complete and operable system.
2. Controls:
   a. Pendant pushbutton control stations with reversing type contactors for electric hoists and/or trolleys.
   b. Single control station if hoist and trolley are both motor-driven.
   c. Suspend control stations from trolleys.
   d. Clearly mark function of each button.
   e. Suspend station in a manner that will protect the electrical conductors against strain.
   f. Control station shall be operable from 115 V power supply.
   g. Ground control station to hoist.
   h. Provide control cable lengths of 1 FT less than distance to nearest floor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install runway rails with center-to-center distance and elevation within +1/8 IN.

B. Warning Signs:
1. Maximum 10 FT intervals along rails with electrical conductors.

2. At stairs or ladders located 6 FT or less from the rail(s).
3. Warning sign legend and colors:
   a. DANGER (red).
   b. HIGH VOLTAGE (black).
   c. 480 Vac (black).
   d. KEEP OFF (red).

3.2 FIELD QUALITY CONTROL

A. Test each crane using 110 percent rated load.

B. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise pre-startup adjustments and installation checks and all field tests.
   3. Conduct initial startup of equipment and perform operational checks.
   4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
   5. Instruct Owner's personnel for 8 HRS at jobsite on operation and maintenance of the hoist, trolley, monorail and crane equipment.

END OF SECTION

SECTION 14551
SHAFTLESS SCREW CONVEYORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shaftless screw conveyor.
   2. Structural supports.
   3. Conveyor trough.
   4. Conveyor accessories and appurtenances.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society for Testing and Materials (ASTM).
      a. D256, Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.
      b. D638, Standard Test Method for Tensile Properties of Plastics.
      c. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
      d. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
      e. D1822, Standard Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials.
      f. D1894, Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting.
   2. American Gear Manufacturers Association (AGMA).
   3. Anti-Friction Bearing Manufacturers Association (AFBMA).
   4. Conveyor Equipment Manufacturers Association (CEMA).
   5. American Institute of Steel Construction (AISC).

B. Steel Fabrication:
   1. Conform to codes for arc and gas welding in Building Construction of the AWS and AISC specifications. Surfaces to be field welded shall be free from loose scale, rust, grease, and paint, and other foreign material, except that mill scale which will withstand vigorous wire brushing may remain. No welding shall be done when the base metal is lower than 0 DegF.
   2. Qualify welding operators in accordance with AWS D1.1.
   3. Welding operators shall be subject to examination for requalification using the equipment, materials, and electrodes employed in the execution of contract work. Such requalification, if ordered by Engineer, shall be done at the expense of Supplier.

C. Spiral and Liner Warranty: The conveyor liner and spiral shall be warranted for a period of 17,500 hours from factory start-up against wear.
   1. Liner: Excessive wear shall be indicated by appearance of the bottom indicator layer (second color) along more than 30 percent of the conveyor length during the first three years of service. If excessive wear occurs, the manufacturer shall provide new formed and banded liner to replace all the liner in the conveyor.
   2. Spiral: Excessive wear on the spiral screw shall be indicated by loss of more than 50 percent of the height of the main outer screw section over 30 percent of the total length of the screw. If excessive screw wear is found the conveyor supplier shall provide new screw to replace the screw in the conveyor.

1.3 SYSTEM DESCRIPTION

A. The screenings conveyor (12C003) will convey screenings from the influent screens to the screenings washer/compactor (12WC006).
   1. Equipment will be automated to operate in specific start-up and shut down running and discharge sequences in conjunction with the screens.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Sections 01340 and 11005.
   2. Fabrication and/or layout drawings:
      a. Detailed drawings showing supports, drives, connection details, materials of construction, etc.
      b. Structural calculations signed by a California Registered Civil or Structural Engineer for all structural support members.
   3. Product technical data including:
      a. Acknowledgment that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
   1. See Section 01342.
   2. Description of Conveyor Assembly lifting and lowering system.

1.5 PROJECT/SITE CONDITIONS

A. Seismic Forces: Zone IV, UBC.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Spirals, liners, troughs, support brackets, and drive assemblies:
      a. Parkson Corporation.
      b. Spirac.
      c. Custom Conveyors Corp.
      d. Or approved equal.
   2. Zero speed switch.
      a. Milltronics ZSS Motion Switch.
      b. Or approved equal.

2.2 MATERIALS

A. Conveyor shall be new and of current manufacture.

B. Conveyor Trough, Tubes, and Chutes: 316 Stainless Steel.

C. Gasketed Access Covers and Hinges: 316 Stainless Steel. Covers to be provided with hinges along entire length of conveyor and bolts along entire length of opposite side.

D. Drive and End Plates: 316 Stainless Steel.

E. Spiral Flights:
   1. Material: Cold formed micro-alloy carbon steel.
   2. Brinell hardness: 225 minimum after cold forming.
   3. Yield strength: 80,000 psi minimum after cold forming.

F. Wear Liner Segment: Dura Slide Xylethon, Spirac Duraflow SPX, or approved equal.
   1. Liners shall include (2) two layers. The outer layer shall be approximately 3 mm thick and shall be of a different color than the inner layer (approximately 9mm thick) to provide a visual indicator when the liner is nearing the end of its useful life.
   2. Minimum requirements for liners.

Property	Units	Value (minimum)
Density	g/cm^3	0.97
Molecular Weight	g/mol	92×10^6
Mechanical Properties		
Tensile Strength	N/mm^2	21
Breaking Strength +23º	N/mm^2	39
Break Elongation	%	400
Torsional Rigidity +23º	N/mm^2	310
Torsional Rigidity -40º	N/mm^2	500
Ball Indentation Hardness	N/mm^2	41
Shore Hardness D	--	64
Impact Strength (with V Notch)	mJ/mm^2	132
Thermal Properties		
Crystalline Melting Range	DegC	137
Co-efficient of linear expansion between 20 DegC to 100 DegC	1/K	1.0×10^{-4}
Heat Conductivity at 20 DegC	WITH/DegC m	0.42
Electrical Properties		
Dielectric Strength	KV/cm	900
Antifriction Properties & Co-Efficient of Friction		
Dynamic Co-efficient of friction	ratio of tension/load	0.08 – 0.12

G. Hardware and Fasteners: Type 316 Stainless Steel.

H. Drive Shaft: AISI 1045 Steel or A572 G50.

I. Structural Supports: 304 L Stainless Steel.

J. Bolts, washers, nuts, fasteners, screws, etc: Type 316 stainless steel.

2.3 DESIGN REQUIREMENTS

A. Maximum Safe Working Load.
   1. Horizontal conveyor load exerted by 100 percent trough fill with conveyed material at a density of 1.5x normal density (90 LB/cf) to compensate for stiffening of material in conveyor.

B. Start-up Load Torque: The torque capacity of the drive unit and the spiral strength shall be sufficient to start the conveyor with 100 percent trough loading after standing a minimum of three (3) days.

C. Vibration: Conveyor system shall be designed to operate functionally without any structural vibrations noticeable to personnel.

D. Design Load Conditions:
   1. General:
      a. Maximum trough fill: 50 percent.
   2. Screw conveyor (12C003):
      a. Solids Content: 15 percent - 35 percent, average of 20 percent.
      b. Maximum Quantity (dry weight basis): See conveyor schedule below.
      c. Wet density: 65 lbs/cu.ft.

E. Conveyor Schedule: Provide horizontal screw conveyors as shown on the Drawings and listed in the following schedule:

Conveyor	Capacity (cf/hr)	Max HP	Max Speed (rpm)	Approx. Length	Spiral Diameter (mm)	Angle (1)	Minimum Cross Sectional Area (mm^2)	Conveyor Direction	Spiral Type (mm)
12C006	70	5	20	24 FT	280	0	--	Push	Single

Notes: (1) Angle of inclination.

F. All designs must conform with the latest edition of the Uniform Building Code.

2.4 COMPONENTS

A. Physical Properties:
   1. Horizontal conveyor trough:
      a. Minimum thickness: 3 MM (0.118 IN).
      b. Diameter: Spiral OD plus 50 MM (2 IN) minimum.
      c. Trough section and chute connecting flanges: 3 MM (0.118 IN) minimum thickness.
   2. Covers:
      a. Minimum thickness: 3 MM (12 GA.)
   3. Chutes:
      a. Minimum size: Length as shown on Drawings. Width to be equal to trough width.
      b. Type 316 stainless steel.
   4. Drive and end plate minimum thicknesses:
      a. Drive end: 12 MM (1/2 IN).
      b. Non-drive end: 10 MM (3/8 IN).
   5. Spiral flights:
      a. Dimensions to comply with Conveyor Schedule.
   6. Wear liner:
      a. Provide with color to indicate wear.
      b. Minimum thickness: 3/8 IN.
      c. Maximum length: 4 FT.
      d. Rolled or broken to fit conveyor trough.
   7. Hardware and fasteners: Type 316 stainless steel.
   8. Drive shaft: AISI 1045 steel or A572 G50.
   9. Structural supports: See Drawings.

B. Troughs:
   1. Rolled U-shape with built-in parallel stainless steel channel or angle stiffeners.
   2. Reinforce all openings with steel angle or bars.
   3. Reinforce trough at all structural support/conveyor support saddle locations as required to prevent trough from becoming dented or disfigured during lowering or lifting processes.
   4. Sections connected with bolted rolled or welded flanges and watertight neoprene gaskets or silicone sealer.
   5. Coordinate opening sizes and connection details with all equipment affected including screens, centrifuge discharge chutes, drains, and service or process water piping connections.

6. All drop chute openings shall be 2 IN smaller than connecting drop chute at interface of connection with a 1 IN overhand on two sides of opening to chute that are perpendicular to conveyor spiral rotational axis.
7. Provide 4 IN diameter threaded drain with ball valve located at trough bottom. Drains to be located as shown on the Drawings.
8. Provide welded rigid flat joint landing strips at top of trough for support and gasketing of removable trough cover.

C. Spiral Flighting:
1. Shaftless design. Cold formed spirals shall show no visible evidence of OD or ID cracking. Grinding of the spiral surface for any reason is not permitted.
2. Designed for a minimum of 15,000 operating hours conveying material described in this specification with less than 10 percent reduction in spiral diameter.
3. Capable of startup with 100 percent of trough filled.
4. Maximum compression or elongation with fully loaded running or start-up: 0.08 IN per FT of length.
5. Cold-formed in sections from continuous rectangular hot-rolled high strength corrosion resistant micro-alloy steel bar concentric to within 1/16 IN. Sectional-welded flighting from plate or Abrasion Resistant (AR) bar, or single width, rolled spirals will not be permitted.
6. The spiral flighting shall be made from cold formed flat hot-rolled bar of 60mm x 25mm (1 IN) minimum thickness with a minimum cross sectional area of 1500mm^2, 80,000 psi minimum yield strength, and 225 minimum Brinell. Material shall be corrosion resistant micro-alloy steel bar and be concentric to within 1/16 IN. The spiral shall be cold formed into the final diameter and pitch in two separate forming stages to reduce spiral neck-down and eliminate spiral cracking.
7. Connected to the drive shaft by welding the spirals to a 3/4 IN , minimum circular torque plate for the horizontal screws properly reinforce with a stiffer gusset welded to flighting. A separate minimum 1 and 3/4 IN respectively connection plate shall be bored with a hole equal to the shaft and the drive shaft shall be concentrically welded to the plate to effectively transmit torque and bolted to the torque plate with No. 8 bolts. Spirals welded directly to the shaft will not be accepted.
8. Spiral connections shall be welded according to AISC B-U3-GF (double V groove) with full penetration welds. Flights shall be welded in a jig to assure true alignment.

D. End Plates:
1. Bolted standard circular or octagonal.
2. Drive end:
   a. Seals: Vertical.
      1) Replaceable mechanical labyrinth friction seal that will allow axial and radial movement of shaft with a minimum of 15,000 hours of wear life without leaking or wearing of the drive shaft.
   b. Seals: Horizontal labyrinth seal stuffing box.
3. End plate designed to carry the full weight of the drive assembly.

E. Trough Covers:
1. Trough covers to be provided with both bolts and hinges. Individual hinged sections with stops to prevent cover swing beyond 30 degrees past vertical.
2. Hinges and cover designed to allow free insertion of spiral lifting tool and removal and replacement of wear liner segments with cover open.
3. Maximum lifting weight per section: 40 LBS.
4. Minimum 2 lifting handles per section.
5. Hold-down fasteners:
   a. 3/8 IN diameter coarse thread bolts with flat washers.
   b. Maximum spacing: 24 IN.
6. Provide a 1 IN turndown rain lip at the sides of covers.
7. Provide 1 IN wide x 1/4 IN thick compressible adhesive mounted closed-cell foam gaskets along top sides of troughs.

8. Provide rain seal at cover joints consisting of rolled integrated rain lips at cover joints with top closure piece.

F. Chutes:
1. Connect to trough with bolted flanges and watertight neoprene gaskets.
2. Section connections made with bolted flanges and watertight neoprene gaskets or silicone sealer.

G. Drives:
1. Comply with Section 11005.
2. Complete with:
   a. Motor and mount.
   b. Trough end plate.
   c. Speed reducer.
   d. Drive shaft assembly.
3. Push configuration as listed in conveyor schedule.
4. Gear drive:
   a. Hollow quill shaft ridged mounted to gear motor.
   b. Gearing: Minimum AGMA Class II.
   c. Single, double, or triple reduction to output speed listed under conveyor schedule.
   d. Shaft mounted drive with shrink disc hollow shaft design.
   e. Capable of supplying 25 percent of the start-up torque required at 100 percent trough fill loading.
   f. Service factor: See Section 11005.
   g. Bearing design:
      1) Antifriction type, ball or roller, oil lubricated.
      2) Full housed.
      3) Minimum AFBMA L-10 life of 30,000 HRS at full motor nameplate HP design speed.
   h. Oil drain and plug.
5. Electric motors:
   a. Single speed.
   b. 1,750 rpm.
   c. 480 V, 3 PH, 60 HZ.
   d. TEFC.
   e. Corrosion resistant.
   f. Accessory control (see subsection Accessories below):
      1) Zero speed switch.
      2) Emergency stop pull cords and switches.
6. V-belt driven speed reducer, or chain driven reducers will not be permitted.

H. Structural Supports:
1. In accordance with support details shown on the Drawings and Division 5 specifications.
2. Provide structural supports as shown on the Drawings to install conveyors and provide lifting and lowering capabilities. Include beams, angles, etc., as required and anchoring devices to attach conveyors to supports.

I. Accessories:
1. Zero-speed switch with a time delayed detection device shall be provided for each conveyor.
   a. Non-contacting totally enclosed probes.
   b. Setpoint adjustments:
      1) 0-2,000 rpm.
      2) 0-60 second time delay.
   c. Repeatability: $\pm$ 1 percent.
   d. Enclosure: NEMA 4X.
   e. Voltage: 120 VAC, 60 HZ.

2. Emergency stop system:
   a. Both sides of each conveyor with one switch per 50 FT maximum length of cable.
   b. Cable shall be orange plastic coated galvanized steel safety cable mounted through eyebolt spaced no more than 8 FT.
   c. Provide 120 volt, 10 amp dry contacts at each emergency stop switch for remote sensing of emergency stop event for alarm and shutdown through conveyor control system of all running conveyors.
   d. Enclosure: NEMA 4X.

2.5 FABRICATION

A. Conveyance system shall be constructed in accordance with CEMA 350 standards, as a minimum, except where exceeded by this specification.

B. Utilize only AWS or European equivalent (Norske Veritas NV) certified welders.

2.6 MAINTENANCE MATERIALS

A. Furnish Owner with the following maintenance materials:
   1. Spiral lifting tool:
      a. Designed to allow one person to lift and lock a segment of spiral a minimum of 1 IN above trough liner. Length of lifted spiral segment shall be long enough to allow removing one existing liner segment and replacing with new segment.
      b. Number: One (1) each.
   2. Wear liner segments: A full set of replacement liners for complete replacement cut to exact size with protective metal strips and banded to maintain the formed shape.
   3. Gear reducer: One (1) of each size (HP, rpm, and torque) supplied.
   4. Motor: One (1) of each size supplied.
   5. Stuffing box seals: Two (2) each.
   6. Bearings: One (1) set for screw.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prior to submittal of shop drawings, verification of all existing and new structures and equipment dimensions and locations that are key to installing equipment specified under this section.

B. Coordinate delivery, storage, and installation of screw conveyor to locations, orientation, and lengths shown in conveyor schedule and on Drawings per manufacturer's written instructions.

C. Electrical installation shall comply with applicable sections of Division 16.

3.2 START-UP AND DEMONSTRATION

A. Refer to requirements of Section 01650.

3.3 FIELD QUALITY CONTROL

A. Equipment start-up services shall be provided per Section 01650.

B. The equipment manufacturer shall provide an approved employed factory trained individual who shall:
   1. Inspect and be present at initial testing of equipment.
   2. Conduct start-up of Equipment and perform operational checks.
   3. Provide Owner with a written statement certifying that manufacturer's equipment has been installed properly, started up, and is ready for operation by Owner's personnel.

4. Instruct Owner's personnel for two days minimum at jobsite on operation, safety and maintenance. Manufacturer representative, in conjunction with Contractor, shall demonstrate the conveyor assembly lifting and lowering system during this two-day period. Contractor shall provide all necessary equipment for this demonstration.

C. Provide services of an approved factory employed and trained individual for a minimum of six days in a minimum of three trips. Start-up will occur on two separate occasions.

D. Manufacturer to provide training for Owner's personnel per Section 01650.

END OF SECTION

SECTION 15060

PIPE AND PIPE FITTINGS: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Process piping systems.
   2. Utility piping systems.
   3. Plumbing piping systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760).
      b. M190, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
      c. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
      d. M294, Interim Specification for Corrugated Polyethylene Pipe 12 to 24 Inch Diameter.
   2. American Iron and Steel Institute (AISI).
   3. American Society of Mechanical Engineers (ASME):
      a. B16.3, Malleable Iron Threaded Fittings.
      b. B16.5, Pipe Flanges and Flanged Fittings.
      c. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
      d. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
      e. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
      f. B36.19, Stainless Steel Pipe.
      g. B40.100, Pressure Gauges and Gauge Attachments.
   4. ASTM International (ASTM):
      a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
      c. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
      d. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      e. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      f. A197, Standard Specification for Cupola Malleable Iron.
      g. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      h. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      i. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
      j. A518, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
      k. A536, Standard Specification for Ductile Iron Castings.
      l. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
      m. A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.

n. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
o. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
p. B88, Standard Specification for Seamless Copper Water Tube.
q. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
r. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
s. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
t. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
u. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
v. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
w. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
x. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
y. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
z. D4101, Standard Specification for Polypropylene Plastic Injection and Extrusion Materials.
aa. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
bb. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

5. American Water Works Association (AWWA):
   a. B300, Standard for Hypochlorites.
   b. C200, Standard for Steel Water Pipe - 6 IN and Larger.
   c. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
   d. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   e. C606, Standard for Grooved and Shouldered Joints.
   f. C651, Standard for Disinfecting Water Mains.
   g. C800, Standard for Underground Service Line Valves and Fittings.
6. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   b. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
   e. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.
7. Chlorine Institute, Inc. (CI):
   a. Pamphlet 6, Piping Systems for Dry Chlorine.
8. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
9. International Plumbing Code (IPC).
10. National Fire Protection Association (NFPA):
    a. 54, National Fuel Gas Code.
    b. 69, Standard on Explosion Prevention Systems.
11. Underwriters Laboratories, Inc. (UL).

B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

1.3 DEFINITIONS

A. Hazardous Gas Systems: Digester gas, chlorine gas, sulfur dioxide gas, carbon dioxide gas, lab gases.

B. PVDF: Polyvinylidene fluoride.

1.4 SYSTEM DESCRIPTION

A. Piping Systems Organization and Definition:
   1. Piping services are grouped into designated systems according to the chemical and physical properties of the fluid conveyed, system pressure, piping size and system materials of construction.
   2. See PIPING SPECIFICATION SCHEDULES in PART 3.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
      c. Separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components.
         1) Attach technical product data on gaskets, pipe, fittings, and other components.
   3. Fabrication and/or layout drawings:
      a. Exterior yard piping drawings (minimum scale 1 IN equals 10 FT) with information including:
         1) Dimensions of piping lengths.
         2) Invert or centerline elevations of piping crossings.
         3) Acknowledgement of bury depth requirements.
         4) Details of fittings, tapping locations, thrust blocks, restrained joint segments, harnessed joint segments, hydrants, and related appurtenances.
         5) Acknowledge designated valve or gate tag numbers, manhole numbers, instrument tag numbers, pipe and line numbers.
         6) Line slopes and vents.
      b. Interior piping drawings (minimum scale 1/8 IN equals 1 FT) with information including:
         1) Dimensions of piping from column lines or wall surfaces.
         2) Invert dimensions of piping.
         3) Centerline elevation and size of intersecting ductwork, conduit/conduit racks, or other potential interferences requiring coordination.
         4) Location and type of pipe supports and anchors.
         5) Locations of valves and valve actuator type.
         6) Details of fittings, tapping locations, equipment connections, flexible expansion joints, connections to equipment, and related appurtenances.
         7) Acknowledgement of valve, equipment and instrument tag numbers.
         8) Provisions for expansion and contraction.
         9) Line slopes and air release vents.
         10) Rough-in data for plumbing fixtures.
      c. Schedule of interconnections to existing piping and method of connection.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
1. Qualifications of lab performing disinfection analysis on water systems.
2. Test reports:
a. Copies of pressure test results on all piping systems.
b. Reports defining results of dielectric testing and corrective action taken.
c. Disinfection test report.
d. Notification of time and date of piping pressure tests.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe coating during handling using methods recommended by manufacturer.
1. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

B. Prevent damage to pipe during transit.
1. Repair abrasions, scars, and blemishes.
2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Insulating unions:
a. "Dielectric" by Epco.
2. Dirt strainers (Y type):
a. Mueller (#351).
b. Sarco.
c. Armstrong.
3. Chemical strainers (Y type):
a. Chemtrol.
b. Asahi.
4. Dry disconnect couplings:
a. Kamlock.
5. Dielectric flange kit:
a. PSI.
b. Maloney.
c. Central Plastics.
6. Pipe saddles (for gage installation):
a. Dresser Style 91 (steel and ductile iron systems).
b. Dresser Style 194 (nonmetallic systems).
7. Expansion joint at FRP and poly tanks:
a. PROCO.
8. Basket strainer:
a. Watts, Lead Free 97FB-CI.
9. AC pipe transition coupling:
a. Romac TC400.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 PIPING SPECIFICATION SCHEDULES

A. Piping system materials, fittings and appurtenances are subject to requirements of specific piping specification schedules located at the end of PART 3 of this Specification Section.

2.3 COMPONENTS AND ACCESSORIES

A. Insulating Components:
   1. Dielectric flange kits:
      a. Flat faced.
      b. 1/8 IN thick dielectric gasket, phenolic, non-asbestos.
      c. Suitable for 175 psi, 210 DegF.
      d. 1/32 IN wall thickness bolt sleeves.
      e. 1/8 IN thick phenolic insulating washers.
   2. Dielectric unions:
      a. Screwed end connections.
      b. Rated at 175 psi, 210 DegF.
      c. Provide dielectric gaskets suitable for continuous operation at union rated temperature and pressure.

B. Dirt Strainers:
   1. Y-type.
   2. Composition bronze.
   3. Rated for test pressure and temperature of system in which they are installed.
   4. 20 mesh Monel screen.
   5. Threaded bronze plug in the blowoff outlet.
   6. Threaded NPT end connections.

C. Strainers for Chemical Applications:
   1. Y-type.
   2. Strainers of same material, test pressure, and temperature rating as system in which strainer is placed.

D. Reducers:
   1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.
   2. Connection size requirements may change from those shown on Drawings depending on equipment furnished.

E. Protective Coating and Lining:
   1. Include pipe, fittings, and appurtenances where coatings, linings, paint, tests and other items are specified.
   2. Field paint pipe in accordance with Specification Section 09905.

F. Underground Warning Tape:
   1. See Specification Section 10400.

G. Pressure Gages:
   1. See Specification Section 11005 and Specification Section 13442.

H. Dry Disconnect Couplings:
   1. Adapters:
      a. Male adapters: Size shown on Drawings.
      b. Adapters:
         1) Female NPT end connection for sludge and flush applications.
         2) Male NPT end connection for chemical applications.
      c. Construct adapters for sludge applications from cast iron or steel.
      d. Construct adapters for chemical and PVC system applications 3 IN and below from polypropylene.
         1) Above 3 IN size, provide stainless steel units.
   2. Couplers:
      a. Built-in valve and spring loaded poppet which close automatically when disconnected.
      b. Designed to remain with only one (1) arm locked in closed position.

c. Construct couplers for sludge applications fabricated from material utilized for adapters.
d. Construct couplers for chemical and PVC system applications 3 IN and less from polypropylene with stainless steel arms and pins.
1) Above 3 IN, provide stainless steel units.
e. Gasket: Compatible with conveyed liquid.
3. Dust caps: For all adapters.

I. Valves:
1. See schematics and details for definition of manual valves used in each system under 4 IN in size.
a. See Specification Section 15100 schedule for valve types 4 IN and above and for automatic valves used in each system.
2. See Specification Section 15100.

J. Expansion Joints at FRP and Poly Tanks:
1. Materials:
a. Bellows: PTFE-62.
b. Flanges: PVC, ductile iron.
c. Limit bolts and nuts: 316 stainless steel.
d. Reinforcing rings: Stainless steel.
2. Pressure rating at 70 DegF: 70 psig.
3. Minimum axial movement: 3/8 IN.

K. Basket Strainer:
1. Materials:
a. Body and retainer cap: ASTM A126 Class B cast iron.
b. Screen: 304 perforated stainless steel.
c. Blowdown plug: ASTM A126 Class B cast iron.
2. All wetted durfaces shall contain less than 0.25 percent of lead by weight.
3. Flanged connections shall meet requirements of specified joining pipe.
4. Strainer shall linclude a bolted cover and cast iron retainer cap with graphite gasket.

PART 3 - EXECUTION

3.1 EXTERIOR BURIED PIPING INSTALLATION

A. Unless otherwise shown on the Drawings, provide a minimum of 3 FT and maximum of 8 FT earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.

B. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01800 and as shown on Drawings.

C. When entering or leaving structures with buried mechanical joint piping, install joint within 2 FT of point where pipe enters or leaves structure.
1. Install second joint not more than 6 FT nor less than 4 FT from first joint.

D. Install expansion devices as necessary to allow expansion and contraction movement.

E. Laying Pipe In Trench:
1. Excavate and backfill trench in accordance with Specification Section 02221.
2. Clean each pipe length thoroughly and inspect for compliance to specifications.
3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
5. Except for first two (2) joints, before making final connections of joints, install two (2) full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
6. Lay pipe in only suitable weather with good trench conditions.

a. Never lay pipe in water except where approved by Engineer.
7. Seal open end of line with watertight plug if pipe laying stopped.
8. Remove water in trench before removal of plug.

F. Lining Up Push-On Joint Piping:
1. Lay piping on route lines shown on Drawings.
2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
3. Observe maximum deflection values stated in manufacturer's written literature.
4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
5. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.

G. Anchorage and Blocking:
1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.
2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
a. Concrete blocks shall not cover pipe joints.
3. Provide bearing area of concrete in accordance with drawing detail.

H. Install underground hazard warning tape per Specification Section 10400.

I. Install insulating components where dissimilar metals are joined together.

3.2 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:
1. Expansion and contraction.
2. Operation and access to equipment, doors, windows, hoists, moving equipment.
3. Headroom and walking space for working areas and aisles.
4. System drainage and air removal.

C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01800 and as shown on the Drawings.

D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

E. Pipe Support:
1. Use methods of piping support as shown on Drawings and as required in Specification Section 15090.
2. Piping support systems for piping 12 IN and greater are shown on the Drawings.
a. Support systems for piping smaller than 12 IN DIA are not shown on the Drawings.
b. Contractor is responsible for design of these support systems per Specification Section 15090.
3. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
4. Size pipe supports with consideration to specific gravity of liquid being piped.

F. Locate and size sleeves and castings required for piping system.
1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

G. Use reducing fittings throughout piping systems.
1. Bushings will not be allowed unless specifically approved.

H. Equipment Drainage and Miscellaneous Piping:
   1. Provide drip pans and piping at equipment where condensation may occur.
   2. Hard pipe stuffing box leakage to nearest floor drain.
   3. Avoid piping over electrical components such as motor control centers, panelboards, etc.
      a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
      b. Hard pipe drainage to nearest floor drain.
   4. Collect system condensate at drip pockets, traps and blowoff valves.
   5. Provide drainage for process piping at locations shown on Drawings in accordance with Drawing details.
   6. For applications defined above and for other miscellaneous piping which is not addressed by a specific piping service category in PART 1, provide 304 stainless steel piping and fittings.
      a. Size to handle application with 3/4 IN being minimum size provided.

I. Unions:
   1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
   2. Mechanical type couplings may serve as unions.
   3. Additional flange unions are not required at flanged connections.

J. Install expansion devices as necessary to allow expansion/contraction movement.

K. Provide full face gaskets on all systems.

L. Anchorage and Blocking:
   1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

M. Equipment Pipe Connections:
   1. Equipment - General:
      a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
      b. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
      c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
         1) Provide tightening torque in accordance with manufacturer's recommendations.
      d. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
      e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
      f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
      g. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
      h. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
         1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
         2) Realign as necessary, install flange bolts and make equipment connection.
      i. Provide utility connections to equipment shown on Drawings, scheduled or specified.
   2. Plumbing and HVAC equipment:
      a. Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment.

b. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or as integral part of equipment.
c. For each water supply piping connection to equipment, furnish and install union and gate or angle valve.
   1) Provide wheel handle stop valve at each laboratory sink water supply.
   2) Minimum size: 1/2 IN.
d. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system.
   1) Size trap as required by IPC.
e. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed.

N. Provide insulating components where dissimilar metals are joined together.

O. Instrument Connections:
   1. See drawing details.

3.3 CONNECTIONS WITH EXISTING PIPING

A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.

B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.

C. Undertake connections in fashion which will disturb system as little as possible.

D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.

E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.

F. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section.

G. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.4 ACCESS PROVISIONS

A. Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping and piping appurtenances requiring service.

B. Size of access panels to allow inspection and removal of items served, minimum 10 x 14 IN size.

C. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type.

D. Provide with key locks, keyed alike, in public use areas.

E. Furnish panels with prime coat of paint.

F. Style and type as required for material in which door installed.

G. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

3.5 CATHODIC PROTECTION

A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.

B. Make all connections from wire or cable by Thermit Cadwelding accomplished by operators experienced in this process.

C. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50 percent of the straight line length.

D. After cadwelding, coat all exposed metallic surfaces with hot applied tape.

3.6 HEAT TRACING

A. See Specification Section 16125 - Heat Tracing Cable.

3.7 PRESSURE GAGES

A. Provide at locations shown on the Drawings and specified.

B. See Specification Section 11005.

3.8 FIELD QUALITY CONTROL

A. Pipe Testing - General:
   1. Test piping systems as follows:
      a. Test exposed, non-insulated piping systems upon completion of system.
      b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
      c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
      d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
   2. Utilize pressures, media and pressure test durations as specified in the PIPING SPECIFICATION SCHEDULES.
   3. Isolate equipment which may be damaged by the specified pressure test conditions.
   4. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
      a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
      b. Notify the Engineer 24 HRS prior to each test.
   5. Completely assemble and test new piping systems prior to connection to existing pipe systems.
   6. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
   7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:
   1. Testing medium: Unless otherwise specified in the PIPING SPECIFICATION SCHEDULES, utilize the following test media.
      a. Process and plant air systems:

PIPE LINE SIZE	SPECIFIED TEST PRESSURE	TESTING MEDIUM
2 IN and smaller	75 psi or less	Air or water
2 IN and smaller	Greater than 75 psi	Water
Greater than 2 IN	3 psi or less	Air or water
Greater than 2 IN	Greater than 3 psi	Water

      b. Laboratory gases and natural gas systems: Cylinder nitrogen.

c. Liquid systems:

PIPE LINE SIZE (DIA)	GRAVITY OR PUMPED	SPECIFIED TEST PRESSURE	TESTING MEDIUM
Up to and including 48 IN	Gravity	25 psig or less	Air or water
Above 48 IN	Gravity	25 psig or less	Water
All sizes	Pumped	250 psig or less	Water

2. Allowable leakage rates:
   a. Hazardous gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test.
   b. Hydrostatic exfiltration and infiltration for sanitary and stormwater sewers (groundwater level is below the top of pipe):
      1) Leakage rate: 200 GAL per inch diameter per mile of pipe per day at average head on test section of 3 FT.
      2) Average head is defined from groundwater elevation to average pipe crown.
      3) Acceptable test head leakage rate for heads greater than 3 FT: Acceptable leakage rate (gallons per inch diameter per mile per day) equals 115 by (actual test head to the 1/2 power).
   c. Hydrostatic infiltration test for sanitary and stormwater sewers (groundwater level is above the top of pipe):
      1) Allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 6 FT.
      2) Leakage rate at heads greater than 6 FT: Allowable leakage rate (gallons per inch diameter per mile of pipe per day) equals 82 by (actual head to the 1/2 power).
   d. Large diameter (above 48 IN) gravity plant piping systems shall have a maximum exfiltration of 25 gpd per inch-mile.
   e. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5 percent of the specified test pressure throughout the duration of the test.
   f. For low pressure (less than 25 psig) air testing, the acceptable time for loss of 1 psig of air pressure shall be:

PIPE SIZE (IN DIA)	TIME, MINUTES/100 FT
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0
42	7.3
48	7.6

3. Hydrostatic pressure testing methodology:
   a. General:
      1) All joints, including welds, are to be left exposed for examination during the test.

2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
3) Provide temporary restraints for expansion joints for additional pressure load under test.
4) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
5) Do not paint or insulate exposed piping until successful performance of pressure test.

b. Soil, waste, drain and vent systems:
1) Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
2) Eliminate leaks before proceeding with work or concealing piping.
3) Minimum test heights shall be 10 FT above highest stack inlet.

c. Larger diameter (above 36 IN) gravity plant piping:
1) Plug downstream end of segment to be tested.
a) Provide bracing as required.
2) Fill segment and upstream structure to normal operating level as per hydraulic profile.
3) Allow 24 HRS for absorption losses.
a) Refill to original level.
4) Provide reservoir to maintain constant head over duration of test.
5) Record reservoir water volume at beginning and end of test.

4. Natural gas systems - testing methodology:
a. Maintain specified test pressure until each joint has been thoroughly examined for leaks by means of soap suds and glycerine.
b. Wipe joints clean after test.

5. Air testing methodology:
a. General:
1) Assure air is ambient temperature.

b. Low pressure air testing:
1) Place plugs in line and inflate to 25 psig.
2) Check pneumatic plugs for proper sealing.
3) Introduce low pressure air into sealed line segment until air pressure reaches 4 psig greater than ground water that may be over the pipe.
a) Use test gage conforming to ASME B40.100 with 0 to 15 psi scale and accuracy of 1 percent of full range.
4) Allow 2 minutes for air pressure to stabilize.
5) After stabilization period (3.5 psig minimum pressure in pipe) discontinue air supply to line segment.
6) Record pressure at beginning and end of test.

C. Dielectric Testing Methods and Criteria:
1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

3.9 CLEANING, DISINFECTION AND PURGING

A. Cleaning:
1. Clean interior of piping systems thoroughly before installing.
2. Maintain pipe in clean condition during installation.
3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.

5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
    a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
    b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
6. After erection of piping and tubing, but prior to installation of service outlet valves, blow natural gas {liquefied petroleum gas} and digester gas systems clear of free moisture and foreign matter by means of air, nitrogen or carbon dioxide.
    a. Oxygen shall never be used.
7. Clean chlorine piping in accordance with CI Pamphlet 6.
8. Purge all neat liquid polymer tubing or piping between the neat polymer storage tank or tote and the polymer blending units with mineral oil to remove residual water prior to introducing neat polymer. Following purging, drain as much of the mineral oil out of the system as possible. Dispose of purged fluids and waste mineral oil in accordance with local environmental regulations.

B. Disinfection of Potable Water Systems:
1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply, source and any appurtenant devices and perform disinfection as prescribed.
2. Perform work, including preventative measures during construction, in full compliance with AWWA C651.
3. Perform disinfection using sodium hypochlorite complying with AWWA B300.
4. Flush each segment of system to provide flushing velocity of not less than 2.5 FT per second.
5. Drain flushing water to sanitary sewer.
    a. Do not drain flushing water to receiving stream.
6. Use continuous feed method of application.
    a. Tag system during disinfection procedure to prevent use.
7. After required contact period, flush system to remove traces of heavily chlorinated water.
8. After final flushing and before placing water in service, obtain an independent laboratory approved by the Owner to collect samples and test for bacteriological quality.
    a. Repeat entire disinfection procedures until satisfactory results are obtained.
9. Secure and deliver to Owner, satisfactory bacteriological reports on samples taken from system.
    a. Ensure sampling and testing procedures are in full compliance to AWWA C651, local water purveyor and applicable requirements of State of California.

C. Purging Natural gas and digester gas:
1. Existing piping:
    a. Turn off gas supply.
    b. Vent line pressure outdoors.
    c. If section exceeds the following, then remaining gas shall be displaced with an inert gas.
        1) 50 FT for 2-1/2 IN pipe.
        2) 30 FT for 3 IN pipe.
        3) 15 FT for 4 IN pipe.
        4) 10 FT for 6 IN pipe.
        5) Any length for 8 IN or larger pipe.
2. New piping:
    a. Including but not limited to:
        1) All fuel gas piping.
        2) Digesters.
        3) Digester gas equipment.

4) Fuel gas trains.

b. Purge air filled system with fuel gas:

1) Providing piping length is less than:

a) 30 FT for 3 IN pipe.

b) 15 FT for 4 IN pipe.

c) 10 FT for 6 IN pipe.

d) Any length for 8 IN and larger pipe.

2) Providing a moderately rapid and continuous flow of fuel gas is introduced.

a) Introduce fuel gas at one (1) end.

b) Vent air at opposite end.

3) Provided fuel gas flow is continuous without interruption until vented gas is free of air.

4) The point of discharge shall not be left unattended during purging.

c. If the piping is 3 IN or larger and exceeds lengths stated above.

1) Purge air with inert gas in accordance with NFPA 54 and NFPA 69.

2) Purge inert gas with fuel gas.

3. Discharge of purged gases:

a. Open end of piping shall not discharge into confined spaces or areas where there are sources of ignition.

3.10 LOCATION OF BURIED OBSTACLES

A. Furnish exact location and description of buried utilities encountered and thrust block placement.

B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.

C. Include such information as location, elevation, coverage, supports and additional pertinent information.

D. Incorporate information on "As-Recorded" Drawings.

3.11 PIPE INSULATION

A. Insulate pipe and pipe fittings in accordance with Specification Section 15183.

3.12 SCHEDULES

A. SPECIFICATION SCHEDULE - SYSTEM 1

1. General:

a. Piping symbol and service:

1) IS – Influent Sewer.

2) PI – Primary Influent.

3) SS – Sanitary Sewer.

4) STD – Storm Drain.

b. Test requirements:

1) Test medium: Low pressure air.

2) Pressure: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

3) Duration: See the FIELD QUALTIY CONTROL Article in PART 3 of this Specification Section.

c. Gaskets:

1) Push-on and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.

2. System components:

a. Pipe size 3 IN through 48 IN:

1) Buried service:

a) Materials: Ductile iron, Class 53.

b) Reference: AWWA/ANSI C151/A21.51.

c) Lining: Cement.

d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN.
f) Joints: Push-on joints with mechanical (stuffing box type) joints at fittings and valves.

B. SPECIFICATION SCHEDULE - SYSTEM 2
1. General:
a. Piping symbol and service:
1) ABI - Aeration Basin Influent.
2) CEN – Centrate.
3) D – Drain.
4) GRO – Grit Overflow.
5) GTO – Gravity thickener Overflow.
6) ML – Mixed Liquor.
7) OF – Overflow.
8) PB – Primary bypass.
9) PE – Primary Effluent.
10) RS – Raw Sewage.
11) SE – Secondary Effluent.
b. Test requirements:
1) Test medium: Water.
2) Pressure: 25 psig.
3) Duration: 6 HRS.
c. Gaskets:
1) Flanged, push-on, and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
2. System components:
a. Pipe size 3 IN through 48 IN:
1) Exposed service:
a) Material:
(1) Flanged: Ductile iron, Class 53.
(2) Grooved type joint system: Use pipe thickness per AWWA C606.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Cement.
d) Coating: Paint.
e) Fittings: Either AWWA/ANSI C110/A21.10 ductile or gray iron.
f) Joints: AWWA/ANSI C115/A21.15 flanged joints with flanges at valves and structure penetrations.
2) Buried service:
a) Materials: Ductile iron, Class 53.
b) Reference: AWWA/ANSI C151/A21.51.
c) Lining: Cement.
d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN.
f) Joints: Push-on joints with mechanical (stuffing box type) joints at fittings and valves.

C. SPECIFICATION SCHEDULE - SYSTEM 3
1. General:
a. Piping symbol and service:

1) DS - Digested Sludge.
2) GR – Grit.
3) GTSL – Gravity Thickened Sludge.
4) PSC - Primary Scum.
5) PSL – Primary Sludge.
6) RAS - Return Activated Sludge.
7) TS – Thickened Sludge.
8) WAS - Waste Activated Sludge.

b. Test requirements:
1) Test medium: Water.
2) Pressure: 125 psig.
3) Duration: 6 HRS.

c. Gaskets:
1) Flanged, push-on and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
2) Grooved coupling joints (ductile and steel): Rubber, AWWA C606.
3) Flanged joints (steel): AWWA C207.

2. System components:
a. Pipe size 3 IN through 24 IN:
1) Exposed service:
a) Material:
(1) Flanged: Ductile iron, Class 53.
(2) Grooved type joint system: Use pipe thickness per AWWA C606.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Glass.
d) Coating: Paint.
e) Fittings: Either AWWA/ANSI C110/A21.10 ductile or gray iron.
f) Joints:
(1) Flanged or grooved type mechanical coupling (AWWA C606) joints.
(2) With both systems, provide screwed-on flanges at equipment, valves and structure penetrations.
2) Buried service:
a) Materials: Ductile iron, Class 53.
b) Reference: AWWA/ANSI C151/A21.51.
c) Lining: Glass.
d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN.
f) Joints: Push-on with mechanical (stuffing box type) joints at fittings and valves.

b. Pipe size greater than 24 IN:
1) Exposed service:
a) Material: Steel, fabricated pipe.
b) Reference: AWWA C200.
c) Lining: Fusion bonded epoxy.
d) Coating: Fusion bonded epoxy.
e) Fittings: AWWA C208.
f) Joints: Butt-welded with rigid AWWA C207 flanges at equipment, valves, and structure penetrations.
2) Buried service:
a) Material: Steel, fabricated pipe.
b) Reference: AWWA C200.
c) Lining: Fusion bonded epoxy.
d) Coating: Fusion bonded epoxy.

e) Fittings: AWWA C208.
f) Joints: Butt welded.

D. SPECIFICATION SCHEDULE - SYSTEM 4 (NOT USED)

E. SPECIFICATION SCHEDULE - SYSTEM 5
1. General:
a. Piping symbol and service:
1) NG - Natural Gas.
b. Test requirements:
1) Test medium: Cylinder Nitrogen.
2) Pressure: 100 psig.
3) Duration: 6 HRS.
2. System components:
a. Pipe size through 26 IN:
1) Exposed service:
a) Material: Steel, Grade B, black, Schedule 40.
b) Reference: ASTM A53.
c) Lining: None.
d) Coating: Paint.
e) Fittings: Malleable iron meeting ASTM A197, ASME B16.3, Class 150.
f) Joints: Threaded, ASME B16.9 steel butt- or socket-welded joints.
2) Buried service:
a) Materials: Steel, Grade B, black, Schedule 40.
b) Reference: ASTM A53.
c) Linings: None.
d) Coatings: Factory coating-mill wrapped with 3-M "Scotchkote," or Energy Coating Company "Encoat" with fittings and uncoated portions fully wrapped after testing with 3-M "Scotchkote" tape.
e) Fittings: Malleable iron meeting ASTM A197, ASME B16.3, Class 150.
f) Joints: Threaded, ASME B16.9 steel butt- or socket-welded joints.

Natural Gas Piping Installation:
1. Install piping in accordance with NFPA, local gas company regulations, codes and local ordinances, complete with necessary appurtenances.
2. Install buried pipe at approximately 30 IN deep.
3. Gas cocks:
a. Install before gas utilization equipment connected to system, at each branch main and at connection to meter.
b. Design to operate safely under pressures indicated.
c. Install ground joint unions at intervals to facilitate repairs.
d. Cocks shall be of type and lubricant recommended by manufacturer for this class of service, and as approved by local gas company.
4. Pipe drainage:
a. Drain horizontal piping to risers.
b. Locate drains where required for system drainage.
c. Install tee fitting with bottom outlet plugged or provide with threaded, capped nipple at bottom of risers or in accordance with applicable codes.
5. Make piping connections with shellacked joints or ground joint unions.
6. Provide vents from gas regulators, pressure reducing valves, and other vented devices to the outdoors and terminate in accordance with applicable codes.
7. Connect piping to pressure reducing valve outside each building as shown on drawings and schedule.
8. Provide flexible connections to vibration isolated equipment suitable for pressures, local and national codes and intended application.
9. Remove cutting and threading burrs.

10. Plug each gas outlet (including valves) with threaded plugs or caps immediately after installation and retain until the piping or equipment connections are completed.
11. Continuously ground gas piping electrically, bond tightly to the grounding connection.
12. Install piping parallel to other piping, but maintain a minimum 12 IN clearance between gas piping and any piping that could reach 200 DegF.
13. All gas piping in air plenums to be all-welded and encased in a Schedule 40 pipe sleeve.
    a. Ends of the sleeve open to atmosphere or sealed with the annullus vented (gas pipe size) to atmosphere.

F. SPECIFICATION SCHEDULE - SYSTEM 6 (NOT USED)

G. SPECIFICATION SCHEDULE - SYSTEM 7
1. General:
    a. Piping symbol and service:
        1) POLY - Polymer
        2) SBS – Sodium Bisulfite.
        3) SHC – Sodium Hypochlorite.
    b. Test requirements pressure lines:
        1) Test medium: Water.
        2) Pressure: 125 psig.
        3) Duration: 6 HRS.
    c. Test requirements vacuum lines:
        1) Test medium: Air.
        2) Pressure: -27 IN HG.
        3) Duration: 6 HRS.
    d. Gaskets and O-rings:
        1) Viton.
2. System components:
    a. Pipe size 12 IN and smaller:
        1) Exposed service:
            a) Material: PVC, Type 1, Grade 1, Schedule 80.
            b) Reference: ASTM D1785.
            c) Lining: None.
            d) Coating: Paint.
            e) Fittings: Solvent welded socket type complying with ASTM D2467.
            f) Joints: Solvent welded with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
            g) For HCL service, provide pipe joint primer and solvent cement specifically formulated for use with this chemical: IPS-70 primer and IPS-724 solvent cement.
        2) Buried service:
            a) Material: PVC, Type 1, Grade 1, Schedule 40.
            b) Reference: ASTM D1785.
            c) Lining: None.
            d) Coating: None.
            e) Fittings: Solvent welded socket type complying with ASTM D2466.
            f) Joints: Solvent welded.

H. SPECIFICATION SCHEDULE - SYSTEM 8
1. General:
    a. Piping symbol and service:
        1) FCL - Ferric Chloride.
        2) SHD - Sodium Hydroxide.
    b. Test requirements:
        1) Test medium: Water.
        2) Pressure: 125 psig.

3) Duration: 6 HRS.
c. Gaskets and O-rings: Polypropylene.
2. System components:
a. Pipe size 12 IN and smaller:
1) Exposed service:
a) Material: CPVC, Schedule 80.
b) Reference: ASTM F441.
c) Lining: None.
d) Coating: Paint.
e) Fittings: Solvent welded socket type complying with ASTM F439.
f) Joints:
(1) Solvent welded with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
(2) For sodium hydroxide, provide pipe joint primer IPS-70 and pipe joint solvent cement IPS-724.

I. SPECIFICATION SCHEDULE - SYSTEM 9
1. General:
a. Piping symbol and service:
1) 1W – No. 1 Water.
2) 2W – No. 2 Water.
3) 3W – No. 3 Water (Chlorinated Effluent).
4) 4W – No. 4 Water (Dechlorinated Effluent).
5) SW – Seal Water.
6) FE – Final Effluent.
b. Test requirements:
1) Test medium: Water.
2) Pressure: 125 psig.
3) Duration: 6 HRS.
c. Gaskets and O-rings:
1) O-rings: Neoprene or rubber.
2) Flanged, push-on and mechanical joints (ductile iron): Rubber, AWWA/ANSI C111/A21.11.
3) Flanged joints (steel): Rubber, AWWA C207.
4) Grooved coupling joints (ductile and steel): Rubber, AWWA C606.
2. System components:
a. Pipe size to 1 IN:
1) Exposed service:
a) Materials: Stainless steel tubing, TP-304L.
b) Reference: ASTM A269.
c) Lining: None.
d) Coating: None.
e) Fittings: Stainless steel 304L compression type tube fittings.
f) Joints: Compression type couplings, unions at equipment and valves.
g) Minimum wall thickness:
(1) 1/16 IN OD: 0.010 IN.
(2) 1/8 to 1/4 IN OD: 0.028 IN.
(3) 5/16 to 1/2 IN OD: 0.049 IN.
(4) 5/8 to 1 IN OD: 0.065 IN.
b. Pipe size 1 IN to 3 IN:
1) Exposed service:
a) Materials:
(1) Threaded: Steel, Grade B, black, Schedule 40.
(2) Grooved type joint system: Use pipe thickness per AWWA C606.
b) Reference: ASTM A53.

c) Lining: None.
d) Coating: Paint.
e) Fittings: Malleable iron or steel meeting ASME B16.3 and ASTM A234.
f) Joints:
(1) Threaded or grooved type mechanical coupling (AWWA C606) joints.
(2) With both systems, provide rigid flanges at equipment, valves and structure penetrations above 2 IN and unions at those locations 2 IN and below.

2) Buried service:
a) Materials: Steel, Schedule 40, Grade B.
b) Reference: ASTM A53.
c) Lining: None.
d) Coating: Bituminous.
e) Fittings: Malleable iron meeting ASME B16.3.
f) Joints: Threaded.

c. Pipe size 3 IN through 24 IN:
1) Exposed service:
a) Materials:
(1) Flanged: Ductile iron, Class 53.
(2) Grooved type mechanical joint system: Use pipe thickness per AWWA C606.
b) Reference: AWWA/ANSI C115/A21.15.
c) Lining: Cement.
d) Coating: Paint.
e) Fittings: Either AWWA/ANSI C110/A21.10 ductile or gray iron.
f) Joints:
(1) Flanged or grooved type mechanical coupling (AWWA C606) joints.
(2) With both systems, provide screwed-on flanges at valves, equipment and structure penetration.

2) Buried service:
a) Materials: Ductile iron, Class 53.
b) Reference: AWWA/ANSI C151/A21.51.
c) Lining: Cement.
d) Coating: Bituminous.
e) Fittings:
(1) Either AWWA/ANSI C110/A21.10 ductile or gray iron.
(2) Optional: AWWA/ANSI C153/A21.53 ductile iron compact fittings for sizes 3 IN to 16 IN.
f) Joints: Push-on with mechanical (stuffing box type) joint at fittings and valves.

3) FE replacement pipe as shown on 06C101:
a) Buried service:
(1) Material: PVC, ASTM D1784.
(2) Reference: AWWA C900/C905 DR25.
(3) Lining: None.
(4) Coating: None.
(5) Fittings: ASTM D3139.
(6) Gasket: ASTM F477.

J. SPECIFICATION SCHEDULE - SYSTEM 10 (NOT USED)

K. SPECIFICATION SCHEDULE - SYSTEM 11
1. General:
a. Piping symbol and service:
1) HPA – High Pressure Air.
2) IA - Instrument Air.

b. Test requirements:
   1) Test medium: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
   2) Pressure: 150 psig.
   3) Duration: 6 HRS.
c. Gaskets and O-rings:
   1) O-ring and flanged joints: Rubber or neoprene, 250 DegF.
   2) Grooved coupling joints (steel): AWWA C606, rubber, 250 DegF.

2. System components:
   a. Pipe size to 1 IN for A, 3/8 IN to 1 IN for IA:
      1) Exposed service:
         a) Material: Stainless steel tubing, TP-304L.
         b) Reference: ASTM A269.
         c) Lining: None.
         d) Coating: None.
         e) Fittings: Stainless steel 304L, compression type tube fittings.
         f) Joints: Compression type couplings, unions at equipment and valves.
   b. Pipe size 1 IN to 4 IN:
      1) Exposed service:
         a) Materials:
            (1) Threaded: Steel, Grade B, black, Schedule 40.
            (2) Grooved type joint system: Use pipe thickness per AWWA C606.
         b) Reference: ASTM A53.
         c) Linings: None.
         d) Coating: Paint.
         e) Fittings: Malleable iron meeting ASME B16.3, ASTM A197 or steel meeting ASME B16.3, ASTM A234.
         f) Joints:
            (1) Threaded or grooved type mechanical coupling (AWWA C606) joints.
            (2) With both systems, provide rigid flanges at equipment, valves and structure penetrations above 2 IN and unions at those locations 2 IN and below.
      2) Buried service:
         a) Materials: Steel, Schedule 40, Grade B, black.
         b) Reference: ASTM A53.
         c) Lining: None.
         d) Coating: Bituminous.
         e) Fittings: Malleable iron meeting ASME B16.3, ASTM A197 or steel meeting ASME B16.3, ASTM A234.
         f) Joints: Threaded.
3. Slope all piping mains approximately 1:100 toward points of drainage.
4. Provide driplegs at low points:
   a. Provide ball type isolation valve.
   b. Route dripleg to nearest wall or column and terminate 4 FT above finished floor.

L. SPECIFICATION SCHEDULE - SYSTEM 12
   1. General:
      a. Piping symbol and service:
         1) LPA - Low Pressure Process Air.
      b. Test requirements:
         1) Test medium: Air.
         2) Pressure: 20 psig.
         3) Duration: 6 HRS.
      c. Gaskets and O-rings:
         1) O-rings and flanged joints: Viton, 300 DegF.
      d. Temperature:

1) Normal: 170 DegF.
2) Maximum: 250 DegF.

2. System components:
   1) Pipe size through 2 IN:
      a) Exposed service outside of channels and tankage:
         (1) Material: Steel, Schedule 40, Grade B, black.
         (2) Reference: ASTM A53.
         (3) Lining: None.
         (4) Coating: Paint.
         (5) Fittings: Malleable iron meeting ASME B16.3, ASTM A197 or steel meeting ASTM A106, Grade B.
         (6) Joints:
            (a) Welded with flanges at equipment and valves.
            (b) Harnessed compression sleeve couplings where indicated on Drawings.
      b) Piping within channels and tankage:
         (1) Material: Stainless steel 304L, Schedule 40.
         (2) Reference: ASTM A778.
         (3) Lining: None.
         (4) Coating: None.
         (5) Fittings: Seamless steel 304L meeting ASTM A774.
         (6) Joints:
            (a) Butt welded with unions at equipment and valves.
            (b) Harnessed compression sleeve couplings where indicated on Drawings.
   2) Pipe size above 2 IN:
      a) Exposed service outside of channels and tankage:
         (1) Material: Steel, Schedule 10, Grade B, black.
         (2) Reference: ASTM A53.
         (3) Lining: None.
         (4) Coating: Paint.
         (5) Fittings: Malleable iron meeting ASME B16.3, ASTM A197 or steel meeting ASTM A106, Grade B.
         (6) Joints:
            (a) Welded with flanges at equipment and valves.
            (b) Harnessed compression sleeve couplings where indicated on Drawings.
      b) Piping within channels and tankage:
         (1) Material: Stainless steel 304L, Schedule 10.
         (2) Reference: ASTM A778.
         (3) Lining: None.
         (4) Coating: None.
         (5) Fittings: Seamless steel 304L meeting ASTM A774.
         (6) Joints:
            (a) Butt welded with flanges at equipment and valves.
            (b) Harnessed compression sleeve couplings where indicated on Drawings.
3. Aeration equipment:
   a. See elsewhere for limits of responsibility and materials specification.

M. SPECIFICATION SCHEDULE - SYSTEM 13
1. General:
   a. Piping symbol and service:
      1) LSG – Low Pressure Sludge Gas.
   b. Test requirements:
      1) Test medium: Air.

2) Pressure: 10 psig.
3) Duration: 6 HRS.

c. Gaskets:
1) Flanged joints: AISI 304 stainless steel, spiral wound, non-asbestos filler, 3/16 IN thick with compression ring to match required flange dimensions.

2. System components:
a. Pipe size 1 IN and greater:
1) Exposed service:
a) Material: Stainless steel, Schedule 10S, Grade TP316L.
b) References: ASTM A312, ASME B36.19.
c) Lining: None.
d) Coating: None.
e) Fittings: Butt welded stainless meeting ASTM A774.
f) Joints: Butt welded with ASTM A182 stainless steel flanges at equipment and valves.
2) Buried service:
a) Material: Stainless steel, Schedule 40S, Grade TP316L.
b) References: ASTM A312, ASME B36.19.
c) Lining: None.
d) Coating: None.
e) Fittings: Butt welded stainless meeting ASTM A774.
f) Joints: Butt welded.

N. SPECIFICATION SCHEDULE - SYSTEM 14 (NOT USED)

O. SPECIFICATION SCHEDULE - SYSTEM 15 (NOT USED)

P. SPECIFICATION SCHEDULE - SYSTEM 16 (NOT USED)

Q. SPECIFICATION SCHEDULE - SYSTEM 17 (NOT USED)

R. SPECIFICATION SCHEDULE - SYSTEM 18 (NOT USED)

S. SPECIFICATION SCHEDULE - SYSTEM 19 (NOT USED)

T. SPECIFICATION SCHEDULE - SYSTEM 20 (NOT USED)

U. SPECIFICATION SCHEDULE - SYSTEM 21
1. General:
a. Piping symbol and service:
1) VT - Vent.
2) VTR – Vent Through Roof.
b. Test requirements:
1) Test medium: Water.
2) Pressure: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
3) Duration: 6 HRS.
c. Gaskets: Rubber, ASTM C564.
2. System components:
a. Pipe size 1-1/4 IN and 1-1/2 IN:
1) Exposed service.
a) Material: Galvanized steel, Schedule 40.
b) Reference: ASTM A53.
c) Lining: Galvanized.
d) Coating: Paint.
e) Fittings: Cast iron drainage.
(1) ASTM A126, Class B.
f) Joints: Threaded.
b. Pipe size 2 IN and larger:

1) Exposed service.
   a) Material: Cast iron soil pipe.
   b) Reference: ASTM A74, CISPI 301.
   c) Lining: None.
   d) Coating: Paint.
   e) Fittings: ASTM A74.
   f) Joints: No-hub with elastomeric sealing sleeve and stainless steel clamp assembly conforming to CISPI 301.
2) Buried service (to 5 FT outside of structure):
   a) Material: Cast-iron soil pipe.
   b) Reference: ASTM A74.
   c) Lining: None.
   d) Coating: Bituminous.
   e) Fittings: ASTM A74.
   f) Joints: Hub and spigot.

Soil and Waste Piping Installation:

1. Install horizontal soil or waste lines less than 4 IN diameter with a slope of not less than 1/4 IN/FT or 2 percent toward the point of disposal.
2. Install 4 IN and larger piping at 1/8 IN per foot.
3. Install as close to construction as possible to maintain maximum head room.
4. Make changes of direction with 1/8 bends and junctions with wye fittings.
5. Use short wye fittings in vertical pipe only.
6. Install handhole test tee at base of each stack.
7. Install cleanouts at dead ends, at changes of direction and at 50 FT intervals on horizontal runs.
   a. Where cleanouts occur in concealed spaces, provide with extensions to floors above or to walls as required.
8. Install piping true to grade and alignment.
   a. Begin at the system low point.
9. Locate vertical extensions of underground piping below partition walls for concealment in wall.
   a. In locations where hubs are wider than partition, set hubs 1 IN below final floor.
10. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.
11. For hub and spigot joints, install hub facing flow.

Vent Piping Installation:

1. Run vent stack parallel to each soil or waste stack to receive branch vents from fixtures.
2. Originate each vent stack from soil or waste pipe at its base.
3. Where possible, combine soil, waste or vent stacks before passing through roof so as to minimize roof openings.
4. Offset pipes running close to exterior walls away from such walls before passing through roof to permit proper flashing.
5. Provide pipes passing through roofs with cast iron increasers minimum of 12 IN below roof one size larger than pipe but in no case less than 4 IN.
6. Terminate each vent with approved frostproof jacket.
7. Carry vent stacks 4 IN and larger full size through roof.
   a. Extend vent stacks at least 12 IN above roofing.
8. Pipe vents from pressure regulating devices in compliance with local codes.
9. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.

V. SPECIFICATION SCHEDULE - SYSTEM 22 (NOT USED)

W. SPECIFICATION SCHEDULE - SYSTEM 23 (NOT USED)

X. SPECIFICATION SCHEDULE - SYSTEM 24 (NOT USED)

Y. SPECIFICATION SCHEDULE - SYSTEM 25 (NOT USED)

Z. SPECIFICATION SCHEDULE - SYSTEM 26 (NOT USED)

AA. SPECIFICATION SCHEDULE - SYSTEM 27

1. General:
   a. Piping symbol and service:
      1) SAM - Sample.
   b. Test requirements pressure lines:
      1) Test medium: Water.
      2) Pressure: 100 psig.
      3) Duration: 6 HRS.
   c. Gaskets and O-rings:
      1) O-rings and flanged joints: Neoprene or rubber.
2. System components:
   a. Pipe size 12 IN and smaller:
      1) Exposed service:
         a) Material: PVC, Type 1, Grade 1, Schedule 80.
         b) Reference: ASTM D1785.
         c) Lining: None.
         d) Coating: Paint.
         e) Fittings: Solvent welded socket type complying with ASTM D2467.
         f) Joints: Solvent welded with unions at valves, penetrations through structures and equipment connections for pipe 2 IN and less and flanges at those locations for pipe above 2 IN.
      2) Buried service:
         a) Material: PVC, Type 1, Grade 1, Schedule 40.
         b) Reference: ASTM D1785.
         c) Lining: None.
         d) Coating: None.
         e) Fittings: Solvent welded socket type complying with ASTM D2466.
         f) Joints: Solvent welded.

BB. SPECIFICATION SCHEDULE - SYSTEM 28 (NOT USED)

END OF SECTION

SECTION 15061
PIPE: STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel pipe, fittings, and appurtenances.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B1.2, Gages and Gaging for Unified Inch Screw Threads.
      c. B16.3, Malleable Iron Threaded Fittings.
      d. B16.5, Pipe Flanges and Flanged Fittings.
      e. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
      f. B16.11, Forged Steel Fittings, Socket Welding and Threaded.
      g. B31.1, Power Piping.
      h. B31.3, Process Piping.
      i. B31.9, Building Services Piping.
      j. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A181, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
      d. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      e. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
      f. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
      g. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
      h. B6, Standard Specification for Zinc.
   3. American Water Works Association (AWWA):
      a. C200, Standard for Steel Water Pipe - 6 IN and Larger.
      b. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel water Pipeline - Enamel and Tape - Hot Applied.
      c. C205, Standard for Cement-Mortar Lining and Coating for Steel Water Pipe - 4 IN and Larger - Shop Applied.
      d. C206, Standard for Field Welding of Steel Water Pipe.
      e. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
      f. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
      g. C209, Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
      h. C210, Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

i. C213, Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
j. C606, Standard for Grooved and Shouldered Joints.
k. M11, Steel Pipe - A Guide for Design and Installation.

4. Society of Automotive Engineers (SAE):
   a. AMS-QQ-P-416, Cadmium Plating Electro deposited.

B. Qualifications:
1. Application of lining and coating materials including preparation of surfaces, priming, and lining and coating of pipe, fittings, and specials, in shop, repairs of any damage to lining or coating occurring during shipment or any other time, and field lining and coating of ends where linings or coatings have been held back for welded field joints, shall be done by established and recognized pipe company acceptable to Engineer.
2. Use only certified welders meeting procedures and performance outlined in ASME Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local building and utility requirements.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15060.
3. Factory test reports.
4. If mechanical grooved type coupling system is used, submit piping, fittings, and appurtenant items which will be utilized.
5. Coating manufacturer's qualifications.
6. Welders certificates.

B. Samples:

C. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Flanged adaptors:
   a. Rockwell (Style 913 (steel)).
   b. Dresser (Style 128 (steel)).
2. Insulating couplings:
   a. Rockwell (Style 416).
   b. Dresser (Style 39).
3. Reducing couplings:
   a. Rockwell (Style 415).
   b. Dresser (Style 62).
4. Transition coupling:
   a. Rockwell (Style 413).
   b. Dresser (Style 62).
5. Compression sleeve coupling:
   a. Rockwell (Style 411 (steel)).
   b. Dresser (Style 38 (steel)).

6. Mechanical couplings and fittings:
    a. Victaulic (Style 07 or 77).
    b. S.P. Fittings.
7. Vibration isolation equipment connections for natural gas:
    a. Flexonics (Model 401H).
8. Flexible connectors for hot water equipment:
    a. Flexonics (FLG Series).
    b. Thermo Tech (F/J/R Series).
9. Factory-applied plastic or epoxy coatings:
    a. "Encoat" Division of Energy Coating Company.
    b. "Scotchkote" Division of 3M Company.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. All materials used in steel piping systems defined in Section 15060 shall meet or exceed pressure test requirements specified for each respective system.

B. Steel Pipe (Fabricated Type):
1. AWWA C200:
    a. ASTM A36, Grade C steel plate.
    b. ASTM A283, Grade D steel plate.
    c. ASTM A572, steel plate.
    d. ASTM A1011, steel sheet.

C. Steel Pipe (Mill Type): ASTM A53, Type E or S.

D. Fittings (For Fabricated Pipe): AWWA C208.

E. Fittings (For Mill Type Pipe):
1. ASTM A234.
2. ASME B16.3, ASME B16.5, ASME B16.9, ASME B16.11.

F. Flanges (Fabricated Pipe):
1. Flange material: ASTM A283, Grade C or D, ASTM A181, Grade 1.
2. Flange finish: Flat faced.

G. Flanges (Mill Type Pipe):
1. ASME B16.5.
2. Flat faced.
3. Slip-on flanges.

H. Nuts and Bolts:
1. Buried: Cadmium-plated meeting SAE AMS-QQ-P-416, Type 1, Class 2 (Cor-Ten) for buried application.
2. Exposed: Mechanical galvanized ASTM B695, Class 40.
3. Heads and dimensions per ASME B1.1.
4. Threaded per ASME B1.1.
5. Project ends 1/4 to 1/2 IN beyond nuts.

I. Gaskets: See individual piping systems in Section 15060.

2.3 MANUFACTURED UNITS

A. Couplings:
1. Flanged adaptors:
    a. Steel or carbon steel body sleeve, flange, followers and Grade 30 rubber gaskets.
    b. Provide units specified in Article 2.1.
    c. Flanges meeting standards of adjoining flanges.

d. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.

2. Compression sleeve coupling:
   a. Steel sleeve, followers Grade 30 and rubber gaskets.
   b. Provide units specified in Article 2.1.
   c. Flanges meeting standards of adjoining flanges.
   d. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.
   e. Provide field coating for buried couplings per AWWA C203.
3. Mechanical coupling joint:
   a. Use of mechanical grooved (AWWA C606) type couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 15060.
   b. Utilize units defined in Article 2.1.

2.4 ACCESSORIES

A. Heating Water Application:
   1. For steel heating lines, provide braided, flanged stainless steel connectors for connection to equipment.
   2. Provide pump connectors with stainless steel construction, rubber filled bellows and flanged end connections.

B. Natural Gas Equipment Isolator: 316L stainless steel, T-321 stainless steel braid with connections compatible with joints in piping system.

2.5 FABRICATION

A. Provide piping (mill or fabricated) for use in this Project with minimum wall thicknesses as follows:
   1. 1/8 - 5 IN DIA pipe: Schedule 40.
   2. 6 - 10 IN DIA pipe: 3/16 IN.
   3. 12 - 14 IN DIA pipe: 7/32 IN.
   4. 16 - 48 IN DIA pipe: 1/4 IN.
   5. 54 - 60 IN DIA pipe: 5/16 IN.
   6. 66 - 72 IN DIA pipe: 3/8 IN.
   7. Sizes through 24 IN are nominal OD.
      a. Sizes greater than 24 are ID.
   8. Wall thicknesses indicated are for standard weight pipe.
      a. Design pipe in accordance with operating pressures shown in Piping Schedules for a design stress limited to 50 percent of yield.

B. Furnish cast parts with lacquer finish compatible with finish coating.

C. Furnish without outside coating of bituminous material any exposed pipe scheduled to be painted.

D. Fabricated Fittings:
   1. AWWA C208.
   2. Assure ratio of radius of bend to diameter of pipe equal to or greater than 1.0.

E. Taper cement mortar linings as required for valve interfacing.

F. Protective Coatings and Linings:

G. Pipe Linings:
   1. Fusion bonded epoxy (pipe 27 IN and larger) in accordance with AWWA C213.
   2. Galvanizing in accordance with ASTM B6.

H. Pipe Coatings:
   1. Fusion-bonded epoxy in accordance with AWWA C213.
   2. Galvanizing in accordance with ASTM B6.

3. Provide enamel linings and coatings in accordance with AWWA C203 and the following:
   a. Potable water: Provide minimum dry film of 5 mils of asphaltic coating non-toxic blend of Gilsonite and brown and steam distilled asphalt.
   b. Nonpotable fluids: Provide minimum dry film of 5 mils of acceptable asphalt base material.
   c. Provide coating in accordance with AWWA C203 and subject to following additional requirements.
      1) Do not use enamel lined or coated steel pipe exposed to temperatures below 10 DegF.
      2) Do not handle enamel-lined or coated pipe when temperature of pipe is below 20 DegF.
4. Galvanize surface in accordance with hot-dip method using any grade of zinc acceptable to ASTM B6.
5. Field paint pipe in accordance with Section 09905.

2.6 SOURCE QUALITY CONTROL

A. Testing:
   1. Shop hydrostatic test fabricated steel pipe and fittings.
   2. Field hydrostatic test all pipe as specified in Section 15060.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Joining Methods - Flanges:
   1. Facing method:
      a. Insert slip-on flange on pipe.
      b. Assure maximum tolerances for flange faces from normal with respect to axis of pipe is 0.005 IN per foot of flange diameter.
      c. Test flanges after welding to pipe for true to face condition and reface, if necessary, to bring to specified tolerance.
   2. Joining method:
      a. Leave 1/8 to 3/8 IN of flange bolts projecting beyond face of nut after tightening.
      b. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, equipment, tank, and other interconnecting piping systems.
      c. When bolting flange joints, exercise extreme care to assure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or cause unnecessary stress, bending or torsional strains being applied to cast flanges or flanged fittings.
         1) Allow one (1) flange free movement in any direction while bolts are being tightened.
      d. Do not assemble adjoining flexible coupled, mechanical coupled or welded joints until flanged joints in piping system have been tightened.
      e. Gradually tighten flange bolts uniformly to permit even gasket compression.
      f. Do not overstress bolts to compensate for poor installation.

C. Joining Method - Welded Joints:
   1. Perform welding in accordance with AWWA C206 and this Section.
   2. For flange attachment perform in accordance with AWWA C207.
   3. Have each welding operator affix an assigned symbol to all his welds.
      a. Mark each longitudinal joint at the extent of each operator's welding.
      b. Mark each circumferential joint, nozzle, or other weld into places 180 degrees apart.
   4. Welding for all process piping shall conform to ASME B31.3.
      a. Welding of utility piping 125 psi and less shall be welded per ASME B31.9.

b. Utility piping above 125 psi shall conform to ASME B31.1.

5. Provide caps, tees, elbows, reducers, etc., manufactured for welded applications.
6. Weldolets may be used for 5 IN and larger pipe provided all slag is removed from inside the pipe.
7. Weld-in nozzles may be used for branch connections to mains and where approved by Engineer.
8. Use all long radius welding elbows for expansion loops and bends.
9. Use long radius reducing welding elbows 90 degree bends and size changes are required.

D. Joining Method - Couplings:

1. Compression sleeve:
   a. Install coupling to allow space of not less than 1/4 IN but not more than 1 IN.
   b. Provide harnessed joint.
      1) Use joint harness arrangements detailed in AWWA M11.
   c. Design harness assembly with adequate number of tie rods for test pressures indicated in Section 15060 and allow for expansion of pipe.
   d. Provide ends to be joined or fitted with compression sleeve couplings of the plain end type.
   e. Grind smooth welds the length of one (1) coupling on either side of joint to be fitted with any coupling.
   f. Assure that outside diameter and out-of-round tolerances are within limits required by coupling manufacturer.
2. Mechanical coupling:
   a. Arrange piping so that pipe ends are in full contact.
   b. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
   c. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

E. Joining Method - Threaded and Coupled (T/C):

1. Provide T/C end conditions that meet ASME B1.2 requirements.
2. Furnish pipe with factory-made T/C ends.
3. Field cut additional threads full and clean with sharp dies.
4. Leave not more than three (3) pipe threads exposed at each branch connection.
5. Ream ends of pipe after threading and before assembly to remove burrs.
6. Use Teflon thread tape on male thread in mating joints.

F. Support exposed piping in accordance with Section 15060.

G. Install buried piping per Section 15060.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 15060.

END OF SECTION

SECTION 15062
PIPE: DUCTILE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile iron piping, fittings, and appurtenances.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. ASTM International (ASTM):
      a. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   3. American Water Works Association (AWWA):
      a. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
      b. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C105/A21.5, Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
      b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
      c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
      e. C150/A21.50, Standard for Thickness Design of Ductile-Iron Pipe.
      f. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
   5. Society of Automotive Engineers (SAE):
      a. AMS-QQ-P-416, Cadmium Plating - Electro-deposited.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15060.
   3. Certification of factory hydrostatic testing.
   4. If mechanical coupling system is used, submit piping, fittings, and appurtenant items which will be utilized to meet system requirements.

B. Samples:

C. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Flanged adaptors:
      a. Rockwell (Style 913 (steel)).
      b. Dresser (Style 128 (steel)).
   2. Compression sleeve coupling:
      a. Rockwell (Style 411 (steel)).
      b. Dresser (Style 38 (steel)).
   3. Mechanical coupling:
      a. Victaulic (Style 31).
      b. Tyler.
   4. Glass lining:
      a. Ceramic Coating (Non-Stick Glass Lining).
      b. Permutit (SG-14 Glass Lining).
   5. Insulating couplings:
      a. Rockwell (Style 416).
      b. Dresser (Style 39).
   6. Reducing couplings:
      a. Rockwell (Style 415).
      b. Dresser (Style 62).
   7. Transition coupling:
      a. Rockwell (Style 413).
      b. Dresser (Style 62).
   8. Polyethylene encasement tape:
      a. Chase (Chasekote 750).
      b. Kendall (Polyken 900).
      c. 3 M (Scotchrap 50).
   9. Restrained joints:
      a. American (Lock Fast) - 12 IN and below.
      b. U.S. Pipe (TR-Flex) - 4 IN to 54 IN.
      c. American (Lock Fast) - Above 12 IN.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Ductile Iron Pipe:
   1. AWWA/ANSI C115/A21.15.
   2. AWWA/ANSI C150/A21.50.
   3. AWWA/ANSI C151/A21.51.

B. Fittings and Flanges:
   1. AWWA/ANSI C110/A21.10.
   2. AWWA/ANSI C115/A21.15.
   3. Flanges drilled and faced per ASME B16.1 for both 125 and 250 psi applications.

C. Nuts and Bolts:
   1. Buried: Cadmium-plated meeting SAE AMS-QQ-P-416, Type 1, Class 2 (Cor-Ten) for buried application.
   2. Exposed: Mechanical galvanized ASTM B695, Class 40.
   3. Heads and dimensions per ASME B1.1.
   4. Threaded per ASME B1.1.
   5. Project ends 1/4 to 1/2 IN beyond nuts.

D. Gaskets: See individual piping system requirements in Section 15060.

E. If mechanical coupling system is used, utilize pipe thickness and grade in accordance with AWWA C606.

F. Polyethylene Encasement: See AWWA/ANSI C105/A21.5.

G. See Piping Schedules in Section 15060.

2.3 MANUFACTURED UNITS

A. Couplings:
   1. Flanged adaptors:
      a. Unit consisting of steel or carbon steel body sleeve, flange, followers, Grade 30 rubber gaskets.
      b. Provide units specified in the ACCEPTABLE MANUFACTURERS Article.
      c. Supply flanges meeting standards of adjoining flanges.
      d. The working pressure rating of the entire assembly shall be greater than or equal to the test pressure specified on piping schedule for each respective piping application.
   2. Compression sleeve coupling:
      a. Unit consisting of steel sleeve, followers, Grade 30 rubber gaskets.
      b. Provide units specified in the ACCEPTABLE MANUFACTURERS Article.
      c. Supply flanges meeting standards of adjoining flanges.
      d. The working pressure rating of the entire assembly shall be greater than or equal to the test pressure specified on piping schedule for each respective piping application.
      e. Provide field coating for buried couplings per AWWA C203.
   3. Mechanical couplings:
      a. Use of mechanical couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 15060.
      b. Utilize units defined in the ACCEPTABLE MANUFACTURERS Article.

2.4 FABRICATION

A. Furnish and install without outside coatings of bituminous material any exposed pipe scheduled to be painted.

B. Furnish cast parts with lacquer finish compatible with finish coat.

C. Glass Lining:
   1. Minimum two-coat process.
      a. Base coat heated to solidly fuse glass to pipe surface.
      b. Subsequent coat(s) heated to form integral bond with preceding coat.
   2. Final finish parameters:
      a. Thickness: 8-12 mils.
      b. Hardness: Above 5 on MOHS scale.
      c. Density: 2.5-3.0 grams per cubic centimeter.
      d. Metal to lining bonding: Capable of withstanding strain of 0.0001 IN/IN without damage to lining.
   3. Complete compatibility between fittings and piping.

2.5 LININGS AND COATINGS

A. Where specified in piping schedule, provide linings to a minimum thickness of 40 mils.
   1. Glass lining.

2.6 SOURCE QUALITY CONTROL

A. Factory Test:
   1. Subject pipe to hydrostatic test of not less than 500 psi with the pipe under the full test pressure for at least 10 seconds.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Joining Method - Push-On Mechanical (Gland-Type) Joints:
   1. Install in accordance with AWWA/ANSI C111/A21.11.
   2. Assemble mechanical joints carefully according to manufacturer's recommendations.
   3. If effective sealing is not obtained, disassemble, thoroughly clean, and reassemble the joint.
   4. Do not overstress bolts.
   5. Where piping utilizes mechanical joints with tie rods, align joint holes to permit installation of harness bolts.

B. Joining Method - Push-On Joints:
   1. Install in accordance with AWWA/ANSI C151/A21.51.
   2. Assemble push-on joints in accordance with manufacturer's directions.
   3. Bevel and lubricate spigot end of pipe to facilitate assembly without damage to gasket.
      a. Use lubricant that is non-toxic, does not support the growth of bacteria, has no deteriorating effects on the gasket material, and imparts no taste or odor to water in pipe.
   4. Assure the gasket groove is thoroughly clean.
   5. For cold weather installation, warm gasket prior to placement in bell.
   6. Taper of bevel shall be approximately 30 degrees with centerline of pipe and approximately 1/4 IN back.

C. Joining Method - Flanged Joints:
   1. Install in accordance with AWWA/ANSI C115/A21.15.
   2. Extend pipe completely through screwed-on flanged and machine flange face and pipe in single operation.
   3. Make flange faces flat and perpendicular to pipe centerline.
   4. When bolting flange joints, exercise extreme care to ensure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress, bending or torsional strains to be applied to cast flanges or flanged fittings.
   5. Allow one (1) flange free movement in any direction while bolts are being tightened.
   6. Do not assemble adjoining flexible joints until flanged joints in piping system have been tightened.
   7. Gradually tighten flange bolts uniformly to permit even gasket compression.

D. Joining Method - Mechanical Coupling Joint:
   1. Arrange piping so that pipe ends are in full contact.
   2. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
   3. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

E. Flange Adaptors 12 IN and Less:
   1. Locate and drill holes for anchor studs after pipe is in place and bolted tight.
   2. Drill holes not more than 1/8 IN larger than diameter of stud projection.

F. Cutting:
   1. Do not damage interior lining material during cutting.
   2. Use abrasive wheel cutters or saws.
   3. Make square cuts.
   4. Bevel and free cut ends of sharp edges after cutting.

G. Support exposed pipe in accordance with Section 15060.

H. Install buried piping in accordance with Section 15060.

I. Install restrained joint systems where specified in Section 15060 under specific piping system.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 15060.

END OF SECTION

SECTION 15063
PIPE: COPPER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Copper piping, fittings, and appurtenances.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
      b. B16.23, Cast Bronze Solder Joint Drainage Fittings - DWV.
      c. B16.26, Cast Bronze Alloy Fittings for Flared Copper Tubes.
   2. ASTM International (ASTM):
      a. B32, Standard Specification for Solder Metal.
      b. B42, Standard Specification for Seamless Copper Pipe, Standard Sizes.
      c. B88, Standard Specification for Seamless Copper Water Tube.
      d. B306, Standard Specification for Copper Drainage Tube (DWV).
   3. American Welding Society (AWS):
      a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.

1.3 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. See Specification Section 15060.

C. Samples:

D. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.4 MATERIALS

A. Copper Tubing:
   1. Pressure non-buried: ASTM B88, Type L hard.
   2. Pressure buried: ASTM B88, Type K.
   3. Non-pressure: ASTM B306.

B. Copper Pipe: ASTM B42, regular strength.

C. Fittings:
   1. Pressure non-buried: ASME B16.22.
   2. Pressure buried: ASME B16.22 or ASME B16.26.
   3. Non-pressure: ASME B16.23

D. Soldering and Brazing:
   1. Non-buried:
      a. ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux up to 180 DegF water temperature.

b. At 180 DegF and above, use brazing alloy with melting temperature above 1000 DegF and suitable flux.

2. Buried: Silver solder per AWS A5.8M/A5.8.

E. See Piping Schedules in Specification Section 15060.

F. Unions:
1. Pipe sizes 2 IN and smaller: Copper, ground joint.
2. Pipe sizes 2-1/2 IN and larger: Brass flanged unions.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Comply with Specification Section 15060.

2.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Specification Section 15060.

B. Utilize only annealed (soft) type tubing where flared joints are used and drawn temper (hard) type tubing where soldered or brazed joints are used.

C. Support exposed piping in accordance with Specification Section 15060 and Specification Section 15090.

D. Install buried piping in accordance with Specification Section 02221 and Specification Section 15060.

END OF SECTION

SECTION 15064
PIPE: PLASTIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic pipe.

1.2 QUALITY ASSURANCE

A. See Specification Section 15060.

B. Referenced Standards:
   1. ASTM International (ASTM):
      a. PVC (polyvinyl chloride) materials:
         1) D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
         2) D1785, Standard Specification for Poly(Vinyl Chloride) PVC Plastic Pipe, Schedules 40, 80 and 120.
         3) D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
         4) D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
         5) D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
         6) D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
         7) F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
         8) F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
         9) F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
         10) F949, Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.
      b. Installation:
         1) D2321, Standard Practice for Underground Installation of Thermosplastic Pipe for Sewers and Other Gravity-Flow Applications.
   2. American Water Works Association (AWWA):
      a. PVC (polyvinyl chloride) materials:
         1) C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 IN Through 12 IN, for Water Distribution.
         2) C905, Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 IN through 48 IN, for Water Transmission and Distribution.
      b. Polyethylene (PE) materials:
         1) C901, Standard for Polyethylene (PE) Pressure Pipe and Tubing, 1/2 IN through 3 IN, for Water Service.
   3. NSF International (NSF).

1.3 SUBMITTALS

A. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

B. See Specification Section 15060.

PART 2 - PRODUCTS

2.1 PVC PRESSURE PIPING (EXPOSED)

A. General:
   1. Provide Schedule 80 pipe with Schedule 80 fittings and appurtenances to locations shown on Drawings.
   2. Furnish materials in full compliance to following material specifications:
      a. Manufacture pipe, fittings and appurtenances from polyvinyl chloride (PVC) compound which meets the requirements of Type 1, Grade 1 (12454-B) Polyvinyl Chloride as outlined in ASTM D1784.
      b. Manufacture pipe, fittings and valves from materials that have been tested and approved for conveying potable water by the NSF.

B. Pipe:
   1. Furnish pipe meeting requirements of ASTM D1785.
   2. Pipe 2 IN and less to be solvent welded.
   3. Pipe larger than 2 IN may be either flanged or solvent welded unless shown otherwise on Drawings.

C. Fittings: Provide ASTM D2467 PVC socket type fittings having the same pressure and temperature rating as the pipe.

D. Flanges/Unions:
   1. Furnish flanges and unions at locations shown on Drawings.
   2. Provide either flanges or unions at valves, penetrations through structures and equipment connections.
   3. For pipe larger than 2 IN, provide 150 LB socket type PVC flange.
   4. For pipe 2 IN and less, provide socket type PVC union with Buna O-rings.
   5. Use flat, full faced natural rubber gaskets at flanged connections.
      a. Furnish heavy hex head bolts, each with one (1) heavy hex nut, ASTM F593 Type 316 stainless steel.
   6. Use spacers supplied by pipe manufacturer when mating raised-faced flanges to other flanges.

E. Installation:
   1. Field threading PVC will not be permitted.
      a. Perform required threaded connections or attachments by the use of factory molded socket by threaded adapters.
      b. Female adapters are not acceptable.
   2. Employ installation and pipe support practices and solvent welding all in compliance to the manufacturer's printed recommendation.
      a. Continuously support PVC piping at liquid operating temperatures in excess of 100 DegF.
      b. For vertical piping, band the pipe at intervals to rigidly support load of twice vertical load.
      c. Support riser clamps on spring hangers.
      d. Do not clamp PVC tightly or restrict movement for expansion and contraction.

2.2 PRESSURE PIPING (UNDERGROUND)

A. Materials: Furnish materials in full compliance with following requirements:
   1. 1/2-3 IN: AWWA C901 PE with Pressure Class of 200 psi per Table A3, AWWA C901.
   2. 4-12 IN: AWWA C900 PVC with Pressure Class of 200 psi per Table 2, AWWA C900.
   3. Joints for PVC pipe shall be the elastomeric-gasket type with a pressure rating not less than pipe pressure rating meeting performance requirements of ASTM D3139.

B. Installation:
   1. Field threading of PVC pipe will not be permitted.

2. Perform installation procedures, handling, thrust blocking, connections, and other appurtenant operations in full compliance to the manufacturer's printed recommendations and in full observance to plan details when more stringent.

2.3 PVC TUBING

A. General: Provide nylon tubing with fittings and appurtenances as shown on Drawings.

B. Materials:
1. Furnish clear outer braided tubing with braid outside the walls.
2. Have tubing manufactured of nylon with working temperatures from 5 to 180 DegF.
3. Design tubing with a minimum safety factor of 4 to 1 ratio of burst pressure to working pressure at maximum temperature.
4. Provide tubing with working pressure of 75 psi at 180 DegF.
5. Ensure that tubing is self-extinguishing and fire resistant.

C. Fittings:
1. Install tubing with nylon fittings and connectors.
2. Use barbed type adapters with stainless steel clamps.
3. Provide fittings capable of withstanding temperatures from a -70 to 250 DegF.
4. Ensure fittings have the same pressure and temperature rating as the tubing.

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Identify each length of pipe clearly at intervals of 5 FT or less.
1. Include manufacturer's name and trademark.
2. Nominal size of pipe, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications and NSF approvals when applicable.

3.2 PRESSURE PIPING (UNDERGROUND)

A. Installation:
1. Field threading of PVC pipe will not be permitted.
2. Perform installation procedures, handling, thrust blocking, connections, and other appurtenant operations in full compliance to the manufacturer's printed recommendations and in full observance to plan details when more stringent.

3.3 PVC TUBING

A. Fittings:
1. Install tubing with nylon fittings and connectors.
2. Use barbed type adapters with stainless steel clamps.
3. Provide fittings capable of withstanding temperatures from a -70 to 250 DegF.
4. Ensure fittings have the same pressure and temperature rating as the tubing.

END OF SECTION

SECTION 15065
DOUBLE CONTAINMENT PIPING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Prefabricated double containment piping systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15060 - Pipe and Pipe Fittings: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.3, Process Piping.
   2. ASTM International (ASTM):
      a. A53, Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      c. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
      d. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      e. D2467, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
      f. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
      g. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
      h. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
      i. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
      j. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

B. Qualifications:
   1. Installer shall be certified by piping system manufacturer.

1.3 DEFINITIONS

A. CPVC: Chlorinated Polyvinyl Chloride.

B. PVC: Polyvinyl Chloride.

1.4 SYSTEM DESCRIPTION

A. Each contained piping system shall consist of primary piping system supported within a secondary containment housing.
   1. Each system shall be provided with suitable drains and vents and be designed to provide for expansion and contraction and complete drainage of both the primary and secondary containment piping.

2. Interstitial supporting devices shall be made from polypropylene supports and shall be provided within the secondary containment pipe, and designed to allow continuous drainage in the annular space to the drain points.
3. Interstitial supports shall be integrally bonded to the primary piping.

1.5 SUBMITTALS

A. Shop Drawings:
1. See Specification section 01340 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 15060.
   a. Include details of pipe fabrications (including supporting devices, method of attachment, spacing, etc.), pre-fabricated double-containment fitting dimensions, starting and terminating connections, high point vent and low point drain details for the secondary containment, valves and accessories.
   b. Submit joint details, methods and location of supports and all other pertinent technical data for all piping to be furnished.
3. Installer certification.
4. Field quality control documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Georg Rischer.
2. ISCO Industries.
3. Rovanco Permapipe.
4. Tricon.
5. ASAHI/America.
6. Or equal.

2.2 MATERIALS

A. Sodium Hypochlorite, Sodium Bisulfite and Ferric Chloride Piping System:
1. Primary and secondary piping:
   a. Piping:
      1) PVC, ASTM D1784.
      2) Schedule 80, ASTM D1785.
   b. Fittings:
      1) PVC, ASTM D1784.
      2) Schedule 80, ASTM D2467.
2. Joints: Solvent welded, ASTM D2564 and ASTM D2855.

2.3 FABRICATION

A. Hydrostatically design in accordance with ASTM D2837.

B. Pre-assemble and pre-test all fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. The manufacturer shall furnish the services of a competent representative to instruct the Contractor's personnel prior to or during the start of installation.

C. Solvent-cement PVC piping joints using heavy body-slow set cement.

D. The splitting and rewelding of contaminant pipe fittings shall not be permitted.

3.2 FIELD QUALITY CONTROL

A. Following installation of the systems, flush clean the primary piping system.
   1. Contractor shall check the operation of all valves and appurtenances.

B. Pressure test the primary piping system at 150 percent of the system design pressure for a period of 1 HR.

C. Pneumatically test the secondary containment piping system at a minimum duration of 2-1/2 HRS.
   1. Soap the external joints and visually inspected for leaks.
   2. Ensure that overpressurization beyond 10 psi cannot occur.
   3. Take precautions to protect against the hazards of a possible brittle fracture under compressed gas.
   4. Tests shall be done in strict accordance with the recommendations of the manufacturer.

END OF SECTION

SECTION 15067

PIPE: STAINLESS STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Stainless steel pipe, fittings, and appurtenances.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
      b. B16.11, Forged Fittings, Socket-Welding and Threaded.
      c. B31.1, Power Piping.
      d. B36.19M Stainless Steel Pipe.
   2. American Society of Mechanical Engineers (ASME):
      a. Section IX, Boiler Pressure Vessel Code; Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operations.
   3. ASTM International (ASTM):
      a. A182/A182M, Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      b. A193/A193M, Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
      c. A194/A194M, Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
      d. A240/A240M, Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
      e. A276, Stainless Steel Bars and Shapes.
      f. A312/A312M, Seamless and Welded Austenitic Stainless Steel Pipes.
      g. A320/A320M, Alloy Steel Bolting Materials for Low-Temperature Service for Pressure and High-Temperature Parts.
      h. A403/A403M, Wrought Austenitic Stainless Steel Piping Fittings.
      i. A409/A409M, Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
      j. A480/A480M, General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      k. A774/A774M, As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
      l. A778, Welded, Unannealed Austenitic Stainless Steel Tubular Products.

B. Qualifications:
   1. Provide shop fabricated stainless steel pipe and fittings from a single manufacturer who is experienced and qualified in the manufacture and fabrication of these specified items. Shop-fabricate and field-install pipe and fittings in accordance with common industry-wide practices and methods, and with these specifications.
   2. Use only certified welders meeting procedures and performance outlined in ASME Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local building and utility requirements.

C. Testing:
   1. Comply with ASTM A312, ASTM A409 HT-0, or ASTM A778, depending on the size and type of stainless steel pipe provided.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Section 15060.
   3. Factory test reports.
   4. If mechanical grooved type coupling system is used, submit piping, fittings, and appurtenant items which will be utilized.
   5. Welders certificates.
   6. Shop fabrication drawings showing details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.
   7. Other data necessary to show conformance of the complete piping system to these specifications.

B. Certifications specified in the following documents:
   1. ASTM A403, Paragraph 14.1
   2. ASTM A774, Paragraph 14.1
   3. ASTM A778, Paragraph 14.1
   4. ASTM A409, Paragraph 17.1

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. Manufacture from ASTM A240 annealed and pickled sheets and plates.

B. Provide Type 316L per ASTM A778. Use only extra low carbon (ELC) materials with 0.03 percent maximum carbon.

C. Manufacture to nominal pipe sizes listed in ANSI B36.19, Table 2.

D. Minimum Wall Thickness. See Section 15060.

E. All materials used in stainless steel piping systems defined in Section 15060 shall meet or exceed pressure test requirements specified for each respective system.

2.2 FITTINGS MATERIALS

A. Manufacture per ASTM A774 of the same material, class, pressure rating, and in at least the same thicknesses as the pipe.

B. Provide “smooth flow” design for long radius elbows up to 24 IN in diameter. Beyond 24 IN diameter, use mitered construction.

C. Reducers: Straight tapered, cone type.

D. Shop-fabricate tees, crosses, laterals, and wyes from pipe.

2.3 CONNECTIONS

A. Flanged:
   1. Unless otherwise specified, use stainless steel slip-on type rolled-angle face rings and 5/8 IN stainless steel backup flanges drilled to ANSI 16.1, Class 125 standard.
   2. Make the angle face ring thickness equal to or greater than the wall of the pipe or fitting to which it is welded.
   3. Continuously weld both sides of flange to the pipe or fitting.
   4. Angle leg: Do not interfere with the flange bolt holes.

B. Taper Threads
   Comply with ANSI B1.20.1 with joint compound or tape suitable for temperatures of 225 DegF.

C. Threaded Pipe, Gage, or Instrument Connections:

1. Use stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276.
2. Shop weld to the pipe at the locations specified.

D. Gaskets:
1. Material:
   a. For LPA service: Viton, suitable for 250 DegF.
   b. Other service: Neoprene.
2. Gaskets for flanged joints: 1/16-IN thick (1/8-IN thick for pipes 12-IN and larger). Provide one piece, full face, gaskets with holes to pass bolts.

E. Nuts, Bolts, and Washers:
1. For exposed outdoor flanges couplings, and fittings, use Type 316 stainless steel.
2. For buried flanges, joints, and fittings, use Type 316 stainless steel.

2.4 COUPLINGS

A. General:
1. Where pipe couplings are specified, shop-prepare the piping for couplings.
2. Unless otherwise specified, use arched-band or grooved type couplings.
3. Gaskets and Seals:
   a. For AA service, suitable for air service temperature of 250 DegF.
   b. ML service: Neoprene.

B. Sleeve Type:
1. Use stainless steel of the same material as the pipe.
2. Use plain-end pipe with external weld beads ground smooth to ensure proper gasket seating.
3. For pressure pipelines, restrain sleeve coupling joints by the use of harness rods connecting across the joint to flange lugs on adjacent flange joints. Where no adjacent flange joints exist, weld stainless steel harness lugs to the pipe to receive the stainless steel harness rods.
4. Sleeve coupling shall be Dresser Style 38 stainless couplings, or equal.

C. Arched-Band Type:
1. Use stainless steel of the same material and wall thickness as the pipe.
2. Manufacturer: Depend-O-Lok type as manufactured by Brico or equal.
3. Use Fixed – FxF, Expansion – ExE, or Fixed by Expansion – FxE as specified or as required.
4. Use plain-end pipe with external weld beads ground smooth and with stainless steel restraining rings shop-welded to the piping for fixed type couplings.

D. Grooved-End Type:
1. Manufacturer: Victaulic Style 77S (stainless steel of same material as the pipe) or equal.
2. Use roll-grooved pipe ends prepared to the coupling manufacturer's specifications.
3. Where roll grooving is impractical, use heavy-wall machine-grooved pipe nipples or machined ring collars fully welded to the pipe or fitting.
4. Taper-bore nipples to the ID of the adjoining pipe to allow full-weld penetration.
5. Weld collars on both sides to the piping.
6. Use nipples and collars of the same alloy as the piping.
7. Where specifically noted on the drawings, Provide rigid grooved-end couplings, Victaulic Style 07 or equal.

E. Expansion Type:
1. Provide flanged rubber arch type, constructed of EPDM with ductile iron retaining rings.
2. Provide retaining rings with baked enamel finish.
3. Drill to connect to the pipe flanges.
4. Include hypalon coating for UV protection.
5. Style: four-arch minimum, capable of a minimum 5 IN of axial extension and minimum of 6 IN axial compression.
6. Install per manufacturer's recommendations to ensure full range of movement is available.

7. Manufacturer: Mercer Style HT504 series rated for 250 DegF minimum or equal.

2.5 FACTORY OR SHOP WELDING

A. General:
1. Weld piping with wall thickness up to 11-gauge (0.120 IN) with the TIG (GTAW) process.
2. Unless otherwise specified, properly beveled heavier-walled piping and weld a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process.
3. Use only filler wire of ELC grades to add to all welds. Provide a cross section at the weld equal to or greater than the parent metal.
4. Produce a smooth and evenly distributed weld deposit with a crown of no more than 1/16 IN on the ID and 3/32” on the OD of the piping.
5. Concavity, undercut, cracks, or crevices are not acceptable.
6. For butt welds, achieve full penetration to the interior surface. Provide inert gas shielding to the interior and exterior of the joint.
7. Remove excessive weld deposits, slag, spatter, and projections by grinding.
8. Grind smooth welds on gasket surfaces shall be ground smooth.

B. Preparation of Surfaces to be Welded:
1. Remove mill scale, slag, grease, oil, paint, rust, and other foreign material.
2. Wire-brush with stainless steel wire brushes and precisely fitted before welding.

C. Weather Conditions:
1. Weld only when the surfaces are completely free of any moisture.
2. Do not weld pipe during periods of high winds or rain unless the areas being welded are properly shielded.

D. Tack Welds, Clips, and Other Attachments:
1. Repair nicks, gouges, notches, and depressions in the base metal in the area of the joint before the joint weld is made.
2. Remove tack welds, clips, and other attachments and repair defects. Exception: Tack welds which occur within the weld area and do not exceed the size of the completed weld need not be removed.
3. Remove all cracked tack welds.
4. Grind defective areas to clean metal and then build up with weld metal. Grind smooth the repaired areas to form a plane surface with the base metal.

E. Defects and Repairs:
1. Remove welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient by chipping or grinding throughout their depth to clean base metal.
2. Do not caulk or peen welds to correct defects.
3. Correct welds deficient in dimension but not in quality by enlarging with additional welding. Before welding thoroughly clean the surface of previously deposited metal and the adjoining plate.
4. Remove by grinding weld deposits, slag, weld spatter, and projections into the interior of the pipe.

2.6 FINISH

A. After all shop operations have been completed, pickle and passivate pipe and fittings in manufacturer’s plant.

B. Next, scrub and wash until discoloration and possible iron picked up from manufacturing process are removed.

C. Standard Finish:
1. For 16-gauge through 8-gauge material: No. 1 or 2B per ASTM A480.
2. For 3/16 IN and heavier plate material: No. 1 mill finish or better per ASTM A480.

2.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01600.

B. Additional Requirements:
   1. Mark all pipe, fittings, and fabrications properly with type, gage, and heat number.
   2. Plug all fabricated piping openings and secure flanges for storage and/or transport after fabrication.
      a. Piece-mark all fabricated piping with identifying numbers or codes, which correspond to the Contractor's layout and installation drawings.
      b. Locate marks on the spools at opposite ends and 180 degrees apart.
   3. Load, block, and lag pipe spools as necessary to ensure protection from damage during shipping.
   4. Store per manufacturer's recommendation.
   5. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

PART 3 - EXECUTION

3.1 PIPE CUTTING, THREADING, AND JOINTING

A. Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

3.2 FIELD WELDING

A. No field welding of stainless steel pipe is permitted unless specifically noted on the Drawings.

3.3 FABRICATION/INSTALLATION REQUIREMENTS

A. During manufacturing, fabricating, handling, and installation stages, prevent contact of any ferrous materials with the stainless steel piping.
   1. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls Use stainless steel saws, drills, files, wire brushes, etc. dedicated for use on stainless steel piping only.
   2. Use pipe storage and fabrication racks which are nonferrous, stainless steel, or rubber-lined.
   3. Use nylon slings or straps for handling stainless steel piping.

B. After installation, wash and rinse all foreign matter from the piping surface.
   1. Treat all welded joints with a pickling solution, brush with stainless steel wire brushes and rinse clean.
   2. If rusting of embedded iron occurs, pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes, and rinse clean.
   3. Remove identifying spool piece marks with paint thinner or solvents.
   4. Wash the entire stainless steel surface with detergent and hot water and rinse clean.

3.4 COATINGS

A. Painting of exposed stainless steel pipe is not required.

END OF SECTION

SECTION 15072
ASBESTOS CEMENT PIPE REMOVAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. This section includes the handling and disposal of existing asbestos cement pipe.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. AWWA
      a. AWWA C400 "Asbestos-Cement Transmission Pipe 6 in. through 16 in for Water and Other Liquids." This Standard has been withdrawn by AWWA, but shall apply to this Contract where referenced.
   2. California Code of Regulations, Title 8, Section 1529, Asbestos.

B. Certification
   1. Removal of ACP pipe shall be performed by a contractor registered by Cal/OSHA and certified by the Contractor's State Licensing Board for asbestos removal.

1.3 HEALTH HAZARD

A. The contractor is warned that asbestos is a known human carcinogen when inhaled and poses serious health risks. Asbestos fibers are easily inhaled and can result in chronic respiratory illness, cancer and other server health effects.

1.4 SUBMITTALS

A. Removal plan.

B. Disposal plan.

PART 2 - NOT USED

PART 3 - PART 3 - EXECUTION

3.1 GENERAL

A. Existing ACP shall be removed where indicated on the plans and as specified in this section to allow installation of the new pipe. Contractor shall minimize the amount of ACP to be removed to the extent possible.

B. Excavation operations should be carefully executed so that pipe damage does not occur prior to removal.

3.2 FRIABLE ASBESTOS MATERIALS

A. All friable asbestos-containing materials (material that can be crumbled, pulverized, or reduced to powder in hand) are regulated as a hazardous waste and must be transported by a licensed hazardous waste hauler and disposed of in an appropriate landfill. If Contractor identifies friable asbestos containing materials at the work site, Contractor shall immediately stop work in the affected area and notify the City's representative.

3.3 CUTTING, HANDLING, AND REMOVAL OF EXISTING ACP

A. The contractor shall be responsible for the proper identification and removal of all asbestos materials.

B. Pipe shall be removed in segments and kept as whole as possible.

C. The Contractor shall perform all cutting and handling of ACP in strict conformance with all applicable Cal/OSHA, EPA and governing health agency requirements. The Contractor shall provide sufficient supervision and monitoring to assure said conformance. The Contractor shall only use manual-cutting tools (snap cutter or hammer) to cut ACP. Powered tools shall not be used to cut ACP.

D. All pipe cutting operations require adequate wetting with potable water to prevent ACP materials from being crumbled by hand pressure and the asbestos fibers becoming airborne (friable).

E. Plan pipe cuts/breaks as necessary to accommodate the size/weight of pipe being removed.

F. The pipe should be cut in lengths not exceeding 60 inches. In no event shall the amount of asbestos-containing material (ACM) so disturbed exceed that which can be contained in one waste bag which shall not exceed 60 inches in length and width.

G. Where pipe re-connection is required, wet, wrap and seal pipe ends in a minimum 6-mil polyethylene film wrap that is securely fastened and taped to close the pipe end after cutting. Wetting is required to prevent ACP fibers from becoming friable.

H. Removal of existing asbestos material shall be performed by a contractor registered by Cal/OSHA and certified by the Contractor's State Licensing Board for asbestos removal. Copies of the certification shall be submitted to the Construction Administrator prior to the commencement of any asbestos removal activities. The contractor or subcontractor shall comply with all State and Federal laws regarding handling and removal of asbestos materials.

I. Removed and "intact" pipe segments shall be wetted, wrapped and sealed in two layers of minimum 6-mil thick plastic sheeting or waste bags.

J. Labels:
   1. Labels shall be affixed to all products containing asbestos and to all containers containing such products, including waste containers.
   2. Labels shall be printed in large, bold letters on a contrasting background.
   3. Labels shall be used in accordance with the requirements of Section 5194 (f) of the General Industry Safety Orders, and shall contain the following information:

      DANGER CONTAINS ASBESTOS FIBERS AVOID CREATING DUST
      CANCER AND LUNG DISEASE HAZARD

3.4 DISPOSAL

A. The Contractor shall dispose of ACP in strict conformance with all applicable Cal/OSHA, EPA and governing health agency requirements. The Contractor shall provide sufficient supervision and monitoring to assure said conformance.

B. The Engineer will obtain the required EPA generator identification numbers, and will sign the hazardous waste manifests for disposal of friable asbestos containing material. The Contractor must dispose of friable and non-friable waste containing asbestos at a disposal facility permitted to accept such material and that meets all the requirements specified by Federal, State, and Local regulations. Notify the proper authorities at the disposal site in advance of delivery of asbestos containing material to the disposal site. Conduct additional sampling deemed necessary by the owner of the disposal facility for acceptance of the material at your expense.

END OF SECTION

SECTION 15090
PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe support and anchor systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping.
      b. B31.3, Process Piping.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A510, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
      c. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
      d. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   3. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
   4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. SP-69, Pipe Hangers and Supports - Selection and Application.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
      d. Scale drawings showing guides, hangers, supports, anchors, structural members and appurtenances to describe the pipe support system.

B. Samples:

C. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 MANUFACTURED UNITS

A. Hanger Rods:
   1. Material:
      a. ASTM A36.
      b. ASTM A575, Grade M1020.
      c. ASTM A576, Grade 1020.
      d. Minimum allowable tensile stress of 12,000 psi at 650 DegF per MSS SP-58.
   2. Continuously threaded.
   3. Electro-galvanized or cadmium plated after threads are cut.
   4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 IN DIA (min)	610
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,960

B. Hangers:
   1. Hangers for use directly on copper pipe: Copper or cadmium plated.
   2. Hangers for use other than directly on copper pipe: Cadmium plated or galvanized.
   3. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER TYPE
All except noted	4 IN and less	ANVIL Figure 108 with Figure 114
All except noted	Over 4 IN	ANVIL Figure 590
Steam, condensate and hot water	All	ANVIL Figure 181, Figure 82

C. Concrete Inserts for Hanger Rods:
   1. Continuous slots: Unistrut #P1000.
   2. Individual inserts: ANVIL Figure 281.
   3. Self-drilling expansion anchors: Phillips flush-end or snap-off end type.

D. Beam Clamps for Hanger Rods:
   1. Heavy duty.
   2. ANVIL Figure 133 or 134.

E. Trapeze Hangers for Suspended Piping:
   1. Material: Steel.
   2. Galvanized.
   3. Angles, channels, or other structural shapes.
   4. Curved roller surfaces at support point corresponding with type of hanger required.

F. Vertical Pipe Supports:
   1. At base of riser.
   2. Lateral movement:
      a. Clamps or brackets:
         1) ANVIL.

G. Expanding Pipe Supports:
   1. Spring hanger type.
   2. MSS SP-58.

H. Pipe Support Saddle:

1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
2. ANVIL Figure 264.

I. Pipe Support Risers:
1. Schedule 40 pipe.
2. 316 stainless steel for exterior installations.
3. As recommended by saddle manufacturer.

J. Pipe Support Base Plate:
1. 4 IN larger than support.
2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
4. Collar welded to floor plate.
5. Edges ground smooth.
6. Assembly hot-dipped galvanized after fabrication.

K. Pipe Covering Protection Saddle:
1. For insulated pipe at point of support.
2. ANVIL Figure 167, Type B.

L. Wall Brackets:
1. For pipe located near walls and 8 FT or more above floor elevation or as otherwise indicated on the Drawings.
2. ANVIL Figure 199.

M. Pipe Anchors:
1. For locations shown on the Drawings.
2. 1/4 IN steel plate construction.
3. Hot-dipped galvanized after fabrication.
4. Designed to prevent movement of pipe at point of attachment.

N. Seismic Restraints:
1. Galvanized steel aircraft cables or steel angles or channels.
2. Steel aircraft cables shall be prestretched to establish a certified minimum modulus of elasticity.
   a. Cable restraints shall be designed to resist seismic tension loads and steel restraints shall be designed to resist both tension and compression loads with a minimum safety factor of 2.
3. Restraint and connections shall be steel assemblies that swivel to the final installation angle.
4. Do not mix cable and steel angle restraints to brace the same system.
5. Steel angles shall be clamped to the threaded hanger rods at the seismic sway restraint locations utilizing a minimum of two (2) ductile iron clamps.
6. Transverse bracing shall be provided at 40 FT-0 IN maximum spacing unless noted otherwise.
7. Longitudinal bracing shall be provided at 80 FT-0 IN maximum spacing unless noted otherwise.
8. At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the center of gravity of the riser.
   a. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 30 FT-0 IN OC.

O. Pipe Guides:
1. For locations on both sides on each expansion joint or loop.
2. To ensure proper alignment of expanding or contracting pipe.
3. ANVIL Figure 256.

P. Sway Strut:
1. ANVIL Figure 640.

2.3 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.
   1. Provide 5 to 1 safety factor.

B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.3.
   2. MSS SP-58 and MSS SP-69.
   3. Except where modified by this Specification.

E. For steam and hot and cold water piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.1.
   2. MSS SP-58 and MSS SP-69.

F. Check all physical clearances between piping, support system and structure.
   1. Provide for vertical adjustment after erection.

G. Support vertical pipe runs in pipe chases at base of riser.
   1. Support pipes for lateral movement with clamps or brackets.

H. Place hangers on outside of pipe insulation.
   1. Use a pipe covering protection saddle for insulated pipe at support point.
   2. Insulated piping 1-1/2 IN and less: Provide a 9 IN length of 9 LB density fiberglass insulation at saddle.
   3. Insulated piping over 1-1/2 IN: Provide a 12 IN length of 9 LB density fiberglass insulation on saddle.

I. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.

J. Pipe Support Spacing:
   1. General:
      a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
      b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
      c. Provide at least one (1) support for each length of pipe at each change of direction and at each valve.
   2. Steel, stainless steel, cast-iron pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15
10 and greater	20

   3. Copper pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2-1/2 and less	5
3 thru 6	10
8 and greater	15

4. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

* Maximum fluid temperature of 120 DegF.

5. Support each length and every fitting:
   a. Bell and spigot piping:
      1) At least one (1) hanger.
      2) Applied at bell.
   b. Mechanical coupling joints:
      1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.
6. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.
7. Provide continuous support for nylon tubing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.

B. Seismic Restraints:
   1. Provide seismic restraints on all piping with the exception of the following:
      a. Piping less than 1 IN DIA when used for gas and compressed air.
      b. Piping less than 2-1/2 IN DIA for all other cases.
      c. Piping suspended by individual hangers where the distance from the top of the pipe to the bottom of the support for the hanger is 12 IN or less.
      d. These restraints shall be capable of resisting seismic loads as defined in the California Building Code (CBC latest edition.

C. Weld Supports:
   1. AWS D1.1.
   2. Weld anchors to pipe in accordance with ASME B31.3.

D. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

E. Inspect hangers for:
   1. Design offset.
   2. Adequacy of clearance for piping and supports in the hot and cold positions.
   3. Guides to permit movement without binding.
   4. Adequacy of anchors.

F. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

G. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
   1. Install concrete inserts as concrete forms are installed.

H. Welding:
   1. Welding rods: ASTM and AWS standards.
   2. Integral attachments:
      a. Include welded-on ears, shoes, plates and angle clips.
      b. Ensure material for integral attachments is of good weldable quality.
   3. Preheating, welding and postheat treating: ASME B31.3, Chapter V.

I. Field Painting:
   1. Comply with Specification Section 09905.

END OF SECTION

SECTION 15097
SEISMIC RESTRAINTS FOR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Seismic restraints for bracing all piping systems specified in Section 15060.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Institute of Steel Construction (AISC)
      a. Construction Manual of Steel Construction, 13th Edition
   2. U.S. Government Services Administration Federal Specification (FEDSPEC)
      a. FEDSPEC WW-H-171e Hangers and Supports, Pipe
   3. Manufacturers Standardization Society
      a. MSS SP-58 Pipe Hangers and Supports – Materials, Design and Manufacture
      b. MSS SP-69 Pipe Hangers and Supports – Selection and Application

1.3 DEFINATIONS

A. Longitudinal Direction: Parallel to the pipe axis.

B. Lateral Direction: Perpendicular to the pipe axis.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Restraint locations, load and anchorage calculations, and manufacturer's drawings as specified in Paragraph 3.1 as part of the submittals for equipment and piping coordination and installation drawings required in Section 15060.
      b. Provide seismic restraint and anchorage load calculations for each restrained pipe system prepared and signed by a civil or structural engineer currently registered in the State of California.
      c. Itemized list of wall sleeves, anchors, support devices, and all other items related to the pipe support system.
      d. Acknowledgement that products submitted meet the requirements of referenced standards.
      e. Submit written certification that:
         1) Equipment conforms to the requirements of Section 1.5 of this specification section.
         2) Written certification to be signed and sealed by a registered professional Civil or Structural Engineer registered in the State of California. Submit certification along with shop drawings.
      f. Structural calculations for the required force level for each component as required in Section 1.5 of this specification section.
         1) Provide summary of loads to each anchor.
         2) Structural calculations shall be signed and sealed by a registered professional Civil or Structural Engineer registered in the State of California. Calculations are required for all piping systems listed in Section 15060.
         3) Number calculation pages.
         4) Include equipment data sheets indicating weight and center of gravity for all pipe accessories.

1.5 REQUIREMENTS FOR BRACING AND ANCHORING

A. General: All pipe and their components and appurtenances, including their bracing, supports and anchorages, shall be designed for wind and seismic forces per the 2013 California Building code (CBC) as follows:
   1. Design for all applicable Load Combinations as defined in CBC Section 1605.2 or Section 1605.3.1 and Section 1605.4.
   2. Design all pipe subject to wind forces per ASCE 7-05 Chapter 6.
      a. Design bracing system for empty condition and wind forces.
      b. Wind Importance Factor $I_P = 1.15$
   3. Systems determined to be Nonstructural Components shall comply with all requirements of ASCE 7-05 Chapter 13.
      a. Indicate in submittal calculations Component Type used per ASCE 7-05 Chapter 13 Table 13.6-1.
      b. Seismic Importance Factor $I_P = 1.5$
      c. W_P = Operating Weight of the Pipe Including Contents and Accessories.
   4. Systems determined to be Nonbuilding Structures Not Similar to Buildings or Nonbuilding Structures Similar to Buildings shall comply with all requirements of ASCE 7-05 Chapter 15.
      a. Indicate in submittal calculations Structure Type used per ASCE 7-05 Chapter 15 Table 15.4-1 or Table 15.4-2.
      b. Seismic Importance Factor $I_P = 1.5$
      c. W_P = Operating Weight of the Pipe Including Contents and Accessories.
   5. Anchorage design shall comply with Appendix D of ACI 318 (Building Code Requirements for Structural Concrete).
      a. For Nonbuilding Structures Not Similar to Buildings or Nonbuilding Structures Similar to Buildings anchors shall comply with IBC Section 1908.1.16.
   6. Each piece of equipment shall be anchored to resist a minimum lateral seismic force required either by Building Code or by the manufacturer of the equipment, or a minimum lateral seismic force of 40 percent of the operating weight of the equipment, whichever is greater. No equipment shall be anchored to vertical structural elements without written approval of the Engineer.

B. Seismic forces shall be considered acting at the center of gravity of the system under consideration.

C. Anchorages shall be designed and detailed assuming that they will not receive special Inspection as defined in the 2013 California Building Code.

D. Anchorage of braces shall be coordinated with the concrete subcontractor so that anchorage may be installed at the time of concrete placement. If calculations and anchorage details are not submitted prior to placement of concrete, the Contractor shall be responsible for any strengthening of concrete elements to resist superimposed seismic or wind loading.

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

F. Operating Conditions:
   1. Provide seismic restraints, specified in this section, to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.
   2. Unless otherwise specified, brace all piping to resist seismic loading caused by forces applied at the individual pipe's center of gravity. Minimum seismic loading: 0.375 g acting in the lateral and longitudinal directions and 0.17 g acting simultaneously in the vertical directions.

G. Restraint Selection:
   1. Unless otherwise specified, select, locate and provide seismic restraints for piping in accordance with the contract documents.

2. Review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.
3. Seismic restraints may be omitted from the following installations:
   a. Gas piping less than 1” inside diameter.
   b. Piping in boiler and mechanical rooms less than 1-1/4 IN inside diameter.
   c. All other piping less than 2-1/2 IN inside diameter.
   d. All piping suspended by individual hangers 12 IN or less in length from the top of the pipe to the bottom of the support for the hanger.
4. Do not brace piping systems to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
5. Size restraints to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.
6. Do not permit contact between a pipe and restraint component of dissimilar metals. Prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.
7. Do not use branch lines to brace main lines.
8. Do not permit seismic bracing to limit the expansion and contraction of the piping system.

PART 2 - MANUFACTURERS

2.1 MANUFACTURERS

A. Carpenter & Patterson.

B. B-Line.

C. Kin-Line.

D. Anvil International.

E. Michigan.

F. Pipe Shields Incorporated.

G. Superstrut.

H. Unistrut.

I. Or equal.

2.2 PRODUCTS

A. Materials:
   1. Restraints, including braces and fittings, pipe and structural attachments, trapeze restraints, and accessories: Type 316 (316L for weldments) stainless steel.
   2. Nuts, bolts and washers, fittings and accessories: Type 316 stainless steel.
   3. Comply with MSS SP-58

B. Pipe Attachments:
   1. Type 1s - Clevis Restraint Attachment:
      a. Type 1, clevis pipe hanger.
   2. Type 3s - Double Bolt Restraint Clamp:
      a. Type 3, double bolt pipe clamp.
   3. Type 4s - Roller Restraint Attachment:
      a. Type 4, adjustable roller hanger.
      b. Size hold down strap as follows based on pipe size:
         1) 1 IN through 2 IN: 1 IN by 1/8 IN thick.
         2) 2-1/2 IN through 4 IN: 1-1/4 IN by 3/l6 IN thick.
         3) 6 IN: 2 IN by 3/l6 IN thick.
         4) 8 IN: 2-1/2 IN by 3/16 IN thick.

5) 10 IN through 16 IN: 2-1/2 IN by 1/4 IN thick.
6) 20 IN: 3 IN by 1/4 IN thick.
7) 24 IN: 3 IN by 3/8 IN thick.

4. Type E 7s - U-Bolt Restraint:
   a. Provide Type 7, U-bolt.
5. Type 13s - Framing Channel Strap Restraint:
   a. Provide Type 13, framing channel pipe strap.
6. Type 14s - Pipe Clamp Restraint:
   a. Provide with configuration and components equivalent to MSS and FEDSPEC Type 4.
   b. Rod attachment and longitudinal brace connection stud shall be fabricated and welded by the manufacturer.
   c. Products:
      1) Steel pipe (insulated): Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
      2) Steel pipe (uninsulated): Superstrut No. S-720, Kin-Line No. S475, or equal.
      3) Cast and ductile iron pipe: Superstrut No. S-720, Kin-Line No. S475, or equal.
      4) Copper pipe (insulated): Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield.
      5) Copper pipe (uninsulated): Superstrut No. S-720, Kin-Line No. S475, or equal, with insulation shield or dielectric lining.
      6) Plastic pipe: Superstrut No. S-720, Kin-Line No. S475, or equal.

C. Trapeze Restraints:
1. Unless otherwise specified, provide trapeze members with a minimum steel thickness of 12-gage, with a maximum deflection 1/240 of the span.
2. Type 20s - Single Channel Lateral Restraint:
   a. Trapeze restraint cross member: 1-5/8” square framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal.
   b. Pipe attachments: Type 13s or Type 7s specified in Paragraph 2.3 B.
   c. Rod stiffeners and lateral brace: as specified in Paragraph 2.3 D.
3. Type 21s - Double Channel Lateral Restraint:
   a. Trapeze restraint cross member: a double channel manufactured assembly, Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal.
   b. Pipe attachments: Type 13s or Type 7s specified in Paragraph 2.3 B.
   c. Rod stiffeners and lateral brace: as specified in Paragraph 2.3 D.
4. Type 22s - Double Channel Longitudinal Restraint
   a. Trapeze restraint cross member: a double channel manufactured assembly, Unistrut P1001, B-Line B22A, Superstrut A-1202, or equal.
   b. Pipe attachments: Type 13s or Type 7s specified in Paragraph 2.3 B.
   c. Rod stiffeners, longitudinal and lateral braces: as specified in Paragraph 2.3 D.

D. Braces and Fittings.
1. Seismic Brace Fitting:
   a. Provide for use with industry standard framing channel.
      1) Provide welded construction, two-piece linked fitting.
      2) Provide means to reduce noise and vibration transmission between the linked fitting parts.
   b. Manufacturers:
      1) Superstrut C-749N series seismic brace.
      2) Kin-Line No. 633 seismic connector fitting.
      3) Or equal.
2. Hanger Rod Stiffener Assembly:
   a. Rod stiffener channel: 1-5/8” square framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, or equal.
   b. Rod stiffener clamps, complete with channel nut: Superstrut ES-142, Kin-Line No. 635, or equal.

3. Type A1 Seismic Brace:
   a. Provide 1-5/8 IN square framing channel, Unistrut P1000, B-Line B22, Superstrut A-1200, Kin-Line No. 4112, or equal.
4. Type A2 Seismic Brace:
   a. Provide 1-5/8 IN wide by 3-3/4 IN deep framing channel, Unistrut P5000, B-Line B11, Superstrut H-1200, Kin-Line No. 8212, or equal.

E. Structural Attachments:
1. General
   a. Unless otherwise specified, provide hanger rod structural attachments.
   b. Structural attachments for longitudinal and lateral seismic braces: as specified in Paragraph 2.2 D.
2. Type SA-1 Attachment:
   a. Brace fitting: as specified in Paragraph 2.2 D.
   b. Concrete anchors: as specified in Section 05505 with embedment and location dimensions as specified.
3. Type SA-2 Attachment:
   a. Brace fitting: as specified in Paragraph 2.2 D.
   b. Concrete anchors: as specified in Section 05505 with embedment and location dimensions as specified.
   c. Framing channel: as specified in Paragraph 2.2 F.
4. Type SA-3 Attachment:
   a. Brace fitting: as specified in Paragraph 2.2 D.
   b. Cap screw, lockwasher and hex nut materials and finish: compatible with structural steel material.
5. Type SA-4 Attachment:
   a. Brace fitting: as specified in Paragraph 2.2 D.
6. Type SA-5 Attachment:
   a. Brace fitting: as specified in Paragraph 2.2 D.
   b. 4 IN x 3 IN x 3/8 IN angle.

F. Accessories
1. Hanger Rods:
   a. Threaded on both ends or continuous threaded.
   b. Sized as specified.
2. Framing Channel:
   a. Roll formed, 12-gage.
   b. Continuous slot along one side with in-turned clamping ridges.
   c. Manufacturers:
      1) Unistrut P1000 series.
      2) B-Line B22 series.
      3) Superstrut A-1200 series.
      4) Or equal.
3. Rod Coupling:
   a. Provide with sight hole in center of coupling body.
   b. Manufacturers:
      1) Anvil International. 135.
      2) Superstrut H-119.
      3) Or equal.

2.3 THERMAL PIPE HANGER SHIELD

A. Provide thermal shields at seismic restraint locations on pipe requiring insulation.

B. Provide thermal pipe hanger shields.

C. Provide Type 316 stainless steel band clamps on thermal shields at longitudinal pipe restraint locations.

PART 3 - EXECUTION

3.1 PIPE RESTRAINT LOCATIONS

A. Locate the first seismic restraint on a piping system not more than 10 FT from the main riser, entrance to a building or piece of equipment.

B. Brace cast iron pipe on each side of a change in direction of 90 degree or more. Brace or stabilize joints in risers between floors.

C. Brace no-hub and bell and spigot cast iron soil pipe longitudinally every 20 FT and laterally every 10 FT.

D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 IN of the elbow or tee of the same size.

E. Indicate seismic restraint locations and components on the piping layout drawings required by Section 15060.
   1. Provide a legend giving load information and restraint component selection at each restraint location.
   2. Provide seismic restraint load calculations conforming to the requirements specified in Paragraph 1.3.

3.2 INSTALLATION

A. Rod Stiffeners:
   1. Use rod stiffener assemblies at seismic restraints for hanger rods over 6 IN in length.
   2. Provide a minimum of two rod stiffener clamps on any rod stiffener assembly.

B. Install lateral and longitudinal bracing between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

C. Construct welded and bolted attachments to the building structural steel which comply with the AISC Manual of Steel Construction. Do not drill or burn holes in the building structural steel without approval of the Construction Manager

D. Use embedded anchor bolts instead of concrete inserts for seismic brace installations in areas below water surface or normally subject to submerging.

E. Install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Make butt joint connections to pipe insulation at the time of insulation installation per the manufacturer’s recommendations.

F. Provide restraint components in contact with plastic pipe which are free of burrs and sharp edges.

G. Ensure rollers roll freely without binding.

H. Provide plastic or rubber end caps at the exposed ends of all framing channels that are located up to 7 FT above the floor.

END OF SECTION

SECTION 15100
VALVES: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Valving, actuators, and valving appurtenances.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Pipe Threads, General Purpose.
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
      c. D638, Standard Test Method for Tensile Properties of Plastics.
      d. D648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
      e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
      f. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
      b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      c. C504, Standard for Rubber-Seated Butterfly Valves.
      d. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
      e. C542, Standard for Electric Motor Actuators for Valves and Slide Gates.
      f. C550, Standard for Protective Coatings for Valves and Hydrants.
      g. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.

1.3 DEFINITIONS

A. The following are definitions of abbreviations used in this Specification Section or one (1) of the individual valve sections:
   1. CWP: Cold water working pressure.
   2. SWP: Steam working pressure.
   3. WOG: Water, oil, gas working pressure.
   4. WWP: Water working pressure.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Valve pressure and temperature rating.
      d. Valve material of construction.
      e. Special linings.
      f. Valve dimensions and weight.
      g. Valve flow coefficient.
      h. Wiring and control diagrams for electric actuators.
   3. Test reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Informational Submittals:
   1. Verification from valve actuator manufacturer that actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted, and that the valve actuator responds correctly to the valve position command.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

2.2 MATERIALS

A. Refer to individual valve Specification Sections.

2.3 VALVE ACTUATORS

A. Valve Actuators - General:
   1. Provide actuators as shown on Drawings or specified.
   2. Counter clockwise opening as viewed from the top.
   3. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
   4. Size actuator to produce required torque with a maximum pull of 80 LB at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 LB on handwheel or chainwheel or 300 foot-pounds torque on the operating nut.
   5. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.
   6. Extension stem:
      a. Install where shown or specified.
      b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
      c. Pin all stem connections.
      d. Center in valve box or grating opening band with guide bushing.

B. Buried Valve Actuators:
   1. Provide screw or slide type adjustable cast iron valve box, 5 IN minimum diameter, 3/16 IN minimum thickness, and identifying cast iron cover rated for traffic load.

2. Box base to enclose buried valve gear box or bonnet.
3. Provide 2 IN standard actuator nuts complying with AWWA C500, Section 3.16.
4. Provide at least two (2) tee handle keys for actuator nuts, with 5 FT extension between key and handle.
5. Extension stem:
   a. Provide for buried valves greater than 4 FT below finish grade.
   b. Extend to within 6 IN of finish grade.
6. Provide concrete pad encasement of valve box as shown for all buried valves unless shown otherwise.

C. Exposed Valve Manual Actuators:
1. Provide for all exposed valves not having electric actuators.
2. Provide handwheels for gate and globe valves.
   a. Size handwheels for valves in accordance with AWWA C500.
3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 IN DIA and smaller.
   a. Lever actuators for butterfly valves shall have a minimum of 5 intermediate lock positions between full open and full close.
   b. Provide at least two (2) levers for each type and size of valve furnished.
4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 IN DIA and larger.
5. Provide gearing for gate valves 20 IN and larger in accordance with AWWA C500.
6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
7. Provide chain actuators for valves 6 FT or higher from finish floor to valve centerline.
   a. Cadmium-plated chain looped to within 3 FT of finish floor.
   b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
8. Provide cast iron floor stands where shown on Drawings.
   a. Stands to be furnished by valve manufacturer with actuator.
   b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.

D. Electric Actuators (480 V, 3 PH):
1. Conform to AWWA C542.
2. Provide electric valve actuators with integral control devices and a remote pushbutton station.
3. Furnish electric actuator integral with valve consisting of:
   a. Motor.
   b. Gearing.
   c. Handwheel.
   d. Limit and torque switches.
   e. Lubricants.
   f. Heating elements.
   g. Wiring.
   h. Terminals for motor power and controls.
   i. Drive nut.
4. Housing/enclosure:
   a. Provide cast iron gear housing and cast iron load bearing enclosure.
   b. Non load bearing enclosure and housing: Aluminum or cast iron.
   c. Rated for area classification shown on Drawings.
   d. Provide O-ring seals for covers and entries.
   e. Terminal and limit switch compartment covers are to be fastened to gear housing by stainless steel fasteners with capture device to prevent loss.
5. Motors:

a. Provide motors that are totally enclosed, high torque design made expressly for valve actuator service and capable of operating the valve under full differential pressure for complete open-close and reverse cycle of travel at least twice in immediate succession without overheating.
b. Design motors in accordance with NEMA MG 1 standards, with Class B insulation, and to operate successfully at any voltage within 10 percent above or below rated voltage.
c. Provide positive method to ensure motor bearings are permanently lubricated.
d. Provide three (3) thermal switches imbedded in windings:
   1) 120 degrees apart.
   2) Provide motor shutdown at high temperature.
e. Motor housing:
   1) Aluminum or cast iron.
   2) Totally enclosed nonventilated with cooling fins.
f. Provide motor capable of operating in any position.
g. Provide motor sealed from gearcase to allow any mounting position.
h. Provide motors suitable for 480 V, 3 PH, 60 Hz.

6. Gearing:
   a. Provide power gearing consisting of heat treated steel helical gears, carburized and hardened alloy steel worm, and alloy bronze worm gear, all grease or oil bath lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter.
   b. Provide gearing mechanism constructed to permit field changes of reduction gear ratio.
   c. Design actuators so that motor comes up to speed before stem load is encountered in either opening or closing operation.
   d. Limit switch gearings and feedback device reduction gearing:
      1) Steel or bronze.
   e. Support rotating shafts with anti-friction bearings.
   f. Provide separate drive nut/thrust bearing assembly:
      1) Mounted to base of actuator.
      2) High tensile bronze.
      3) Quarter turn actuator: Provide 90 degree mounting intervals.
      4) Provide grease fitting on drive assembly.
7. Handwheel:
   a. Permanently attached for manual operation.
   b. Positive declutch mechanism to engage and disengage handwheel.
   c. Handwheel shall not rotate during motor operation.
   d. Inoperable motor shall not prevent manual operation.
8. Limit torque and thrust loads in both closing and opening directions by torque limit switches.
   a. Provide torque switches with micrometer adjustment and reference setting indicator.
      1) Assure adjustment variation of approximately 40 percent in torque setting.
   b. Provide switches having rating of not less than 6 A at 120 Vac and 2.2 A at 115 Vdc.
   c. Limit and torque switches shall have totally sealed contacts.
9. Furnish electric actuator with two (2) geared limit switch assemblies with each switch assembly having four (4) separate limit switches:
   a. Assure each limit switch assembly is geared to driving mechanism and is independently adjustable to trip at any point at and between the fully open and fully closed valve position.
   b. Provide minimum of two (2) normally open contacts and two (2) normally closed contacts at each end of valve travel.
   c. Provide switches with inductive contact rating of not less than 6 A at 120 Vac, 3 A at 240 Vac, 1.5 A at 480 Vac, 2.2 A at 115 Vdc and 1.1 A at 230 Vdc.
   d. Limit switches shall be fully adjustable when power is applied to actuator.
10. Provide space heating elements sized to prevent condensation in both motor and geared limit switch compartment(s).
   a. Furnish heating elements rated at 120 Vac with heaters continuously energized.

11. Open-close actuator controls:
    a. Provide control assembly with necessary holding relays, reversing starter, control transformers of sufficient capacity to provide control power, space heating element power and valve position transmitter.
    b. Provide control assembly in an enclosure rated for the defined area classification.
    c. Controls for open/close actuator:
        1) Provide remote pushbutton station with enclosure rated for area classification shown on Drawings with:
            a) Open pushbutton.
            b) Close pushbutton.
            c) Stop pushbutton.
            d) Remote/local switch.
            e) Full open light.
            f) Full close light.
            g) Open and close relays as required.
        2) Provide control enclosure to accept:
            a) Remote open/close switches.
        3) Provide contacts in control enclosure:
            a) Remote/local contact.
            b) Full open contact.
            c) Full close contact.
        4) Wire all components to an internal terminal strip and include mounted wiring diagram inside enclosure.
12. Additional requirements for modulating valve actuators:
    a. Proportional position servo-amplifier mounted integral with the actuator control compartment.
    b. Positioning of valve shall be proportional to a 4-20 mA signal input to the position servo-amplifier when remote control has been selected.
    c. Servo-amplifier adjustments shall include zero, span, gain, and dead-band.
    d. Provide 4-20 mA signal position control as shown on the Drawings that interfaces with the position control/position feedback instrumentation wiring to and from PLC.

E. Electric Actuators (120 V, 1 PH):
1. General:
    a. Self contained including motor, gearing, torque switch, limit switches and cast housing.
    b. Electrical enclosure: NEMA 4 or NEMA 7 to comply with area rating classification shown on Drawings.
    c. Factory assembled requiring only field connection of power and control wires.
    d. Comply with Specification Section 11005.
2. Motors:
    a. Produce 1.5 times the required torque.
    b. Sized for two (2) complete open-close cycles without overheating.
    c. One (1) fully closed to fully open cycle to occur within 60 SEC.
    d. Class F insulation.
    e. Operate at plus or minus 10 percent voltage.
    f. 120 Volt, single phase, 60 Hz.
    g. Provide thermal cutout switch and internal heater for actuator enclosure.
    h. Control wiring as shown on Drawing control diagrams.
3. Remote pushbutton station:
    a. Enclosure: NEMA 4 stainless steel.
    b. Control relays shall include:
        1) Open relay.
        2) Closed relay.
        3) PLC interface relay.
    c. Push-to-test indicating lights shall include:
        1) Open.

2) Closed.
3) Remote.

d. Selector switches shall include:
1) Local-Remote.
2) Open-Close.

e. Space heater for enclosure.

f. Control wiring as shown on control diagrams.

g. Wire all components to an internal terminal strip and include mounted wiring diagram inside enclosure.

2.4 FABRICATION

A. End Connections:
1. Provide the type of end connections for valves as required in the Piping Schedules presented in Specification Section 15060 or as shown on the Drawings.
2. Comply with the following standards:
a. Threaded: ASME B1.20.1.
b. Flanged: ASME B16.1, Class 125 unless otherwise noted or AWWA C207.
c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.
d. Soldered: ASME B16.18.
e. Grooved: Rigid joints per Table 5 of AWWA C606.

B. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.

C. Nuts, Bolts, and Washers:
1. Wetted or internal to be bronze or stainless steel.
a. Exposed to be zinc or cadmium plated.

D. On Insulated Piping: Provide valves with extended stems to permit proper insulation application without interference from handle.

E. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Painting Requirements: Comply with Specification Section 09905 for painting and protective coatings.

C. Setting Buried Valves:
1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
2. Set valves and valve boxes plumb.
3. Place valve boxes directly over valves with top of box being brought to surface of finished grade.
4. Install in closed position.
5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
6. After installation, backfill up to top of box for a minimum distance of 4 FT on each side of box.

D. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.

E. For grooved coupling valves, install rigid type couplings.

F. Install electric actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.

G. For threaded valves, provide union on one (1) side within 2 FT of valve to allow valve removal.

H. Install valves accessible for operation, inspection, and maintenance.

3.2 ADJUSTMENT

A. Adjust valves, actuators and appurtenant equipment to comply with Specification Section 01650.
   1. Operate valve, open and close at system pressures.

B. For all 120 Vac and 480 Vac electric actuators, employ and pay for services of valve actuator manufacturer's field service representative to:
   1. Inspect valve actuators covered by this Specification Section.
   2. Supervise adjustments and installation checks:
      a. Open and close valves electrically under local manual and demonstrate that all limit switches are properly adjusted and that switch contacts are functioning properly by verifying the inputs are received at the remote input/output (RIO) panels or local control panel as appropriate.
      b. Position modulating valves electrically under local manual control and demonstrate that the valve position feedback potentiometer is properly adjusted and that the feedback signal is received at the RIO panels or local control panel as appropriate.
      c. Simulate a valve position command signal at the RIO panel or local control panel as appropriate and demonstrate that the valve is controlled to the desired position without excessive hunting.
   3. Provide Owner with a written statement that the valve actuator manufacturer has verified that the actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted and that the valve actuator responds correctly to the valve position command.

3.3 SCHEDULES

VALVE TAG	SERVICE	TYPE	ELECTRICAL, V/Ph	VALVE TYPE	LOCATION
12SLG101	RS	Open/Close	480/3	Slide Gate	Headworks
12SLG102	RS	Open/Close	480/3	Slide Gate	Headworks
12SLG201	RS	Open/Close	480/3	Slide Gate	Headworks
12SLG202	RS	Open/Close	480/3	Slide Gate	Headworks
12SLG203	RS	Open/Close	480/3	Slide Gate	Headworks
12SLG204	RS	Open/Close	480/3	Slide Gate	Headworks
13SLG101	PE	Open/Close	480/3	Slide Gate	Grit Basins
13SLG102	PE	Open/Close	480/3	Slide Gate	Grit Basins
13SLG201	PE	Open/Close	480/3	Slide Gate	Grit Basins
13SLG202	PE	Open/Close	480/3	Slide Gate	Grit Basins
13SLG203	PE	Open/Close	480/3	Slide Gate	Grit Basins
31G112	ML	Open/Close	480/3	Slide Gate	Aeration Basins
31G113	ML	Open/Close	480/3	Slide Gate	Aeration Basins
31FV103	LPA	Modulating	480/3	Butterfly Valve	Aeration Basins
31FV104	LPA	Modulating	480/3	Butterfly Valve	Aeration Basins

VALVE TAG	SERVICE	TYPE	ELECTRICAL, V/Ph	VALVE TYPE	LOCATION
31FV105	LPA	Modulating	480/3	Butterfly Valve	Aeration Basins
31FV203	LPA	Modulating	480/3	Butterfly Valve	Aeration Basins
31FV204	LPA	Modulating	480/3	Butterfly Valve	Aeration Basins
31FV205	LPA	Modulating	480/3	Butterfly Valve	Aeration Basins
32FV001	PE	Open/Close	480/3	Plug Valve	Primary Effluent and Mixed Liquor Flow Split Box
32FV002	PE	Open/Close	480/3	Plug Valve	Primary Effluent and Mixed Liquor Flow Split Box
32FV003	PE	Open/Close	480/3	Plug Valve	Primary Effluent and Mixed Liquor Flow Split Box
75FCV010	SHC	Open/Close	120/1	Ball Valve	Sodium Hypochlorite Chemical Storage
75FCV011	SHC	Open/Close	120/1	Ball Valve	Sodium Hypochlorite Chemical Storage
75FCV111	SBS	Open/Close	120/1	Ball Valve	Sodium Bisulfite Chemical Storage
75FCV112	SBS	Open/Close	120/1	Ball Valve	Sodium Bisulfite Chemical Storage

END OF SECTION

SECTION 15101
GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gate valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. American Water Works Association (AWWA):
      a. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      b. C504, Standard for Rubber-Seated Butterfly Valves.
      c. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
      d. C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-9, Spot Facing for Bronze, Iron and Steel Flanges.
      b. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
      c. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 DEFINITIONS

A. OS&Y: Outside Screw and Yoke.

B. NRS: Non-rising Stem.

C. RS: Rising Stem.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 VALVES: WATER, STEAM CONDENSATE, STEAM TO 125 PSI, AIR; 2-1/2 IN AND SMALLER

A. Class 125 bronze gate valve.

B. Comply with MSS SP-80.

C. Materials:
   1. Body, bonnet, wedge: Bronze.
   2. Stem: Silicon bronze.
   3. Packing: Aramid fibers with graphite (Kevlar®).

D. Design Requirements:
   1. 125 psi steam, 200 psi nonshock WOG.
   2. Screw in bonnet, non-rising stem, solid wedge.

E. Acceptable Manufacturers:
   1. Nibco.
   2. Stockham.

2.3 VALVES: STEAM CONDENSATE, STEAM TO 125 PSI, AIR; 3 IN AND LARGER

A. Class 125 iron body gate valve.

B. Comply with MSS SP-70.

C. Materials:
   1. Body, bonnet, wedge: Cast iron, ASTM A126, Class B.
   2. Stem: Brass, bronze, or copper silicon alloy.

D. Design Requirements:
   1. 125 psi steam to 400 DegF, 200 psi WOG.
   2. Bolted bonnet, OS&Y, solid wedge, bronze mounted.

E. Acceptable Manufacturers:
   1. Nibco.
   2. Stockham.

2.4 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, NON-POTABLE, AND WASTEWATER)

A. Double Disc Gate Valve, 3 to 12 IN (Water Application):
   1. Comply with AWWA C500.
   2. Materials:
      a. Seating surfaces, stems, stem nut: Bronze.
      b. Body, disc: Cast iron.
   3. Design requirements:
      a. 200 psi working pressure.
      b. Buried: NRS, O-ring stem seal, 2 IN operation nut.
      c. Exposed: NRS, O-ring stem seal, handwheel.
   4. Acceptable manufacturers:
      a. American Flow Control.
      b. Clow.
      c. M&H.
      d. Mueller.

B. Resilient Wedge Gate Valves, 2 to 48 IN (Water, Wastewater Application):
   1. Comply with AWWA C509.
   2. Materials:
      a. Stem and stem nut: Bronze.
         1) Wetted bronze parts in low zinc bronze.

2) Aluminum bronze components: Heat treated per AWWA C504.

b. Body, gate: Ductile iron.

c. Resilient wedge: Fully encapsulated rubber wedge. Ethylene Propylene Diene Monomer (EPDM).

3. Design requirements:

a. Minimum 200 psi working pressure.

b. Buried: NRS, O-ring stem seal, 2 IN square operating nut.

c. Exposed: OS&Y, stuffing box stem seal, handwheel.

d. Counter clockwise open rotation.

e. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.

1) Comply with AWWA C550.

2) Wetted bronze parts in low zinc bronze.

3) Aluminum bronze components: Heat treated per AWWA C504.

4. Acceptable manufacturers:

a. Clow.

b. Mueller.

c. American Flow Control.

d. M & H.

2.5 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.

1. Furnish actuator integral with valve.

B. Refer to Specification Section 15100 for actuator requirements.

2.6 FABRICATION

A. General:

1. Provide valves with clear waterways the full diameter of the valve.

B. Spot valves in accordance with MSS SP-9.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 15100.

B. Where larger buried valves utilize smaller bypass valves, provide a second valve box installed over the bypass valve operating nut.

C. Do not install gate valves inverted or with the stems sloped more than 45 degrees from the upright unless the valve was ordered and manufactured specifically for this orientation.

END OF SECTION

SECTION 15102
PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plug valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
      b. A536, Standard Specification for Ductile Iron Castings.
      c. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C504, Standard for Rubber-Seated Butterfly Valves.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. See Specification Section 15100.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 NON-LUBRICATED ECCENTRIC PLUG VALVES (SEWAGE, SLUDGE, SEWAGE GAS APPLICATIONS)

A. Acceptable Manufacturers:
   1. DeZurik.
   2. ValMatic.
   3. Victaulic.
   4. Or approved equal.

B. Materials:
   1. Body: Cast-iron ASTM A126, Class B.

2. Plug: One-piece construction ductile iron, ASTM A536 65-45-12 or cast iron, ASTM A126 Class B.
3. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Type A durometer hardness per ASTM D2240.
4. Shaft bearing bushings: Permanently lubricated TFE or Delrin sleeve type stainless steel or bronze.
5. Valve seats: Welded-in overlay of 90 percent nickel, minimum Brinell hardness of 200, (minimum 1/8 IN thick).
6. Stem seal: Nitrile butadiene packing or Buna-N dual U-cups per AWWA C504, Section 3.7.

2.3 LUBRICATED SEAL PLUG VALVES (NATURAL GAS APPLICATIONS)

A. Acceptable Manufacturers:
   1. Nordstrom.
   2. Walworth.
   3. Or equal.

B. Materials:
   1. Body: Cast iron ASTM A126, Class B.
   2. Plug: Cast iron ASTM A126, Class B.
   3. Plug facing: Teflon on tapered plug.
   4. Valve seats: Gas-resistant lubricant/sealant.

2.4 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuator.
   1. Furnish actuator integral with valve.

B. Refer to Specification Section 15100 for actuator requirements.

2.5 DESIGN REQUIREMENTS

A. Non-Lubricated Eccentric Plug Valves (Wastewater, Sludge):
   1. Port area:
      a. Valves 4 IN through 20 IN: Equal to or exceed 80 percent of full pipe area.
      b. Valves greater than 20 IN: 100 percent equivalent full pipe area.
   2. Valve body: Fitted with bolted bonnet.
   3. End connections: See Specification Section 15100.
   4. Stem seal: Adjustable and replaceable without disassembling valve or bonnet.
   5. Designed for seating drip tight in any flow direction.
   6. Rating:
      a. 1/2 through 12 IN, 175 psi working pressure.
      b. 14 through 36 IN, 150 psi working pressure.
      c. Three-way valves, 125 psi working pressure.
   7. Actuator:
      a. Actuator gearing in enclosure suitable for running in oil with seals on shaft to prevent entry of dirt or water.
      b. Positive identification on actuator indicating valve position.
      c. Adjustable stop to set closing torque.

B. Lubricated Plug Valves (Natural Gas):
   1. Pressure lubricated valve with sealed ports and grooves.
      a. Re-seatable under full pressure in any position.
   2. Pressure rating: 200 psi WOG.
   3. Port area: Minimum 60 percent of pipe area.
   4. Acceptable to local gas company.

2.6 FABRICATION

A. See Specification Section 15100.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 15100.

B. Install valves with valve stem horizontal, plug seat on inlet side and with plug rotating up into the open position for valves in horizontal lines.

C. Install valve with actuator above pipe or plug centerline.

END OF SECTION

SECTION 15103
BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Butterfly valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings - NPS 1/2 Through NPS 24.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
      e. A436, Standard Specification for Austenitic Gray Iron Castings.
      f. A536, Standard Specification for Ductile Iron Castings.
   3. American Water Works Association (AWWA):
      a. C504, Standard for Rubber-Seated Butterfly Valves.
   4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-67, Butterfly Valves.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.
   3. For valves 8 IN and larger, furnish "Affidavit of Compliance" with Owner in accordance with AWWA C504.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. DeZurik.
   2. Clow.
   3. Bray.
   4. Pratt.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 BUTTERFLY VALVES

A. Comply with AWWA C504.

B. Materials:
   1. Valve bodies:
      a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
      b. Wafer valves may be constructed of ASTM A48, Class 40 cast iron.
   2. Valve shafts:
      a. Stainless steel, 18-8, Type 304 or 316.
   3. Valve discs:
      a. Potable and nonpotable water:
         1) ASTM A48, Class 40 cast iron.
         2) ASTM A536, Grade 65-45-12 ductile iron Nylon 11 Coated.
         3) ASTM A436, Type 1 alloy cast iron.
         4) Bronze in accordance with AWWA C504.
      b. Air and similar applications: ASTM A48, Class 40 cast iron.
   4. Valve seats:
      a. Potable and nonpotable water.
         1) Buna-N.
      b. Heating water and air 180 to 250 DegF.
         1) EPDM.

C. Design Requirements:
   1. Seat type:
      a. Resilient.
      b. Meet the intent of AWWA C504.
   2. Exposed and submerged valves 3 through 20 IN.
      a. Body type: Wafer or short body flange (laying length may vary from AWWA C504).
      b. Equip wafer type with fully tapped lugs drilled per ASME B16.5.
   3. Exposed and submerged valves 24 IN and larger:
      a. Body type: Short body flange.
      b. Working pressure: Rated for 150 psi (Class 150B per AWWA C504).
   4. Direct buried valves:
      a. All valves: Working pressure rated for 150 psi (Class 150B per AWWA C504).

2.3 ACCESSORIES

A. Refer to Drawings and/or valve schedule for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Section 15100 for actuator requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 15100.

END OF SECTION

SECTION 15104
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ball valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

1.3 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.
   3. Test results for AWWA valves.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 METALLIC BALL VALVES 1/4 TO 3 IN DIA

A. Comply with FS WW-V-35C Type II, Class A.

B. Acceptable Manufacturers:
   1. Apollo.
   2. Jamesbury.
   3. Watts.
   4. Stockham.
   5. Nibco.

C. Materials:
   1. Body: Bronze.

2. Stem, stem gland nut: Brass.
3. Ball: Brass, chrome plated.
4. Seats, stuffing box ring, and thrust washer: Reinforced Teflon.
5. Handle: Vinyl coated or zinc- or cadmium-plated steel.

D. Design Requirements:
1. Rated for 400 psi and 250 DegF, WOG for threaded end applications and 285 psi WOG and 150 psi saturated steam service for flanged end applications.
2. Handles showing direction of opening.
3. Stuffing boxes capable of being repacked under pressure and adjustable for wear.
4. Stem with reinforced Teflon stuffing box ring and blowout-proof design.
5. Renewable reinforced Teflon seats.
6. Ball design which does not allow media contact with stem.
7. Balancing stop for all applications.
8. Bodies with mounting pad for applications requiring actuators.

2.3 PLASTIC BALL VALVES: 1/2 IN TO 4 IN DIA

A. Acceptable Manufacturers:
1. Chemtrol.
2. Spears.
3. ASAHI/America.

B. Materials:
1. Body, stem, ball, handle, end connectors:
a. PVC ASTM D1784-12454B or CPVC ASTM D1784-23447-B PVDF.
2. Ball Seat: Teflon.
3. O-rings: Viton.

C. Design Requirements:
1. Rated at 150 psi at 75 DegF.
2. Double or "true union" design.
3. Blocks both directions, upstream and downstream.
4. Union nut capable of compensating for seat wear.
5. Body with mounting pad for actuators where required.
6. Capable of being disconnected at downstream end under full line pressure.
7. Sodium hypochlorite service:
a. Provide "vented" ball valves for all service with greater than 5 percent concentrated sodium hypochlorite.

2.4 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.
1. Furnish actuator integral with valve.

B. Refer to Specification Section 15100 for actuator requirements.

2.5 SOURCE QUALITY CONTROL

A. Shop test AWWA C507 ball valves in accordance with AWWA C507.

B. Furnish record of test.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 15100.

3.2 FIELD QUALITY CONTROL

A. For AWWA C507 ball valves, and in accordance with Specification Section 01650 employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise adjustments and installation checks.
   3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
   4. Conduct startup of equipment and perform operational checks.
   5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, has been started up, and is ready for operation by Owner's personnel.

END OF SECTION

SECTION 15106
CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Check valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. American Water Works Association (AWWA):
      a. C508, Standard for Swing-Check Valves for Waterworks Service, 2 IN through 24 IN NPS.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
      b. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 15100.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, manufacturers listed under the valve with types are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 CHECK VALVES: 2.5 IN AND SMALLER

A. Class 125 Bronze Swing Check Valves (Fuel Oil, Compressed Air, Water, Wastewater):
   1. Comply with MSS SP-80.
   2. Acceptable manufacturers:
      a. Nibco T413-Y.
      b. Stockham B-319Y.
   3. Materials:
      a. Body, bonnet, disc: Bronze.

4. Design requirements:
    a. 125 psi steam to 406 DegF, 200 psi WOG.
    b. Horizontal swing, renewable disc.

B. Class 150 Bronze Lift Check Valves (Fuel Oil, Compressed Air):
1. Comply with MSS SP-80.
2. Acceptable manufacturers:
    a. Stockham B-322B.
    b. Powell 158B.
3. Materials:
    a. Body, cap, disc holder: Bronze.
    b. Disc: Buna-N.
4. Design requirements:
    a. 150 psi to 150 DegF, 300 psi WOG.
    b. Lift check, union cap.

C. Class 200 Bronze Swing Check Valves (Steam 125 to 200 psi):
1. Comply with MSS SP-80.
2. Acceptable manufacturers:
    a. Nibco T473B.
    b. Stockham B345.
3. Materials:
    a. Body, bonnet, disc: Bronze.
4. Design requirements:
    a. 200 psi steam to 550 DegF, 400 psi WOG.
    b. Horizontal swing, Y-pattern.
    c. Renewable disc.

2.3 SWING CHECK VALVES: 3 IN TO 24 IN

A. Swing Check Valves (Water, Wastewater, Sludge):
1. Comply with AWWA C508.
2. Acceptable manufacturers:
    a. Clow.
    b. American Darling.
    c. Golden Anderson.
3. Materials:
    a. Body and cover: Cast iron.
    b. Seat ring, hinge: Bronze.
    c. Disc:
        1) 3 to 4 IN: Bronze.
        2) 6 to 24 IN: Cast iron with bronze face.
        3) 6 to 24 IN: Cast iron with rubber face.
    d. Hinge shaft: Stainless steel.
    e. Bearings, connecting hardware: Bronze.
4. Design requirements:
    a. 175 psi working pressure (3 to 12 IN).
    b. 150 psi working pressure (14 to 24 IN).
    c. Furnish with outside weight and lever or lever and spring.

2.4 CUSHIONED SWING CHECK VALVES: 2 IN TO 24 IN

A. Class 125, 250.

B. Comply with AWWA C508.

C. Acceptable Manufacturers:
1. Air:
    a. Golden Anderson Figure 250D (Class 250).

b. APCO Series 6000.

D. Materials:
1. Body, cover, disc, levers: Cast iron or cast steel.
2. Seat: Bronze or stainless steel.
3. Seat ring: Bronze or rubber (Buna-N).
4. Hinge: Stainless steel.
5. Cushion cylinder: Metallic corrosion resistant material.

E. Design Requirements:
1. Seat ring: Replaceable.
2. Hinge: Extend out both sides with lever and weight.
3. Cushion: Air type with adjustable speed control.

2.5 DOUBLE DOOR CHECK VALVES

A. Class 250.

B. Acceptable Manufacturers:
1. APCO Series 9000 (2 to 48 IN).
2. Nibco W920-W (2 to 24 IN).
3. Technocheck by Techno Corporation.

C. Materials:
1. Body: Cast iron wafer style.
2. Doors:
a. 2 to 12 IN: Aluminum bronze.
b. 14 to 54 IN: Ductile iron, bronze faced.
3. Hinge and stop pins: Stainless steel, 316.
4. Spring: Stainless steel, T316.
5. Seat: Buna-N.

2.6 BALL CHECK VALVES: 1/2 IN TO 4 IN

A. 150 psi at 73 DegF.

B. Acceptable Manufacturers:
1. R&G Sloane.
2. Corr Tech.

C. Materials:
1. Body: PVC or CPVC.
2. Ball: Glass filled or polypropylene.
3. Seals: Viton or EPDM.

D. Design Requirements:
1. Connectors: Double union.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 15100.

B. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 15114
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Air release and vacuum relief valves.
   2. Automatic control valves:
      a. Pressure relief and pressure-sustaining valves.
   3. Solenoid valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Gas Association (AGA).
   2. American Society of Mechanical Engineers (ASME):
      a. B16.1, Cast Iron Pipe Flanges and Flanged Fittings - Classes 25, 125 and 250.
   3. American Water Works Association (AWWA):
      a. C512, Standard for Air-Release, Air-Vacuum, and Combination Air Valves for Waterworks Service.
      b. C550, Standard for Protective Interior Coatings for Valves and Hydrants.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Section 15100.

B. Operation and Maintenance Manuals:
   1. See Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 AIR RELEASE VALVES

A. General: Conform to AWWA C512.

B. Alternate 1:
   1. Water
      a. Combination Air Release and Vacuum Valve:
         1) Acceptable manufacturers:
            a) GA Industries, Figure 945 or 960,
            b) APCO Series S-140C (1 IN-4 IN).

2) Materials:
   a) Body and cover: Cast iron.
   b) Float, linkage and hardware: Stainless steel.
   c) Seat: Buna-N.
3) Design requirements:
   a) Size: As shown.
   b) Working pressure: 250 psi.
   c) Release 10 cfm at 10 psi differential at 150 psi line pressure.
   d) Air vacuum capacity: 20 scfm at 5 psi differential from atmospheric.
   e) Provide isolation valve, type as shown.
   f) Provide control for slow release of air through valve to prevent valve slamming shut from excessive air or water velocity through the valve.

C. Wastewater:

D. Air Release Valve:
1. Acceptable manufacturers:
   a. GA Industries, Figure 925 or 927.
   b. APCO S-400.
   c. ARI D-020.
2. Materials:
   a. Body and cover: Cast iron or semi-steel.
   b. Float and linkage: Stainless steel.
   c. Seat: Viton or Buna-N.
3. Design requirements:
   a. Working pressure: 250 psi.
   b. Release 10 cfm at 10 psi differential at 75 psi line pressure.
   c. Inlet 2 IN NPT, outlet 1/2 IN NPT.
   d. Flush accessories:
      1) Inlet shut-off valve.
      2) Blow-off valve.
      3) Clear water inlet valve.
      4) Hose and quick disconnect coupling.
   e. Provide isolation valve, type as shown.

2.3 COMBINATION AIR RELEASE AND VACUUM VALVES

A. Outfall Pipeline at High Point:
1. Acceptable manufacturers:
   a. APCO Series S-1500CS.
   b. Crispin SVR/S20S.
   c. Golden Anderson Fig 993.
   d. ARI D-023.
   e. Or equal.
2. Size: 6 IN.

B. Rodeo Effluent Pump Station Discharge:
1. Acceptable manufacturers:
   a. APCO Series S-1500-TC.
   b. ARI K-060-HF-NS.
   c. Or equal.
2. Size: 3 IN.
3. Pinole effluent pump discharge, Qty 3.
   a. Acceptable manufacturers:
      1) APCL Series S-1500-TC.
      2) ARI K-060-HF-NS.
      3) Or equal.
   b. Size: 3 IN.

4. Pinole effluent pump station header:
    a. Acceptable manufacturers:
        1) APCL Series S-1500-TC.
        2) ARI K-060-HF-NS.
        3) Or equal.
    b. Size: 4 IN.

C. Materials:
1. Body and cover: Cast iron ASTM A48.
2. Float: Stainless steel.
3. Seat: Buna-N or EPDM.

D. Design Requirements:
1. Working pressure: 150 psi.
2. Provide isolation valve.
3. Provide control for slow release of air through valve to prevent valve slamming shut from excessive air or water velocity through the valve.

2.4 SOLENOID VALVES (1 IN AND SMALLER)

A. General Service (Water):
1. Acceptable manufacturer:
    a. ASCO or equal.
2. Materials:
    a. Body: Brass.
    b. Seat: Buna-N.
    c. Insulation: Class F.
3. Design requirements:
    a. 110 Vac.
    b. Two-way, normally closed.
    c. Enclosure: Compatible with area classifications indicated on Drawings.
    d. Working pressure, air and water: 125 psig.
4. Accessories: Provide strainer on supply.

2.5 ACCESSORIES

A. Furnish any accessories required to provide a completely operable valve.

2.6 FABRICATION

A. Completely shop assemble unit including any interconnecting piping, speed control valves, control isolation valves and electrical components.

B. Provide internal epoxy coating suitable for potable water for all iron body valves in accordance with AWWA C550.

2.7 MAINTENANCE MATERIALS

A. Provide one (1) set of any special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: See Section 11005 and Section 15100.

B. Air Release and Pressure Relief Valves:
1. Pipe exhaust to a suitable disposal point.

2. Where exhausted to a trapped floor drain, terminate exhaust line 6 IN minimum above floor.

3.2 FIELD QUALITY CONTROL

A. Clean, inspect, and operate valve to ensure all parts are operable and valve seats properly.

B. Check and adjust valves and accessories in accordance with manufacturer's instructions and place into operation.

END OF SECTION

SECTION 15115
WATER CONTROL GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water control gates.
   2. Sluice gates.
   3. Slide (fabricated) gates.
   4. Flap gates or valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A126, Gray Iron Castings for Valves Flanges, and Pipe Fittings.
      b. A276 Stainless Steel Bars and Shapes.
      c. B103 Phosphor Bronze Plate, Sheet, Strip, and Roller Bar.
      d. B209 Aluminum and Aluminum Sheet and Plate.
      e. B221 Aluminum and Aluminum – Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
      f. B584 Copper Alloy Sand Castings for General Applications.
      g. ASTM D2000 Rubber Products for Automotive Applications.
   2. American Water Works Association (AWWA):
      a. C560, Standard for Cast-Iron Slide Gates.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Unit Responsibility: Assign unit responsibility as specified in Paragraph 11005 - 1.2F to the gate manufacturer for combined equipment consisting of gate, operator, and wall thimble (where applicable).

1.3 SUBMITTALS

A. Comply with Section 01340.

B. Contract Document Coordination:
   1. Provide copies of the following contract documents, with addenda updates, that apply to the equipment in this section marked to show specific changes necessary for the supplied equipment. If no changes are required, the document shall be marked “No Changes Required”.
      a. This specification section and referenced sections.
      b. Process and Instrumentation Diagrams.
      c. Control Wiring Diagrams.
      d. Mechanical Arrangement and Detail Drawings.
   2. Submit completed certification of unit responsibility.

C. Product technical data including:
   1. Acknowledgment that products submitted meet the requirements of standards referenced.
   2. Product information, calculations, charts, or graphs to verify that the product provided meets the requirements set forth in this specification.
   3. Parts list including materials of construction.
   4. Calculations justifying the size of stems, gate, slide reinforcing, and operators.

5. Manufacturer's recommended installation instructions with detail drawings showing installation in the specific structure for each gate and operator.

D. Operating Characteristics.

E. Shop Drawings:
1. Plan, cross section, and details showing proposed mounting for each size and typical application of gate.

F. Provide equipment anchorage calculations per Section 11005 demonstrating compliance with the applicable requirements.

G. Operation and Maintenance Information:
1. See Section 01342 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals."

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Water control gates:
a. Rodney Hunt.
b. Hydro Gate Corporation.
c. Golden Harvest, Inc.
d. Or equal.

B. Submit request for substitution in accordance with Specification Section 01640.

2.2 SLUICE GATES

A. General:
1. Provide gates, stems, lifts and other appurtenances of size, type, material and construction shown on the Contract Drawings and specified.
2. Gates meet requirements of AWWA C560 as modified per this Specification Section.

B. Material:
1. Seating faces: ASTM B103 or B139, bronze.
2. Seals: Provide resilient seals for flush bottom gates of neoprene.
3. Wedges: ASTM B584, bronze, CA 872.
4. Anchor bolts, assembly bolts and nuts: ASTM A276, Type 304, stainless steel.
5. Stems and stem couplings: ASTM A276, Type 304, stainless steel.
6. Gate, guide, frame, wall thimbles: ASTM A126, Class B, cast iron, wall thimbles.
7. Yoke: ASTM A126, Class A, cast iron.

2.3 SLIDE GATES

A. General:
1. Self-contained slide gates with operators in accordance with the configuration noted in the gate schedule or shown on the Contract Drawings.
2. Maximum leakage rate: Not to exceed 0.1 gpm per foot of seat perimeter with water at top of gate slide and operating in seating position.

B. Material:
1. Frame and Slide: ASTM B209 and ASTM B-211 Aluminum, Alloy 6061 – T6.
2. Guides, guide rails, cross bars, and head rails: ASTM B209 and ASTM B-211 Aluminum, Alloy 6061 – T6; or ASTM B-211 Aluminum, Alloy 6063-T5.
3. Anchor bolts: ASTM A276 Type 304 or 316 stainless steel.

4. Stems and stem couplings: ASTM A-276 Type 303, 304, or 316 stainless steel.
5. Flush bottom and “J” bulb seals: ASTM D-2000 BC610 – 615, Buna-Nor neoprene rubber.

C. Fabrication:
1. Frame and guides:
   a. Rigid, welded gate frame and guides: Composed of the guide rails, cross bars, and headrails, with a clear opening the same size as the waterway, unless otherwise specified.
   b. Flatback, spigotback, or embedded type as shown on Contract Drawings.
   c. Construct guides incorporating a dual slot design.
      1) The primary slot will accept the plate of the slide (disc).
      2) The secondary slot will be sufficiently wide to accept the reinforcing ribs of the disc.
   d. Design guides for maximum rigidity: Weight not less than 3 LBS per foot.
   e. Guides of sufficient length to support two-thirds the height of the slide, when the gate is fully open.
   f. Extend the head angle or yoke 42 IN above the operating floor.
   g. Provide guides of sufficient strength so that no further reinforcing will be required.
   h. Design yoke to support the operating device formed by members welded or bolted at the top of the guides.
   i. Design yoke arrangement such that the disc and stem can be removed without disconnecting yoke.
   j. Design yoke to support the lift forces when subjected to a load of 80 LB pull on the operator.
   k. Design gates with J-seals at the side attached to frame.
   l. For embedded type gates provide molded resilient seat mounted at bottom of disc for flush bottom closure and seal against embedded portion of the frame in the channel invert or have a resilient seat mounted on frame flush at channel invert.
   m. Design weir gates or downward opening gates with J-seal attached to bottom frame.
   n. Design bottom frame member as a minimum of 3 IN of material bearing against slide for weir or downward opening gates.
   o. Utilize J-seals and resilient seats of synthetic rubber conforming to AWWA C560.
2. Slide (disc):
   a. Plate reinforced slide with structural shapes welded to the plate.
   b. Slide cover maximum deflection: 1/360 of the span of the gate under maximum head.
   c. Extend reinforcing ribs to guides so that the seating surface of the guide is reinforced.
   d. Stem connection of either clevis type, with structural members welded to slide and a bolt to act as pivot pin, or a threaded and bolted (or keyed) thrust nut supported in welded nut pocket.
   e. Pocket and yoke of gate capable of taking at least twice the rated thrust output of the operator at 40 LBS pull. Slide material same as frame and guides.
3. Stem:
   a. Of suitable length and ample strength for the intended service.
   b. Stem diameter capable of withstanding twice the rated output of the operator at 40 LB pull, and supported such that L/r ratio for unsupported part of the stem shall not exceed 200.

D. Slide Gate Schedule:

EQUIPMENT NUMBER	TYPE	SIZE W x H	SEAT HD-FT	UNSEAT HD-FT	TYPE LIFT	GUIDE FRAME	SELF CONTAINED / PEDESTAL
12SLG101	Slide Gate	36 IN x 60 IN	15	15	Elec/Hdwhl	Embedded	Pedestal
12SLG102	Slide Gate	36 IN x 60 IN	15	15	Elec/Hdwhl	Embedded	Pedestal
12SLG201	Slide Gate	36 IN x 60 IN	15	15	Elec/Hdwhl	Embedded	Pedestal
12SLG202	Slide Gate	36 IN x 60 IN	15	15	Elec/Hdwhl	Embedded	Pedestal
12SLG203	Slide Gate	36 IN x 60 IN	15	15	Elec/Hdwhl	Embedded	Pedestal
12SLG204	Slide Gate	36 IN x 60 IN	15	15	Elec/Hdwhl	Embedded	Pedestal
22SLG001	Weir Gate	48 IN x 48 IN	-	-	Hdwhl	Wall Mount	Self Contained
22SLG002	Weir Gate	48 IN x 48 IN	-	-	Hdwhl	Wall Mount	Self Contained
22SLG003	Weir Gate	48 IN x 48 IN	-	-	Hdwhl	Wall Mount	Self Contained
31G112	Slide Gate	36 IN x 36 IN	3	3	Hdwhl	Embedded	Self Contained
31G113	Slide Gate	36 IN x 36 IN	3	3	Hdwhl	Embedded	Self Contained
31G116	Slide Gate	36 IN x 36 IN	3	3	Hdwhl	Embedded	Self Contained
31G117	Slide Gate	36 IN x 36 IN	3	3	Hdwhl	Embedded	Self Contained
31G118	Slide Gate	36 IN x 72 IN	8	8	Hdwhl	Embedded	Self Contained
31G212	Slide Gate	36 IN x 36 IN	3	3	Hdwhl	Embedded	Self Contained
31G213	Slide Gate	36 IN x 36 IN	3	3	Hdwhl	Embedded	Self Contained
31G216	Slide Gate	36 IN x 60 IN	3	3	Hdwhl	Embedded	Self Contained
31G217	Slide Gate	36 IN x 60 IN	3	3	Hdwhl	Embedded	Self Contained
31G218	Slide Gate	36 IN x 72 IN	8	8	Hdwhl	Embedded	Self Contained
32G101	Weir Gate	108 IN x 15 IN	-	-	Hdwhl	Embedded	Self Contained
32G201	Weir Gate	108 IN x 15 IN	-	-	Hdwhl	Wall Mount	Self Contained

2.4 GATE OPERATORS AND LIFTS

A. General:
1. Provide lifts in accordance with AWWA C560 or as modified in this Specification Section.
2. Provide all lifts with clear butyrate plastic stem cover with Mylar open-close indicator.

B. Manual Operators:
1. Centerline of crank or handwheel approximately 36 IN above operating floor, unless otherwise shown.
2. Maximum effort of 40 LBS on crank or handwheel shall operate gate after unseating gate from wedges bored upon seating head specified.

C. Electric Operators:
1. Electric motor-operated lift mechanism including electric motor, reduction gearing, stem nut, pedestal, torque and limit switches, enclosure strip heaters, reversing magnetic starter, pushbutton control, indicator lights, shop wiring, gear case, and handwheel for operation in case of power failure.
2. Unit to be complete in a NEMA 4X enclosure requiring only the field connection of 3 PH, 460 V electric power.
3. Gate operation speed: 12 IN per minute.
4. See Section 15100 for additional requirements.

2.5 ALL GATES, VALVES, OPERATORS AND LIFTS

A. Comply to requirements of Specification Section 11005.

B. Provide gates, including lift, designed with a minimum factor of safety of five.
1. Provide rising stems on all gates.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01600.

3.2 INSTALLATION

A. Align, connect, and install gates at locations specified and shown on the Drawings and as recommended, in writing, by the manufacturer.

B. When installing aluminum slide gates, dielectrically isolate aluminum frame from anchor bolts. Use one-piece sleeves and washers molded from acetal resin, as supplied Pipeline Seal & Insulator Co., or equal.

3.3 FIELD PAINTING

A. Paint cast iron components of sluice gates as specified in Section 09905.

3.4 TESTING

A. Comply with Section 01650.

B. After completion of installation, field test each gate to demonstrate compliance with specified performance requirements. Inspection, testing, and certification shall be provided, and testing procedures and forms shall be submitted and used, as specified in Section 01650.

C. Sluice Gate Field Leakage Tests:
   1. Perform as specified in Section 4.6, Paragraph 4.6.8 of AWWA C560.
   2. Maximum allowable leakage rate: 0.10 gallons per minute per foot of seating perimeter for the seating head specified and 0.20 gallons per minute per foot of seating perimeter for the unseating head specified.
   3. Conduct field leakage tests with no head on one side of the gate being tested.

D. Aluminum FRP Slide Gate Field Leakage Tests:
   1. Perform as specified in AWWA C513, Section 4.5, Paragraph 4.5.
   2. Maximum allowable leakage: 0.10 gal/min/ft of seating perimeter for both seating and unseating heads.
   3. Conduct field leakage test with no head on one side of the gate being tested.

3.5 MANUFACTURER SUPPLIES SERVICES

A. Provide factory-trained personnel to direct installation and initial operation of gates.

3.6 TRAINING

A. Comply with Section 01650.

END OF SECTION

SECTION 15150
SPECIALTY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Specialty valves which are auxiliary to process piping systems.

1.2 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Section 15100.

B. Operation and Maintenance Manuals:
   1. See Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 HOSE VALVES

A. Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, with threaded nipple adapter for hose connection.

B. Hose valves on 1W piping only shall be provided with a UPC compliant non-removable backflow prevention device.

C. Acceptable Manufacturers:
   1. Crane 17.
   2. Lunkenheimer 214.
   3. Powell 151.
   4. Or equal.

2.2 FLUSHING COCKS

A. Flushing cocks shall consist of a neoprene-faced eccentric plug valve with a hose nipple adapter if required. Unless specified otherwise, flushing cocks shall be 1 IN in diameter.

B. Acceptable Manufacturers:
   1. DeZurik 159/118-S.
   2. Keystone Fig. 541.
   3. Or equal.

2.3 QUICK DISCONNECTS

A. Quick disconnects shall not be disconnectable under pressure.

B. Quick disconnects for air service shall be Swagelok, Tomco, or equal, and shall be ½ IN, unless otherwise specified.

C. Quick disconnects for water service shall be EverTite Part B, Gate Part B, or equal, and shall be 1 IN, unless specified otherwise.

2.4 STOP AND DRAIN VALVES

A. Stop and drain valves shall be Mueller H-10284, or equal.

2.5 PRESSURE RELIEF VALVES

A. Size and pressure settings shall be as specified or as required for the service intended.

B. Pressure relief valves for air shall be ASME certified, Watts Fig. 41A, Lonergan L14/L40 Series or equal.

C. Pressure relief valves for cold and hot water shall be McDonnell and Miller 230, Watts 174A, Cash Acme F-82, Lonergan L14/L40 Series, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 15183
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Insulation:
      a. Piping insulation.
      b. Duct insulation.
      c. Equipment insulation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 15090 – Pipe Support Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
      b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
      c. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      e. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
      f. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
      g. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
      h. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
      i. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      j. E96, Standard Test Methods for Water Vapor Transmission of Materials.
      k. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
   2. National Fire Protection Association (NFPA):
      a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   3. Underwriters Laboratories, Inc. (UL):
      a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

c. Submit complete specification of insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.

3. Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
4. Certifications: Products will meet the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fiberglass insulation:
      a. Certainteed Corporation.
      b. Schuller (Manville).
      c. Owens Corning.
      d. Knauf.
      e. Or equal.
   2. PVC jacket:
      a. Ceel-Co.
      b. PIC Plastics.
      c. Or equal.
   3. Equipment insulation:
      a. Certainteed Corporation.
      b. Schuller (Manville).
      c. Owens Corning.
      d. Or equal.
   4. Ductwork insulation:
      a. Certainteed.
      b. Schuller (Manville).
      c. Owens Corning.
      d. Or equal.

2.2 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:
   1. Preformed fiberglass pipe insulation:
      a. Density: 4 LBS/CF.
      b. Temperature rated: 650 DegF.
      c. Average thermal conductivity not to exceed 0.22 (Btu-IN)/(HR-FT^2-DegF) at mean temperature of 75 DegF.
      d. Fire hazard rating:
         1) UL 723, ASTM E84, NFPA 255.
         2) Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Moisture adsorption:
      a. ASTM C553.
      b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120 DegF and 96 percent RH.
   3. Fungi and bacteria resistance:
      a. ASTM C665.
      b. Does not breed or promote growth.
      c. Flame attenuated glass fibers bonded with thermosetting resin.
   4. Piping jackets (general applications):

a. PVC: Preformed 0.028 IN thick PVC jackets fabricated from B.F. Goodrich PVC sheeting V-66 with proven resistance to ultraviolet degradation when temperatures do not exceed the limits of PVC.
b. Piping jacket not required on concealed piping.

5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.3 EQUIPMENT INSULATION

A. Insulation for Equipment:
1. Fire hazard classification:
a. UL 723, ASTM E84, NFPA 255.
b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
2. Provide minimum insulation thickness conforming to Schedules, or as shown on Drawings.

2.4 DUCTWORK INSULATION: FIBERGLASS

A. Provide minimum insulation thickness conforming to Schedule, or as shown on Drawings.

B. Duct Interior Lining Board:
1. Acoustical performance: Minimum noise reduction coefficients (NRC) is 0.45 when tested in accordance with ASTM C423 on ASTM F25 mounting.
2. Fire hazard classification:
a. UL 723, ASTM E84, NFPA 255.
b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
3. Service temperature:
a. ASTM C411.
b. Cooling and heating ducts up to 200 DegF.
4. Velocity rating:
a. ASTM C1071.
b. Maximum average air velocity is rated at 600 fpm.
5. Moisture adsorption:
a. ASTM C553.
b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120 DegF and 96 percent RH.
6. Fungi and bacteria resistance:
a. ASTM C665.
b. Does not breed or promote growth.
7. Size and performance:
a. ASTM C518 and ASTM C177.
b. 1 IN thickness, long textiled glass-type fibers firmly bonded by thermosetting resin.
c. At 75 DegF mean temperature, the k value, expressed as (Btu-IN)/(HR-FT^2-DegF) does not exceed 0.27.
8. Duct sizes shown on Drawings are inside dimensions and shall account for interior lining board thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
1. Piping below ground covered with earth will not be insulated, unless noted otherwise.
2. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
3. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.

a. Consider ductwork, piping and equipment above ceilings as concealed.

4. Provide release for insulation application after installation and testing is complete.
   a. Apply insulation on clean, dry surfaces after inspection.
5. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
6. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
   a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
   b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
7. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.

C. Piping Insulation - Fiberglass:
1. Apply over clean dry pipe.
   a. Butt all joints together firmly.
2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
4. PVC pipe jacket:
   a. Apply jacketing with a minimum of 1 IN overlap.
      1) Weld longitudinal and circumferential seams with adhesives as recommended by manufacturer.
   b. Provide slip-joints every 30 FT and between fittings if distance exceeds 8 FT.
      1) Construct slip-joints by overlapping jacket sections 6 to 10 IN.
   c. Provide premolded PVC covers of same material and manufacturer as jacket for fittings, valves, flanges, and related items in insulated piping systems.
5. Aluminum pipe jacket:
   a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
   b. Provide smooth and straight joint with a minimum 2 IN overlap.
   c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 IN back from edge.
   d. Center spacing of screws 5 IN maximum or as required to provide smooth tight-fitted joints.
   e. Place joints on least exposed side of piping to obtain neat appearance.

D. Equipment: Install per manufacturer's instructions.

E. Ductwork Insulation - Fiberglass:
1. Duct interior lining board:
   a. Impaling over pins.
      1) Apply insulation with edges tightly butted.
      2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.
      3) Clip pins off close to clip.
      4) Space pins as required to hold insulation firmly against duct surface but not less than one (1) pin per 1.5 SF.
      5) Seal joints and speed clips with 3 IN wide strip of facing adhered with Benjamin Foster 85-20 adhesive.
   b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive.
      1) Cover the entire surface of duct with adhesive.
      2) Use corner metal angle to protect edge of insulation.
      3) Protect edge of insulation.
      4) Seal joints as above.

F. Install interior duct lining board as indicated above.

3.2 REPAIR

A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

3.3 SCHEDULES

A. Insulate chemical storage tanks for following chemicals:
   1. Sodium hydroxide.
   2. Sodium hypochlorite.
   3. Sodium bisulfite.

END OF SECTION

SECTION 15440
PLUMBING FIXTURES AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plumbing fixtures, trim, and equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. American National Standards Institute (ANSI):
      a. Z358.1, Emergency Eyewash and Shower Equipment.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. 90.1 IP, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   4. American Society of Mechanical Engineers (ASME):
      a. A112.19.3, Stainless Steel Plumbing Fixtures (Designed for Residential Use).
   5. American Society of Sanitation Engineers (ASSE):
      a. 1011, Performance Requirements for Hose Connection Vacuum Breaker.
   6. Canadian Standards Association (CSA).
   7. NSF International (NSF).
   8. Underwriters Laboratories, Inc. (UL).
   9. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2012 Edition including all 2013 amendments, referred to herein as California Building Code.
      b. Local Codes:
         1) City of Pinole.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005 and Specification Section 15060.
   3. Color selection charts for Owner color selection.
   4. Fabrication and/or layout drawings:
      a. Layout plan(s) showing dimensions, elevations, etc.
      b. Details showing connections, installation, rough-in locations, etc.
   5. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Chemical-resistance data.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Emergency shower and eyewash:
      a. Speakman.
      b. Haws.
      c. Guardian Equipment.
   2. Hose bibs:
      a. Nibco.
      b. Woodford.
   3. Hydrants:
      a. Wade.
      b. Josam.
      c. Smith.
   4. Reduced pressure backflow preventer:
      a. Watts.
      b. Febco.
      c. Clayton.
   5. Hose racks:
      a. Strahman Valves, Inc., Model HR-100.
   6. Hose valve:
      a. Guardian Fire Equipment.
      b. Wilkins.

2.2 MANUFACTURED UNITS

A. Emergency Fixtures:
   1. Emergency shower and eye/face wash (ESEW):
      a. ANSI Z358.1.
      b. Flow switch:
         1) Rating: 125/250 V, 5 A.
         2) Single pole, double throw.
         3) UL listed.
      c. Deluge shower head:
         1) Stay-open ball valve.
         2) Pull-chain.
      d. Eye/face wash:
         1) Aerated eye/face wash with stainless steel bowl.
         2) Stay-open full port ball valve.
         3) Push handle control for eye/face wash.
         4) Supply line strainer for eye/face wash.
      e. Type:
         1) ESEW-1 (free standing, cast flange base and pull-chain for shower): Speakman SE-601.
         2) ESEW-2 (freezeproof, floor-mounted, and push handle for shower and eyewash): Haws 8300 FP.

B. Traps:
   1. Floor and equipment drains:
      a. Same material and coating as the piping system.
      b. 3 IN minimum seal.

C. Cleanouts (CO):
   1. Cleanouts for cast iron pipe:
      a. Tapped extra heavy cast iron ferrule.
      b. Calked into cast iron fittings.
      c. Extra heavy brass neoprene seal screw plug with solid hexagonal nut.
   2. Cleanouts for steel pipe: Extra heavy brass screw plug in drainage fittings.
   3. Code:
      a. Provide cleanouts of same size as pipe up to 4 IN and not less than 4 IN for larger pipes.
   4. Cleanouts installed in completely accessible pipe chases or where piping is exposed do not require special covers.

D. Hose Bibb (HB-1):
   1. 3/4 IN boiler drain with attached vacuum breaker-backflow preventer.
   2. Vacuum breaker: Non-removable, manual draining, meeting the requirements of the ASSE 1011.

E. Hose Valve:
   1. Cast brass.
   2. Minimum pressure rating 150 psi.
   3. Angle configuration.
   4. Hose outlet connection 1-1/2 IN or 2-1/2 IN as shown on Drawings or scheduled.
   5. Pin lug protective hose thread cap with chain.

F. Hydrants:
   1. Yard hydrant (YH):
      a. Non-freeze.
      b. Galvanized casing.
      c. Bury depth per Specification Section 15060.
      d. Brass mechanism.
      e. Type: YH-1 (post type, aluminum housing wheel operating handle, 1-1/2 IN inlet and 1-1/2 IN hose connection) Wade W-8610.
      f. Casing guard.

G. Hose Racks:
   1. Stainless steel.
   2. 3/4 IN hose capacity: 50 FT.

H. Electric Water Heater (EWH):
   1. Emergency shower applications:
      a. Meet ANSI Z3581 for tepid water requirements.
      b. Provide 23 GPM with a 15 DegF temperature rise.
      c. Voltage: 480 Delta, 3 PH.
      d. NEMA 4 enclosure.
      e. Mixing valve set to deliver tepid water (~ 65 DegF).
      f. Power: 54 KW.

I. Reduced Pressure Backflow Preventer:
   1. Backflow preventers consist of two (2) check valves, test cocks and relief valve, all assembled as an integral unit.
   2. Reduced pressure backflow preventers Watts 909.
   3. Backflow preventer to have threaded ends in sizes through 2 IN, flanged 2-1/2 IN and larger.
   4. Pressure loss through backflow preventer not exceeding 14 psi at design flow.
   5. Provide air gap and pipe discharge to within 6 IN of finished floor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cross Connection: Do not install any plumbing components that will provide a cross connection between potable and non-potable or drainage systems.

B. Fixtures:
   1. Install fixtures at locations indicated on Drawings and in compliance with local Codes.
   2. Connect plumbing supply, drain and vent line sizes as shown on Drawings.
   3. Set proper grounds to form secure base for each fixture and rigid setting.
   4. Install emergency fixtures in accordance with ANSI Z358.1.

C. Drains:
   1. Install drains at locations indicated on Drawings and in compliance with local Codes.
   2. In uncovered concrete slabs:
      a. Install at the low points of surface areas to be drained or as indicated.
      b. Set tops of drains flush with the finished floor.
      c. Install drain flashing collar or a flange so that no leakage occurs between the drain and the adjoining surfaces.
      d. Maintain the integrity of waterproof membranes, where penetrated.

D. Yard Hydrants:
   1. Install plumb.
   2. Provide concrete around pipe as shown on Drawing.
   3. For buried applications, install Schedule 80 PVC drainage nipple sized to match drain port as provided by manufacturer.
      a. Extent nipple into crushed rock.
   4. For applications at elevated slabs, provide 1/2 IN Schedule 80 PVC from drain port to drain.

E. Hose Racks:
   1. Adjacent to hose bibbs, top of rack 36 IN above finished floor or grade.
   2. Concrete or masonry walls: Mount with 5/8 IN x 2-1/2 IN stainless steel expansion anchors.
   3. Handrail:
      a. Bolt hose rack to 24 IN x 24 IN x 1/4 IN aluminum plate with 5/8 IN stainless steel bolts.
      b. Attach to handrail with 3/8 IN stainless steel through bolt at each corner of the plate.
   4. Pedestal:
      a. Bolt hose rack to 24 IN to 24 IN x 1/4 IN aluminum plate with 5/8 IN stainless steel bolts.
      b. Attach to pedestal with two (2) 1/2 IN stainless steel bolts through handrail.

F. Hose Bibbs:
   1. Install 36 IN above finished floor.
   2. In exterior locations, provide interior isolation valve.

G. Cleanouts:
   1. Install cleanouts:
      a. Above floor in each vertical riser that connects to horizontal branch below floor.
      b. At test tee to receive proper test plugs in each vertical riser at least every other floor.
      c. As required by local Code.

H. Water Heater:
   1. Install all water heaters in accordance with details, manufacturer's recommendations, and applicable Codes.
   2. Connect hot and cold water piping to the unit with line-size, isolation valves and dielectric unions.

3. Start up the unit and adjust all controls for proper temperature control and maximum efficiency.
4. Where indicated, install instantaneous electric water heaters in enclosure rated for area classification.
   a. Silicone seal all piping and wiring penetrations.

I. Reduce Pressure Backflow Preventer: Install on water lines as required by Code.

3.2 FIELD QUALITY CONTROL

A. Test piping and fixtures for leaks per Specification Section 15060.

END OF SECTION

SECTION 15605
HVAC: EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Heating, ventilating, and cooling equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Air Movement and Control Association (AMCA).
   2. Air Conditioning and Refrigeration Institute (ARI).
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
      b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
      c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   4. Canadian Standards Association (CSA).
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. National Roofing Contractors Association (NRCA).
   8. Underwriters Laboratories, Inc. (UL):
      a. 507, Standard for Electric Fans.
   9. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2012 Edition including all 2013 amendments, referred to herein as California Building Code.

B. Miscellaneous:
   1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
   2. Corrosion protection of equipment to be as specified herein.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Wiring diagrams.
      d. Control diagrams.
      e. Manufacturer's catalog cuts and technical data.
      f. Corrosion-protection information.
      g. Fan curves.
      h. Sound data.
      i. Vibration isolation.

j. Control description.
k. Performance data on all equipment.

4. Certifications:
   a. Provide certification of thickness of corrosion-protection coating.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Vibration isolation assemblies:
      a. Mason.
      b. Vibration Mounting and Controls Co.
   2. Corrosion-protective coatings:
      a. Heresite and Chemical Co.; "Heresite."
      b. Aero-Marine Engineering, Inc.
   3. Cooling coils - direct expansion:
      a. Carrier.
      b. Daikin.
      c. McQuay.
   4. Unit heater - electric:
      a. Brasch.
      b. Chromalox.
      c. Markel.
   5. Packaged roof-top AC units:
      a. Trane.
      b. McQuay.
      c. Carrier.
   6. Roof-mounted propeller-type supply air fans:
      a. Loren Cook.
      b. Aerovent.
      c. PennBarry Ventilator Co., Inc.

2.2 GENERAL

A. All Manufactured Units:
   1. Comply with Specification Section 11005.
   2. Factory wired and assembled.
   3. Use fasteners made of same material as unit.
   4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
      a. Type: As per Table 42, Chapter 47, ASHRAE HVAC Applications Handbook.

B. Indicated manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.
   1. Type:
      a. Corrosion-resistant materials:
         1) Aluminum.
         2) Stainless steel.
         3) FRP.
      b. Corrosion-resistant coating:
         1) Phenolic-based coating:

2) 3 mil minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 DegF.
3) 5 mil baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 DegF.
4) Factory applied.
5) Provide factory certification of application.

2.3 MANUFACTURED UNITS

A. Equipment Coils:
1. Cooling coils - direct expansion:
a. ARI certified.
b. Material:
1) Aluminum.
2) Copper with aluminum fins for use in administration units only.
c. Fin spacing: Minimum 80 fins per foot.
d. Minimum standard operating limit: 250 psi.
e. Size and capacity as scheduled.

B. Unit Heater - Electric:
1. Type: Horizontal.
2. UL listed for non-rated areas.
3. Material:
a. Cabinet: 18 GA steel.
b. Heating elements: Copper-clad steel.
4. Fan motors:
a. See Specification Section 11005.
b. Built-in automatic reset overload protection.
5. Dynamically balanced fan.
6. Built-in automatic reset cutout protection.
7. Accessories:
a. Mounting bracket.
b. 40 to 90 DegF, 5 DegF differential wall-mounted thermostat.
8. Electrical, fan motor, and airflow data as scheduled on Drawings.

C. Packaged Roof-Top AC Units:
1. UL listed.
2. Designed for outdoor application.
3. Materials:
a. Frame and base: Minimum 14 GA galvanized steel.
b. Exterior panels: Minimum 17 GA galvanized steel.
c. Door liners for downstream access doors: Minimum 20 GA galvanized steel.
d. Gaskets: Dual durometer vinyl.
e. Insulation: 1 IN thick neoprene-coated glass fiber.
f. Fans: Painted rolled steel or galvanized steel.
g. Roof curb: Minimum 12 GA galvanized steel.
4. Cabinet, casing and frame:
a. Cross broken-top sections.
b. Designed to operate at total static pressure up to 5.5 IN WG.
c. Hinged side panels with single lever latching.
d. Completely insulated.
e. Base equipped with lifting brackets with lifting holes.
f. Hail screen for condenser coil.
5. Refrigerant condensing section:
a. Compressors:
1) Heavy duty, reciprocating, semi-hermetic type.
2) Positive displacement oil pump.

3) Suction and discharge service valves.
4) Crankcase heater.
5) Thermal overload protection.

b. Refrigeration circuit:
1) Sight glass.
2) Filter dryer.
3) Manual shut-off valve.
4) High pressure relief valve.

c. Compressor isolators.

d. Condenser coils:
1) Nominal 3/8 IN OD seamless copper mechanically bonded to corrugated aluminum fins.
2) Factory leak tested at 315 psig under water.

e. Condenser fans:
1) Direct drive: See Specification Section 11005.
2) Propeller-type.

f. Condenser fan motors:
1) Heavy duty, inherently protected, non-reversing.
2) Permanently lubricated bearings.
3) Integral rain shield.

6. Cooling coil section:
a. Evaporator coils: See paragraph(s) in Article 2.3, Equipment Coils.
b. Evaporator coil circuiting:
1) Adjustable thermal expansion valve per circuit with external equalizer.
2) Combination row/split face circuiting.
c. Drain pan:
1) Mastic-coated:
2) Threaded drain connections.

7. Supply fan section:
a. Supply fans:
1) Double-width, double-inlet centrifugal type.
2) Forward curved.
3) Solid steel shafts.
4) 200,000 HR relubricative ball-bearings.
b. Fan motors:
1) See Specification Section 11005.
2) Relubricative ball-bearings.
3) Adjustable base.
4) TEFC.
c. Driver and driven sheaves:
1) Keyed hub type.
2) Drive sheaves: Fixed pitch diameter.
3) Driver:
a) Shipped with variable pitch diameter sheave.
b) Fixed pitch diameter size based on approved test and balance reports.
4) V-belt drives sized for 150 percent motor horsepower.
d. Isolated fan assembly.

8. Filter section:
a. Filters: See Specification Section 15890.
b. Access doors for filter removal.

9. Outdoor air section:
a. Designed to form a plenum.
b. 0 to 100-percent outside air with economizer control.
c. Horizontal louvers with rain lip and birdscreen.
d. Floor sloped for water drainage.

e. Dampers:
   1) Sized to handle 100-percent supply air volume.
   2) Arranged vertically to encourage mixing of return and outside airstreams.
   3) Airfoil type.
   4) Fully gasketed and side sealed.
f. Adjustable potentiometer.
g. Adjustable enthalpy control outside of airstream.
h. Modulating spring return type damper motor.
i. Powered exhaust.

10. Electrical:
    a. Factory wired in accordance with NFPA 70 requirements.
    b. 115 V control circuit transformer.
    c. 115 V receptacle.
    d. Supply air firestat.
    e. System service switch.
    f. Control circuit fuse.
    g. Individually fused supply and return fan motors, compressor and condenser fan motor branch circuits.
    h. Weatherproof control panel with dead-front cover over main power controls.
    i. Disconnect switch.
11. Remote monitoring panel to include:
    a. "Auto-Cool" switch.
    b. "On-Off" fan switch.
    c. Minimum outside air damper potentiometer.
    d. Supply fan operation signal lights.
    e. Mechanical cooling malfunction indicating light.
    f. Clogged filters indicating light.
12. Size and capacity as scheduled on Drawings.

D. Roof-Mounted Propeller-Type Supply Air Fans:
1. AMCA certified.
2. Belt-driven.
3. Materials:
   a. Propeller: Cast aluminum or aluminum.
   b. Hood and fan housing: Aluminum.
   c. Curb cap: Aluminum.
   d. Orifice: Aluminum.
   e. Drive shaft: Solid steel.
   f. Sheaves: Cast iron.
4. Propeller:
   a. Statically and dynamically balanced.
   b. Airfoil design blades.
5. Continuously welded construction.
6. Bearings:
   a. Cast iron pillow blocks.
   b. Concentric bearing locking collar for drive shafts 1 IN and larger.
      1) SKF "ConCentra."
      2) Dodge "D Lock."
   c. Regreaseable.
   d. 200,000 HR average life.
7. Motor: See Specification Section 11005.
   a. TEFC.
8. Adjustable motor base.
   a. Driver and driven sheaves:
      1) Keyed hub type.
      2) Drive sheaves: Fixed pitch diameter.

3) Driver:
   a) Shipped with variable pitch diameter sheave.
   b) Fixed pitch diameter size based on approved test and balance reports.
4) V-belt drives sized for 150 percent motor horsepower.

9. Accessories:
   a. Roof curb.
   b. Non-fused safety disconnect.
   c. Backdraft damper: See Specification Section 15890.
   d. Extended grease lines and fittings.
10. Size and capacity as scheduled on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Specification Section 11005.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

3.2 FIELD QUALITY CONTROL

A. Comply with Specification Section 15990.

3.3 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

END OF SECTION

SECTION 15885
ODOR CONTROL SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work to be performed under this section shall consist of furnishing all labor, materials, equipment and incidentals necessary to install and test the odor control system, in place, complete with all appurtenances.
   1. Two single-stage odor control systems serving the Headworks and Solids Handling Facility shall consist of a bioscrubber system utilizing biologically active synthetic media with automated water/nutrient injection spray system, foul air fan, foul air ductwork, dampers, system control panel and other required equipment and appurtenances to provide a complete and functioning system.
   2. The system shall be provided with a permanent water recirculation system that is used to establish the biological growth on the media during startup or after system upsets, if required or with a once-through irrigation system.

1.2 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
   1. Air Movement and Control Association (AMCA):
      a. 210, Laboratory Methods of Testing Fans for Rating Purposes.
      b. 300, Test Code for Sound Rating Air Moving Devices.
   2. American National Standards Institute (ANSI):
      a. B73.1M, Horizontal End Suction Centrifugal Pumps for Chemical Process.
   3. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A582, Standard Specification for Free Machining Stainless Steel Bars.
      c. D833, Definition of Terms Related to Plastics.
      d. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
      e. D2563, Recommended Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts.
      f. D2583, Test for Indentation Hardness of Rigid Plastics by Means of Barcol Impression.
      g. D2584, Test for Ignition Loss of Cured Reinforced Resin.
      h. D3299, Standard Specification for Filament-Wound Glass Fiber Reinforced Polyester Chemical-Resistant Tanks.
      i. D4097, Standard Specification for Contact-Molded Glass-Fiber- Reinforced Thermoset Resin Chemical-Resistant Tanks.
      j. E679, Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits.
      k. ASTM D2996, Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) pipe.
   4. National Bureau of Standards (NBS):
      a. PS15, Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.
   5. National Electrical Manufacturers Association (NEMA)
   6. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):
      a. HVAC Duct Construction Standards - Metal and Flexible.

1.3 SUBMITTALS

A. Submit under provisions of Section 01340.

B. Shop Drawings and Product Data:
   1. Fiberglass resin manufacturer's technical data on composition and characteristic of resin for fiberglass items.
   2. Octave Band Sound power level information for rotating equipment.
   3. Manufacturer's technical data on equipment used.
   4. List of materials of construction.
   5. Scaled drawings (minimum 1/4 IN = 1 FT - 0 IN) showing layout of chemical system, control panels, pumps, ductwork, duct supports, fans, stack and other equipment used.
   6. Schematic and process and instrument diagram drawings to include itemized components, piping, valves, flow rates, pump and fan horsepower, pressures, control panels and equipment names. Schematic and process and instrumentation diagrams shall indicate process flow rates through the system in all operational modes.
   7. Control and power wiring diagrams.
   8. Complete drawings on control panel, panel wiring drawings and descriptive information on all components used.
   9. Ladder logic schematic control diagrams, and control narrative of the programmable logic controller (PLC), if provided.
   10. Certifications: Qualifications cited herein.
   11. Test reports:
      a. Hydrostatic and burn tests on fiberglass vessels
      b. Performance test reports.
      c. Field sound level measurements.
   12. Proposed odor testing laboratory qualifications.
   13. Testing procedures.

C. Calculations:
   1. Submit detailed design calculations for exhaust stack and foul air duct support design, including tension, compression, cantilever, vibration ovaling and dynamic stability as applicable and fan anchorage calculations. Calculations shall be stamped by a licensed Structural Engineer.
   2. Submit utility and nutrient use calculations and fan sizing calculations.

D. Samples: Vessel, duct, and pipe wall.

E. Miscellaneous:
   1. Odor control field test report.
   2. Qualifications and installation reference list with contact names and numbers.
   3. Warranty

1.4 QUALITY ASSURANCE

A. Qualifications: The odor control system manufacturer shall have at least five (5) years experience in the manufacture of biological odor control equipment, according to these general design concepts, and can provide evidence of continued successful operation with limited maintenance, limited replacement of parts, and a good record of acceptance by operators at other installations. The manufacturer shall have at least four (4) bioscrubber type odor control systems in successful operation for at least 2 years. The reference systems shall utilize the same type of 100 percent synthetic media, and equivalent or lower H2S design criteria. Manufacturer shall have a minimum of ten years of odor control experience.
   1. The foul air ductwork and damper manufacturer shall have similar products that have been in use in similar service for not less than three (3) years.

B. Warranty:
   1. An amount equal to 10 percent of the invoice price of the odor control system equipment shall be retained by the District until the performance testing requirements have been satisfactorily completed and accepted.
   2. The Contractor shall be responsible for all costs for modifications if performance requirements are not in compliance with the Contract Documents.
   3. The bioscrubber manufacturer shall warrant the bioscrubber vessel against all defects in workmanship and materials for a period of three (3) years from the date of a successful performance test.
   4. The bioscrubber manufacturer shall warrant the suitability of the biological reactor media for a period of ten (10) years from the date of delivery, provided that the system is operated in accordance with the Operating and Maintenance Manual provided by the manufacturer. In the event of a failure of the media within the ten (10) year warranty period, the manufacturer shall replace the media at no expense to the City of Pinole, City of Hercules, or Contractor.

1.5 SYSTEM DESCRIPTION

A. The odor control system will be utilized to remove volatile malodorous components characteristic of municipal sewage off-gases. These gases could contain but are not limited to ammonia, chlorine, dimethyl sulfide, diphenyl sulfide, ethyl mercaptans, indole, hydrogen sulfide, methyl amine, methyl mercaptans, and skatole.
   1. The system shall be designed to allow the formation of a pH gradient within the media bed, to allow the growth of autotrophic bacteria for Hydrogen Sulfide oxidation, and heterotrophic bacteria for the oxidation of other Reduced Sulfur Compounds (RSC's).

B. The odor control system consists of one odor control train.

C. Odor control system manufacturer shall be responsible for the complete system including all equipment, piping and controls required for the odor control system. The odor reduction system includes but is not limited to the odor control equipment (bioscrubber), nutrient feed pumps and systems, controls, system control panel and foul air fan:
   1. The WPCP 3W water supply is pressurized to 60 psi. If water pressure to the scrubber is required to be above 60 psi manufacturer to provide a booster pump that is integral to the odor control system. The booster pump shall be powered and controlled by the packaged controls in the electrical panel and programmed logic controller (PLC).

D. The odor control manufacturer shall review the plans and these provisions herein to assure all equipment necessary for a fully operational system is provided. If additional equipment, piping, controls, conduit and wiring or miscellaneous items are required above those shown or specified, manufacturer shall design, furnish, and install such equipment. Additional equipment piping, controls, conduit and wiring or miscellaneous items required must be of a quality that is at least equal in terms of materials, quality of construction and efficiency as specified herein.

E. NFPA 820 Requirements:
   1. Design and fabricate the entire odor control system to meet the requirements of NFPA 820.
   2. All motors and electrical work within three feet of the exterior of foul air ducting and the scrubber tower and fan shall be rated or suitable for a Class 1, Div 2, Group D area.
   3. All motors and electrical work within the foul air ducting and the scrubber tower and fan shall be rated or suitable for a Class 1, Div. 1, Group D area.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Subject to compliance with the Contract Documents, the following manufacturers of the odor control system are acceptable:
   1. Evoqua.

2. Bio Air.
3. Purafil.
4. Or approved equal.

B. Fiberglass Ductwork: Peabody Spunstrand, Ceilcote, or approved equal.

C. FRP Manual Dampers: Swartwout, or approved equal.

D. Where a Manufacturer's standard equipment name is used in these specification, the intent is to establish a minimum standard in terms of equipment quality, performance, functionality and experience. Substitutions as detailed must be pre-approved by the Engineer prior to bidding. Request for pre-approval must be received in writing 21 days prior to the bid opening date and must include the following supporting documentation and information:
   1. Provide project specific drawings showing arrangement of scrubber, blower and electrical and water control panels.
   2. Provide project specific Process and Instrumentation Diagram (P&IDs).
   3. Calculations showing cost of operation, power consumption, water consumption, nutrient consumption, expected media life, etc.
   4. A list of ten (10) similar installations with contact names and phone numbers, length of time in operation and volume of air being treated. Provide performance data for each reference, showing H_2S removal percent.
   5. Installation list detailing equipment capacity, length of time in service, performance record and performance records for two installations for a minimum 1 week duration for each system.
   6. Local service center details.
   7. Qualifications of key individuals.
   8. Company financial documentation, D&B report, Bonding Capacity, etc.

E. Any substitutions or deviations in equipment or arrangement from the shown on the Drawings or specified herein shall be the responsibility of the Contractor. Any deviation must be accompanied by detailed structural, mechanical and electrical Drawings and additional supporting data for review by the Owner and the Owner's Engineer and must be stamped and certified by a registered Professional Engineer (PE). No cost for such modifications hall be bourne by the District.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Total Design Air Flow:
   1. Headworks: 2,880 cfm.
   2. Solids Handling Facility: 3,760 cfm.

B. Headloss: Maximum flange-to-flange pressure loss through bioscrubber unit shall be maximum 6 IN water column at the design air flow rate, for a period of up to one year after completion of the performance testing. External static pressure shall be 2 IN water column.

C. Odorous Air Sources:
   1. Healdworks:
      a. Wetwells.
      b. Screenings, diversion and overflow channels.
      c. Grit basins.
      d. Grit channels.
   2. Solids Handling Facility:
      a. Loadout.
      b. Thickening room.
      c. Gravity thickener.

D. Inlet Air Hydrogen Sulfide Concentration: The odor control system shall meet the specified performance requirements under the following inlet air H2S concentrations:
   1. 25 ppm – maximum.
   2. 10 ppm – average.

E. Hydrogen Sulfide Percent Removal: 99 percent removal for total bioscrubber system or 0.1 ppm outlet concentration, whichever is greater.

F. Wind and Seismic Design Requirements: Design reactor vessels and exhaust stack shall be designed to the following specifications, codes and criteria:
   1. Applicable specifications and codes:
      a. California Building Code 2013, with applicable editions of the code referenced standards.
      b. ASCE7-10.
      c. ACI-318-11, ACI-350-06.
      d. Local jurisdiction amendments.
   2. Design criteria:
      a. Applies to all structures (UNO):
         1) Dead load:
            a) Actual tributary structure weight.
            b) Superimposed dead load: Actual weight of any mechanical equipment.
         2) Live load:
            a) Slab on grade: 250 PSF.
            b) Roof: 20 PSF (not reducible).
         3) Wind:
            a) Basic wind speed: V=115 PSF.
            b) Exposure: C.
            c) Risk category: III.
         4) Seismic:
            a) Above grade, non water bearing structures:
               (1) Risk category: III.
               (2) Importance factor: 1.25.
               (3) Spectral response acceleration, S_s=1.736.
               (4) Spectral response acceleration, S_1=0.688.
               (5) Site class: D.
               (6) Seismic design category: D.
               (7) Spectral response coefficient, S_{DS}=1.157.
               (8) Spectral response coefficient, S_{D1}=0.688.
               (9) Non-building structure type: Flat-bottom ground supported tank mechanically anchored.
               (10) Analysis procedure: Equivalent lateral force analysis.
               (11) Design basic shear:
                  (a) $V=C_S*W$
                  (b) W is the effective seismic weight.
         5) Snow load: Not applicable.

G. Allowable Noise Level: The odor control system shall not have a free field noise level at a distance of 3 FT of more than 82 dBA. An acoustic fan enclosure described herein and other noise attenuation measures shall be provided as required to meet the specified noise limit.

2.3 MATERIALS

A. Vessels, Ducts and Stack:
   1. Construction Material and Method: Fiberglass -- filament wound for all cylindrical shapes, spray up or lay up techniques for fittings, flanges, rectangular duct, and other custom shapes.
   2. Construction Requirements: Applicable standards shall included ASTM D3299 for filament wound tanks, D4097 for contact molded tanks, ASTM D2996, and National Bureau of Standards Voluntary Product Standard NBS PS15.
   3. Reinforcing for ducts shall be per SMACNA. Minimum wall thickness for ducts shall be based on structural calculations stamped by a Structural Engineer licensed in the state of California.

4. Resin:
    a. Commercial grade evaluated as a laminate by test or determined by previous service for an environment which may contain ammonia, chlorine, dimethyl sulfide, diphenyl sulfide, ethyl mercaptans, indole, hydrogen sulfide, methylamine, methyl mercaptan, skatole, potassium permangenate, sodium hypochlorite, hydrogen peroxide, sodium hydroxide or potassium hydroxide.
    b. Resin used in the system liner shall be a premium vinyl ester type such as Hetron 922FR by Ashland Chemicals, Derakane 510C by Dow Chemical, or approved equal. The resin shall be reinforced with an inner veil of suitable synthetic organic fiber such as Nexus 111-00010.
    c. Shall not contain thixotropic agents or pigments.
    d. Ultraviolet stabilizer shall be provided.
    e. Five (5) percent antimony trioxide added for fire retardation.

B. Fiberglass Material:
1. Commercial grade with a complying agent to provide bond between the glass fiber reinforcement and the resin.
2. Vessel and ducts shall have an average glass fiber content of 55 percent ±5 percent by weight per ASTM D2584.
3. Exterior Surface: Ferro-white, pebble gray, or an equivalent gel coat finish. The outer surface of the fabricated product shall be relatively smooth and no glass fibers shall be exposed.
4. Inner Corrosion Barrier: Resin-rich, 10-15 mil minimum, not to exceed 20 percent ±5 percent non-continuous glass fiber by weight.
5. Inner Mat Layer: Minimum two layers of chopped-strand mat or two passes of chopped roving to a total of 3 oz per square feet.
6. Should the chopped roving technique be employed, the chopped fibers shall be 1/2 to 2 IN in length.
7. Thickness inner corrosion barrier plus the inner mat layers shall be 100 mils minimum with 27 percent ±5 percent glass fiber by weight.
8. Structural Laminate:
    a. For cylindrical pipe or duct, a continuous process of filament winding at a helical angle of 65 degrees (+ or - 5 degrees) shall be applied to form the structural wall. The minimum thickness of the laminate shall be determined by the structural calculations generated and stamped by a P.E. licensed in the State of California.
    b. For fittings, flanges, custom shapes and rectangular duct, a hand lay-up/random chopped technique for building the structural wall shall be employed. At no time shall the structural wall thickness be less than the minimum value determined by calculations generated and stamped by a P.E. licensed in the State of California.
9. Exterior Layer:
    a. A final layer of paraffinated gell coat having UV inhibitor shall be applied to the surface of the FRP laminate.
    b. Gel coat shall be pigmented to match color selected by Engineer.
10. The vessels and ducts shall be cured to at least 90 percent of the minimum Barcol hardness specified by the resin manufacturer.

2.4 COMPONENT REQUIREMENTS

A. Reactor Vessels – General:
1. All materials of construction for the bioscrubber vessel and appurtenances shall be corrosion resistant. The exterior of the reactor vessel shall incorporate a surface veil for superior durability.
2. The reactor vessel shall have the following information printed on nameplates of appropriate size for the equipment involved:
    a. Name of Manufacturer
    b. Capacity in Gallons
    c. Chemical Environment

d. Manufacturer Serial Number
e. Year Built
f. Name and Equipment Number
g. Purchase Order Number
h. Design Pressure and Temperature
i. Resin

3. All flanges shall be made by hand lay-up. Press molded flanges shall not be allowed.
4. The machine facing of the back of hand lay-up flanges is not permitted. All boltholes shall be spot faced for AE size washers if required.
5. Flange drilling on pipe connections shall be in accordance with ANSI B-16.5 for 150 PSI pressure class. Flange thickness shall be per ASTM D3299, Table 4, for 25 PSI pressure rating.
6. All nozzles, 4 IN and smaller, shall be reinforced with gussets.
7. Boltholes in flanged nozzles are to straddle the vertical centerline. Tolerance for bolt holes' location and diameter of bolt circle shall be plus or minus 1/8 IN.
8. On all flanged joints use minimum 1/8 IN thick full-faced elastomeric gaskets having Shore A Durometer hardness of 40 to 60.
9. Reinforcement of nozzle and manhole openings in vessel walls shall be in accordance with the requirement of Appendix 1-4 of Section X of the ASME Boiler and Pressure Vessel Code. The reinforcement pad shall consist of plies of mat.
10. Threaded couplings shall not be allowed below the operating/overflow liquid level.
11. Neoprene Pad: Provide 1/4 IN thick 60 durometer neoprene rubber sheet under bioscrubber vessel.

B. Bioscrubber Reactor Vessel:
1. The bioscrubber reactor of the required height shall be a single free-standing tower/vessel including media and media bed irrigation system. The vessel shall be designed to support the required number of media layers and treatment stages. Provide a 1-IN diameter air inlet sample port with CPVC ball valve. Provide a minimum 2-IN diameter drain with CPVC valve.
2. Height of scrubber shall be maximum 16 FT to top of discharge flanges.

C. Bioscrubber Media:
1. The bioscrubber media shall be composed of high porosity synthetic media composed of chemically resistant polyurethane. The media shall be designed to facilitate the growth of bacteria necessary for biological oxidation of odorous compounds as required to meet the specified performance. The bioscrubber equipment manufacturer shall be responsible for providing the proper media content to ensure system meets specified performance. Organic media shall not be allowed.
2. The media shall resist shrinking or swelling with varying moisture content.
3. Media layers shall be self supporting, enclosed in a chemically resistant frame or random packed.
4. The treatment layers shall be designed not to short circuit or be subject to channeling under operating conditions.

D. Bioscrubber Internal Mist Eliminator:
1. Provide high efficiency, chevron-type mist eliminator.
2. Removal Efficiency: 99 percent of mist particles 40 microns and larger.
3. Removal Efficiency: 90 percent of mist particles 10 microns to 40 microns.

E. Bioscrubber Irrigation System:
1. The bioscrubber reactor shall be configured with fluid injection spray nozzle(s) located above each media layer for proper irrigation. Each spray nozzle shall be inspected and tested by the manufacturer to ensure even dispersion of irrigation water, and certified to be operating properly after installation and prior to the mechanical commissioning.

2. The irrigation rate and frequency shall be determined by bioscrubber manufacturer for specified process requirements. A once-through irrigation system shall operate satisfactorily at an average water flow rate of not more than 2.5 gpm and an instantaneous water flow rate of 25 gpm at a water supply pressure of 60 psi.
3. A water control panel (15LCP001, 63LCP001) shall contain all necessary piping, valves and instruments for proper operation of the irrigation system. The water panel shall be NEMA 4X 316 stainless steel. Panel shall be free standing with legs for mounting to concrete. Provide a panel circuit breaker with a lockable external operator. Circuit breaker shall meet the requirements of Section 16010.
4. Nutrient addition system:
   a. A nutrient addition system shall be suitable for 24 hours per day operation and shall be provided to add supplemental nutrients to the irrigation water supply. Capacity of system, type of nutrients and size of nutrient storage tanks shall be as required to meet the specified system performance. Nutrient storage tank shall be sized for a minimum of 30 days supply.
   b. The nutrient metering pump shall be mounted in the water control panel cabinet and shall be sized to deliver the required volume of nutrient solution to the bioscubber media. The metering pump shall be solenoid type, with manual control by adjustable stroke length and stroke frequency. Metering pump performance shall be reproducible to within +/- 3 percent of maximum capacity, and be certified for indoor or outdoor use. Head and end fitting material shall be GFPPL, seats and O-ring material shall be TFE, and ball material shall be ceramic. Minimum discharge pressure shall be as required to meet system operational requirements, but not less than 50 psig. A pressure relief valve with appropriate setting for the operating conditions shall be provided. Provide other accessories, including back-pressure valves and isolation valves. Metering pump shall be Wallace and Tiernan Premia 75 or equal.
5. Makeup water system:
   a. Makeup water system shall include the following in the water control panel:
      1) Level control switch (15LSHL001, 63SDHL001) located in bioscrubber sump.
      2) Automatic makeup water valve: PVC ball valve with 120 V operator suitable for location/environment.
      3) Makeup water rotometer (if a recirculation system is used): Glass tube with 5 IN scale and stainless steel frame, 5 gpm midrange capacity.
   b. The level switch shall control the level in the scrubber sump and have the following minimum performance:
      1) Measurement: RF impedance.
      2) Sensitivity: 0.2 PF or better.
      3) Drift: 0.003 PF per DegF.
      4) Power: 115 Vac.
      5) Output: DPDT, two Form C contacts, 5A resistive at 115 Vac.
      6) Classification: Suitable for the environment in which switch is installed. Provide intrinsically safe barriers or relays as required.
      7) Unit shall be Great Lakes Instruments 14L-1-D-ON or approved equal.
   c. Once-through irrigation system shall include a flow meter in the water control panel and shall have the following minimum performance:
      1) Flow range: 0.3 to 20 FT/S.
      2) Linearity: $\pm$ 1 percent of full range.
      3) Repeatability: $\pm$ 0.5 percent of full range.
      4) Power: 24 VDC.
      5) Unit shall be GF Signet 2536 or approved equal.
   d. Water booster pump (if required):
      1) Pump shall be centrifugal inline type with TEFC premium efficiency motor.
      2) Mount pump in the water panel.
      3) Controlled by pressure switch in water line.
6. Output signals:
   a. Provide isolated contact output signals for connection to the station PLC:

1) Nutrient Pump ON.
2) Nutrient Storage Tank Low.
3) Makeup Water Valve Closed.

F. Bioscrubber Control Panels (15LCP002, 63LCP002):
1. The control panel shall be NEMA 4X 316 stainless steel and shall be free standing for mounting on concrete slab or shall have factory installed legs for mounting on concrete slab.
2. The control functions shall be monitored and operated by an Allen Bradley Micrologix 1100 PLC, or equal, if a PLC is required.
3. The control panel shall require only a single electrical connection, 480 VAC, 3-phase, 50 ampere.
   a. Control panel will be installed outside and shall be suitable for that exposure.
   b. Provide main breaker with front panel operating handle.
   c. Provide interior breakers for all drives and controls.
   d. Provide control power transformer and power supplies as required.
   e. Provide, mount and wire all required power and control devices for complete operation of the odor control system.
   f. All wiring for equipment outside the control panel shall be brought to external connection terminal strips except for the 480 volt feeder and wiring to motors which may be wired directly to the breaker and starters.
   g. All 480 volt wiring and components shall be separated from the lower voltage components, marked with warning placards and barriered.
   h. Provide isolated contact output signals for connection to the station PLC:
      1) Combustible Gas Alarm.
      2) Combustible Gas Warning.
      3) Combustible Gas Trouble.
      4) Power On.
      5) System Online.
      6) Recirc Pump On (if required).
      7) Foul air Fan On.
      8) Recirc Pump Fail (if required).
      9) System Fail.
   i. Provide isolated analog (4-20 mA) output signals for connection to the station PLC:
      1) Percent LEL.
      2) Suction Pressure (Vacuum) Foul air Fan.
      3) Scrubber pH.

G. Bioscrubber Recirculation System (if required):
1. The bioscrubber manufacturer shall provide a permanent recirculation system for the reactor as required.
2. The recirculation pump shall be corrosion-resistant and suitable for the intended service. The pump motor shall not exceed 5 horsepower.
   a. Motor shall be 3-phase, TEFC or explosion proof, 460 volt, 3-phase, 60 Hz, 1.15 SF and class F or H insulation.
3. A pH sensor and transmitter shall be furnished and installed as shown on the Drawings.
   a. pH sensors:
      1) Provide insertion type or flow through sensor at scrubber with differential type electrode to minimize measurement errors.
      2) Automatic temperature compensation.
      3) Complete with mounting hardware and adequate cable to extend to transmitters on chemical feed panel.
      4) pH probe leads should be arranged for easy field calibration of the unit.
      5) Unit illustrated: Hach with mounting hardware, or approved equal.
   b. pH Meter/Transmitter:
      1) Provide two-wire receiver-analyzers mounted in the control panel.
      2) Liquid crystal digital display range: 0-14 (PH).

3) NEMA 4X enclosure or as meets NFPA 820.
4) Internal 24 Vdc power source to power pH probe.
5) Minimum performances:
   a) Sensitivity: 0.1 percent of span.
   b) Stability: 0.1 percent of span/24 HRS non-cumulative.
   c) Non-linearity: 0.1 percent of full scale.
   d) Repeatability: 0.05 mA.
   e) Response time: 2 seconds.
6) Unit shall be Hach, or approved equal.

c. Calibration kit:
   1) Provide a pH calibration kit with buffers.

H. Foul Air Fan:
1. The foul air fan shall be AMCA certified, single-width single-inlet centrifugal arrangement as designed and manufactured by The New York Blower Company, Hartzell, Universal Fan and Blower, or approved equal. The fan shall be sized to meet the requirements of the odor control system and shall have non-overloading horsepower capacity. Maximum motor horsepower shall be 20 horsepower.
2. Maximum sound level at 3 FT from fan shall be 82 dBA.
3. The fan shall be constructed such that all surfaces in contact with the corrosive gas stream are to be made of corrosion-resistant FRP. AMCA Arrangement 4, which places the motor shaft in the corrosive air stream is unacceptable. A nominal 1-IN pipe drain coupling shall be welded to the fan scroll at the lowest point.
4. All nuts, bolts and fasteners in contact with the gas stream shall be type 316 stainless steel.
5. Fan wheels shall utilize backwardly-inclined blades and be constructed of solid FRP with vinyl ester resin for spark and corrosion resistance.
6. Solid 316 stainless steel fan shaft.
7. Fan ratings shall be based on tests made in accordance with AMCA Standard 210 and licensed to bear the AMCA Certified Ratings Seal for Air Performance. Fans not licensed to bear the AMCA Seal for performance shall be tested, at contractor's expense, in an AMCA Registered Laboratory.
8. Fan shall be constructed in accordance with ASTM D-4167 standard specification for fiber-reinforced plastic fans and blowers to ensure structural integrity.
9. All parts exposed to the gas stream shall be constructed of, or encapsulated in, an FRP laminate capable of resisting continuous airstream temperatures of up to 250 DegF. All resins shall be clear to allow detection of subsurface imperfections. Use of pigments, gel coats, inhibitors and additives which may disguise flaws in the laminate is prohibited.
10. Fan housing shall be constructed of a fire-retardant polyester resin with an ASTM E84 Class I rating. Housing laminate construction shall conform to ASTM Standard C-582.
11. Wheel shall have non-overloading design for increased efficiency and shall be statically and dynamically balanced.
12. Wheel hub shall be completely encapsulated in FRP to ensure corrosion-resistant integrity. Steel wheels coated with FRP, or wheels with taper-lock hubs are not acceptable.
13. Bearings shall be self-aligning, grease lubricated heavy pillow block type located outside the airstream and rated for 150,000 hours average life.
14. The motor shall be premium efficiency, 460 Volt AC, 3 Phase, 60 Hz, 1.15 SF and class F or H insulation, electric motor as manufactured by US Electric Motors, Baldor, Reliance, Weg, or Siemens. The motor shall be Totally Enclosed Fan Cooled (TEFC) rated for Class 1, Division 2, Group D, or Explosion Proof (XP) to meet the applicable NFPA area classification. V-belts and drives shall be sized for 150 percent of motor capacity and provided with a belt guard.
15. Furnish a rigid acoustical fan enclosure and sound attenuation devices if required to provide the required level of sound attenuation. The fan enclosure shall be constructed of 316 stainless steel or FRP outer skin with stiffeners made of the same material. The sound adsorptive material shall be located between the stiffeners. 2-IN thick panels rated at NRC 0.95 shall be provided. Provide louvered vents for heat dissipation/ventilation adequate for

motor rating. Provide hinged doors with heavy duty hardware and seals for operator access to fan and motor for required maintenance. Enclosure shall be provided in two sections to allow for fan extraction.

16. Provide a Combustible Gas Detection system (15AE/AIT001, 63AE/AIT001) for installation in ducting at fan suction. Refer to Section 13442 for Gas Detection specifications.
    a. Provide a rotating alarm beacon on the top of the bioscrubber control panel. The beacon shall be actuated upon a combustible gas alarm. The combustible gas alarm shall be latching and shall not be cleared until the alarm condition is removed and a RESET pushbutton is pressed.
17. Provide a fan suction (vacuum) transmitter (15PIT001, 63PIT001).

I. Exhaust Stack:
    1. Provide a minimum 24-IN diameter FRP exhaust stack with height as shown on the plans. Exhaust stack shall be of free-standing design without guy wires.
    2. Discharge and Intake Air Sample Ports: Provide 1 IN diameter air sample ports with tubing to grade level and CPVC ball valves.
    3. Grounding pads: Provide two 316 stainless steel ground connection points on the vessel.
    4. Weather cap on discharge.

J. Static Pressure Gages (15PI001, 15PI002, 63PI001, 63PI002):
    1. Gages for measuring static pressure shall be industrial type pressure gages with range suitable for specific location. Pressure gauges shall be provided on the upstream and downstream side of the bioscrubber reactor vessel. Rosemount 3051, Dwyer Magnehilic, or equal.

K. Foul Air Duct Supports:
    1. Foul air duct supports shall be constructed of Type 316 stainless steel or FRP structural members. Type 316 stainless steel banding straps shall be provided around ducts except where supports occur at flanged connections. Support for ductwork shall comply with SMACNA.

L. Dampers, flexible connections, ductwork, transitions upstream of fan suction shall be provided by Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The odor control equipment shall be installed in strict accordance with the equipment manufacturer’s written instructions and approved submittals. Coordinate equipment and piping installation and anchorage with various trades and vessel manufacturer

B. Utilize template for location of anchorage. Align, level, wedge and plumb units to match piping interfaces as required.

C. Exercise care in bolting flanged joints so that there is no restraint in the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint. Provide tightening torque in accordance with manufacturer's recommendations. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.

D. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange. Realign as necessary, install flange bolts and make equipment connection.

E. Utilize anchor bolts and nuts (two jam nuts per bolt) to secure equipment.

F. Install nutrient feed system, including rotameter, isolation valve, suction line strainer, siphon valve and other appurtenances, in accordance with approved shop drawings.

G. Assemble and install ductwork in accordance with recognized industry practices. All joints shall be flanged or sleeved and made water-tight. Flanged joints shall be provided at all connections where dismantling may be required. Duct at field connections shall be provided with at least 6 IN of additional length for trim. Flanges for field duct connections shall be provided with one side loose for field adjustment. Align ductwork accurately at connections, within 1/8 IN misalignment tolerance and with internal surfaces smooth.

H. A manufacturer's factory-trained technical representative (not sales representative) shall be present as specified in paragraph 3.5.

3.2 FACTORY TESTING

A. Fiberglass Vessels:
   1. Hydrostatically test vessels prior to shipment, with water to the bottom of the air inlet flange for a minimum of 24 hours. The water shall be held with no visible signs of leaks or excessive wall deflection. The Owner reserves the right to be present at the fabricator's facility during testing. Notify the Owner two (2) weeks prior to the performance of the test.
   2. Perform minimum two burn tests of cutouts from areas where access doors, or piping cutouts are required to verify glass resin ratio.

3.3 INSPECTION AND STARTUP

A. Start-up of the system and all controls shall be the responsibility of the Contractor and equipment manufacturer. Factory-trained personnel shall be utilized to complete this activity. Start-up shall commence following a visual inspection and check out of the system by the equipment manufacturer's technical representative and Owner.

B. Start-up work performed by the Contractor and equipment manufacturer's representative shall include performing air flow measurements and adjusting fan sheaves and belts and position of the dampers to match the design air flow rates to the extent possible. This work shall include adjusting air flow and pressure to verify the operating point and capacity of the system is as shown on the schematic and process and instrument diagram for all operating modes.

C. Contractor and equipment manufacturer's representative shall cooperate with District staff to assure that all signals provided to the District PLC are checked out and operational.

D. An acclimation period of up to 6 weeks but no less than 3 weeks after initial startup and when pump station begins pumping sewage shall be allowed. Once the acclimation period is completed, the equipment manufacturer shall commence odor system performance testing as outlined in the following section.

3.4 FIELD TESTING

A. Functional Testing:
   1. Fiberglass vessels test:
      a. Hydrostatically test all vessels with water to the bottom of the air inlet flange after field installation is complete. Hold water for a minimum of 24 hours with no visible signs of leaks or excessive wall deflection greater than 1/4 IN.

2. Odor Control System Performance Testing:
    a. Test the odor control system to certify the performance is met. Perform testing after bioscrubber has been in service for at least 30 days. H2S performance testing shall be performed after all the foul air piping has been installed and the new pump station is in full operation.
        1) Coordinate schedule according to Section 01650 and substantial completion.
    b. Odor control system performance testing shall be conducted by an approved third party independent odor testing lab. All testing costs shall be borne by Contractor. The test results shall be submitted in writing within thirty (30) days of completion of the performance test.
    c. H2S Performance Testing:
        1) The vessel shall be operated at the specified design air flow rate, which shall be documented before performance testing begins.
        2) Testing for hydrogen sulfide (H2S) shall be conducted. An App-Tek Gas Data Logger (or equal) with a 0 – 1,000 ppm sensor shall be used to measure inlet concentrations to the bioscrubber. An App-Tek Gas Data Logger with a 0 – 2 ppm sensor shall be used to measure the outlet concentrations at the outlet of the bioscrubber.
        3) Inlet and outlet H2S concentrations shall each be recorded at one minute intervals for a twenty four (24) hour testing period. The inlet and outlet measurements shall be taken simultaneously.
    d. Evaluation of Test Results: If the odor control system fails to meet the performance criteria of this section, it will be the Contractor's responsibility to make all modifications necessary to improve performance at no cost to the District. The Contractor shall pay for all additional testing required to verify that performance criteria are being met.
        1) The Contractor shall prepare a test report and submit it to the Engineer. The report shall include procedures, data, calculations, and results.
3. Sound Level Measurements:
    a. Measure sound level at property lines and determine maximum actual sound level.
    b. Contractor to make any modifications needed until sound level criteria are met.

B. Operational Testing:
    1. A field operational test shall be made of the entire odor control system, including instruments, controls, motors, pumps, drive, and valves, to ensure compliance with the performance specified herein.
    2. All expenses for conducting the testing shall be paid by the Contractor. All equipment and instrumentation required for the odor control testing shall be provided by the Contractor.
    3. 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. Proper operation of control devices, switches, level switches, and alarm devices shall be demonstrated. If process conditions cannot be manipulated to demonstrate operation of alarm or control switches, then they shall be actuated artificially to effect the required demonstration. Demonstration shall include verification that all indicators and read-outs are functioning as required. All parts shall operate satisfactorily in all respects and in accordance with the specified requirements for the full duration of the test period.

3.5 TRAINING/MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and classroom designated by the Construction Manager for the minimum hour(s) listed below for work under this section, travel time excluded:

1. Pre-demonstration services, inspection and certification of installation: 8 hours.
2. Instruct the District's personnel on operation and maintenance: 12 hours.
   a. Training shall be provided in accordance with Section 01650.
3. System testing: 16 hours.

END OF SECTION

SECTION 15890
HVAC: DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. HVAC ductwork and accessories.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. 52, Method of Testing Air Conditioning Devices Used in General Ventilation for Removing Particulate Matter.
   2. National Fire Protection Association (NFPA).
   3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Ducted Electric Heat Guide for Air Handling Systems.
      b. HVAC Duct Construction Standards - Metal and Flexible.
   4. Underwriters Laboratory, Inc. (UL):
      a. 555, Standard for Safety Fire Damper and Ceiling Fire Damper.
      b. 555S, Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems.
      c. Building Materials Directory.
   5. Building code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2012 Edition including all 2013 amendments, referred to herein as California Building Code.

B. Qualifications:
   1. Fabricator: Firms regularly engaged in the manufacture of the specific product, of type, size required, whose products have been in use in similar service for not less than three (3) years.
   2. Installers: Firm with at least five (5) years installation experience on products similar to that required for this Project.

1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005.
   3. Efficiency ratings per ASHRAE 52 for factory built and assembled filter units.
   4. Scaled ductwork drawings (1/4 IN equals 1 FT) showing duct and accessory layout and support.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01342 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Miscellaneous Submittal:
   1. Documentation of qualifications for fabricators and installers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Transverse joints (factory fabricated aluminum):
      a. Ductmate Industries, Inc.
   2. Fiberglass ductwork:
      a. Peabody Spunstrand.
      b. Ceilcote.
   3. Turning vanes:
      a. Ductmate Industries, Inc.
      b. Duro Dyne.
      c. SEMCO Incorporated.
      d. Ward Industries, Inc.
   4. Flexible duct connections:
      a. Vent Fabrics.
      b. Duro Dyne.
   5. Flexible connector thrust restraint:
      a. Mason WB.
   6. Grilles and registers:
      a. Anemostat.
      b. Carnes.
      c. Titus.
   7. Manual (volume) dampers:
      a. Air Balance.
      b. Ruskin.
      c. American Warming.
   8. Duct sealers:
      a. Chicago Mastic.
      b. 3M Co.
      c. Permatex.
      d. Benjamin Foster.

2.2 COMPONENTS

A. Duct and Fittings (Metallic):
   1. Materials: 3003 H-14 aluminum alloy.
   2. Fabrication:
      a. Minimum sheet material thickness:
         1) Ducts with largest side or diameter to 30 IN: 0.05 IN thick.
         2) Ducts with largest side or diameter greater than 30 IN: 0.08 IN thick.
      b. Utilize SMACNA HVAC Duct Construction Standards for the minimum sheet material thickness specified herein.
         1) Heavier gage sheet material may be used with associated reinforcement as an alternate to minimum thickness specified.
         2) Lighter gage sheet material with associated reinforcement shall not be used as an alternate to minimum thickness specified.
      c. Longitudinal seams:
         1) 0.050 material:
            a) Pittsburgh seam.
            b) Continuously welded.

2) 0.080 material: Continuously welded.

d. Continuously weld seams on factory assembled units.

e. Transverse joints (Alternate A):

1) SMACNA T-22 companion flange.

2) Gasketed.

3) Rigidity class:

a) Ducts with largest side or diameter to 30 IN: SMACNA Class D (1-1/2 x 1-1/2 x 1/8 IN angles).

b) Ducts with largest side or diameter greater than 30 to 54 IN: SMACNA Class H (2-1/2 x 2-1/2 x 3/16 IN angles).

f. Transverse joints (Alternate B):

1) Materials and fabrication:

a) Angles: Aluminum.

(1) Ductmate 35.

b) Corners: Aluminum.

(1) Ductmate DC 35.

c) Snap cleats: Aluminized or stainless steel.

d) Gaskets: Closed cell neoprene.

e) Bolts: Stainless steel.

f) Sheet metal screws: Self-drilling stainless steel with unthreaded section under head.

2) Fabrication:

a) Rigidity class: SMACNA Class H.

b) 3/8 IN DIA x 1 IN bolts.

B. Duct and Fittings (FRP)

1. Materials:

a. Resin:

1) Halogenated polyester with 5 percent antimony trioxide.

2) No fillers allowed except for fire retardance and UV protection.

2. Fabrication:

a. Comply with NBS PS-15.

b. Surface mat liner:

1) Resin-rich polyester liner with C-Veil glass on bore surface.

2) Minimum thickness: 20 mils.

3) 90 percent resin and 10 percent glass.

c. Structural layer:

1) Filament wound glass and resin.

d. Exterior layer:

1) Sufficient resin to ensure coverage of glass fibers.

2) Smooth surface free of sharp projections.

3) Ultra violet inhibiting agent.

e. Liner or layers shall not contain siliceous sand or other granular fillers.

f. Minimum glass content: 50 percent.

g. Minimum wall thickness:

1) 6 through 20 IN DIA: 0.125 IN.

2) 21 through 36 IN DIA: 0.187 IN.

3) 37 IN DIA and larger: 0.250 IN.

4) For rectangular ductwork:

a) Substitute longest side for diameter stated above.

b) Minimum wall thickness is as determined from a) above plus 0.0625 IN.

3. Fittings from mitered sections:

a. Elbows:

1) Centerline radius:

a) Standard: 1.5 times the duct diameter.

b) Short (where indicated on drawings): 1.0 times the duct diameter.

2) 0 to 30 degrees: One (1) miter/two (2) gore.
3) 31 to 60 degrees: Two (2) miter/three (3) gore.
4) 61 to 90 degrees: Four (4) miter/five (5) gore
5) 61 to 90 degrees short radius: Four (4) miter/five (5) gore.

4. Flanged equipment connections:
   a. Hand lay-up per NBS PS-15.
5. Joints:
   a. Same material as pipe.
   b. Meet or exceed hoop tensile strength and axial strength requirements of the duct.
   c. Butt and wrap.
6. Minimum physical properties:
   a. Thermal conductivity (K value): 1.7 BTU/HR/FT(2)/DegF/IN.
   b. Specific Gravity: 1.4 to 1.9.
   c. Thermal coefficient of expansion: 9 to 14 x 10-6 IN/IN DegF.
   d. Barcol hardness: 40 to 55.
   e. Izod impact strength: 18 to 22 FT-LB/IN of notch
   f. Heat distortion temp.: 210 to 310 DegF at 260 psi.
   g. Compressive strength: 15,000 to 25,000 psi.
   h. Tensile strength: 9,000 to 12,000 psi.
   i. Flexural strength: 14,000 to 20,000 psi.
   j. Flexural modulus: 700,000 to 900,000 psi.
   k. Water absorption: 0.18 percent at 24 HRS ambient temperature.
   l. Temperature limits: 250 DegF continuous.

C. Supports and Hangers:
1. Materials:
   a. Support angles: Aluminum or stainless steel.
   b. Hanger rods: Stainless steel.
   c. Anchors: Stainless steel wedge type.
2. Fabrication: Trapeze type units.

D. Turning Vanes:
1. Materials: Same as duct.
2. Fabrication:
   a. Fabricate double vane units.
   b. Pressure drop through elbows: Maximum 20 percent of velocity pressure.

E. Flexible Connections:
1. Materials: Hypalon, double coated closely woven glass fabric.
2. Fabrication: Withstand 4.5 IN water column, positive and negative pressure.

F. Air Grille and Register Assembly:
1. Materials:
   a. Assembly: Extruded aluminum.
   b. Gaskets: Sponge rubber.
2. Fabrication:
   a. Supply registers (SR-1): Two (2) sets individually adjustable louvers.
   b. Exhaust and return registers (RR-1): 45-degree deflection front blades.
   c. Dampers: Key-operated opposed blade.
   d. Screws, duct collars, and transitions as required.
   e. Finish:
      1) Manufacturer's standard factory applied finish.
      2) Color: White.

G. Air Filters:
1. Materials:
   a. Holding frame: Aluminum.
2. Fabrication:

a. Factory built and assembled unit.
b. Efficiency rating as per ASHRAE 52.
c. 2 IN thickness minimum.
d. Efficiency: 20 percent.
e. Air velocity: 450 FPM maximum.
f. Clean pressure drop: 0.2 IN WG maximum.
g. Size, capacity, and type: As recommended by air conditioning unit manufacturer.

H. Fiberglass Round Volume Dampers:
1. Frame and flanges: Vinyl ester resin.
2. Blade: Vinyl ester resin.
3. Surface veil: 30 mil resin rich.
4. Axle: Pultruded FRP, vinyl ester resin, minimum 1 IN DIA.
5. Blade seal:
a. Neoprene.
b. Full circumferential.
c. Maximum leakage of 3.0 cfm/sf at 10 IN w.g.
6. Shaft seal: Neoprene O-ring.
7. Bearings: Molded PTFE.
8. Crank lever and hand quadrant: 316 SS, locking.
9. Flanges integral to web.
10. Damper to match ductwork size.
11. Swartout Model 912, or equal.

2.3 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish Owner with the following extra materials:
a. Twelve complete filter media changes for each filter unit.
b. Filter media used during construction is in addition to this requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 11005.

B. Metal Ductwork:
1. Install with longitudinal seams sealed for zero leakage.
a. For welded seams, submit sample for approval by Engineer.
2. Install gaskets at each transverse joint and fasten sections together with bolts.
a. Tighten for zero leakage.
3. Install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards.
4. Install turning vanes in square elbows:
a. Unsupported vane length not to exceed 48 IN.
b. Position vanes at proper angle to meet specified pressure drop.
5. Install flexible connections at fans:
a. Locate as close as possible to fan.
b. Allow 1 IN of slack to prevent vibration transmission.
c. Install thrust restraints across connectors.

C. Dampers:
1. Install where indicated on Drawings of sizes shown.

D. Air Grille and Register Assemblies:
1. Install where shown on Drawings of size and capacities scheduled on Drawings.

2. Install prime painted grilles and registers in areas where duct work is concealed.
   a. Field paint to match adjacent surface finish.

E. Air Filters:
   1. Do not operate equipment during construction without filters.

END OF SECTION

SECTION 15970
INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Instrumentation and control for HVAC systems.
   2. Temperature control.
   3. Ventilation control.
   4. Heating control.
   5. Cooling control.
   6. Control wiring.
   7. Panels and accessories.
   8. Miscellaneous.

1.2 QUALITY ASSURANCE

A. See Specification Section 11005.

B. Referenced Standards:
   1. ASTM International (ASTM):
      a. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   2. Instrumentation, Systems, and Automation Society (ISA):
      a. S5.1, Instrumentation Symbols and Identification.
      b. S5.4, Standard Instrument Loop Diagrams.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL).

C. Miscellaneous:
   1. Controls to be in compliance with Specification Section 16010 for NEMA and NFPA 70 enclosure class requirements unless noted or specified otherwise.
   2. Unless specifically noted otherwise, components of systems shall be industrial duty suitable for moist, corrosive environments.

1.3 SYSTEM DESCRIPTION

A. Work shall be provided as an integrated operating system.

B. Provide a complete system of automatic temperature control, thermostats, relays, valves, damper operators and other associated controls and appurtenances required to maintain minimum conditions described in detail herein and on Drawings, together with thermometers, gages and other accessory equipment.
   1. Assemble control system with complete system of wiring and conduit to fulfill requirements of the Contract Documents.

C. Install system using competent mechanics under direct supervision of control manufacturer.

D. Controls, as set out in "Sequence of Operation," are designed to illustrate operating functions only.
   1. Control sequence shall be considered supplementary to "Sequence of Operation."

2. These minimum specified items, and any additional controls, not indicated but required to meet performance as outlined in the Contract Documents, shall be furnished and installed at no additional cost to Owner to make a complete system.

E. Sequence of Operation - General:
1. Sequence of operation indicated illustrates basic operating functions only.
2. Contractor shall review Drawings and submit complete installation data, including minor details, to provide proper operation in his proposal.
3. Where an item differs from specifications, control manufacturer shall submit manufacturer's recommendations subject to Engineer's approval.
4. See sequence on Drawings.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Wiring diagrams showing point to point termination with auxiliary interlocks for each item in each control loop.
3. Information on equipment proposed for use including corrosion protection.
4. Instrument loop diagrams and word description of loop function for each individual unit controlled including auxiliary interlocks in full compliance with ISA S5.4.
   a. Show components in system and ensure diagrams are in full compliance with ISA S5.1 (Instrumentation Symbols and Identification) and other related ISA standards.

B. Quality Control Submittals:
1. Secure from equipment manufacturers, detailed and complete control and power wiring diagrams, word descriptions of controls provided as part of the HVAC equipment or equipment interfaced or interlocked thereto, and submit with equipment manufacturer's submittals.
   a. Provide the above information to control manufacturer.

C. Operation and Maintenance Manuals:
1. See Specification Section 01342 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

1.5 PROJECT CONDITIONS

A. Unless stated otherwise, the environment and air streams will include varying concentrations of the following chemical components:
1. H_2SO_4 - Sulfuric acid.
2. NH_3 - Ammonia.
3. Cl_2 - Chlorine.
4. H_2S - Hydrogen sulfide.
5. HCl - Hydrochloric acid.
6. Condensation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Manufacturer's catalog numbers hereinafter are for reference to type, style, dimension, related items and to establish a standard of quality.

a. Reference to a manufacturer's number hereinafter does not imply full compliance to these Specifications.

2. Instrumentation and control systems:
   a. Honeywell.
   b. Johnson Control Co.

2.2 EQUIPMENT

A. Electric Control Instruments:
   1. Provide stainless steel sensing elements type thermostats with liquid filled, compensated thermal systems so that equally spaced dial graduations are possible over entire range.
      a. Make thermal systems field detachable with averaging or plain bulbs as installation conditions dictate.
      b. Provide sensing elements minimum of 60 IN in length and suitable for operation from -30 to 300 DegF.
      c. Provide reverse acting on-off type thermostats for controlling ventilating fans.
      d. Provide multiple stage thermostats where designated in Paragraph "Sequence of Operation."
   2. Provide transformers for supplying current to control equipment operating at less than 120 V and where required by manufacturer's automatic control system design capable of supplying 125 percent of energy requirements of equipment connected for not less than 1 HR.
      a. Enclose transformers in UL listed cabinets with conduit connections.
      b. Provide fused disconnect switches on both primary and secondary sides.
      c. Provide in full compliance with Division 16 Specification Sections.
   3. Provide each thermostat with an accurate red-reading thermometer sensing temperature outside of enclosure.
   4. Label thermostat with identification tag of HVAC equipment controlled using phenolic nameplate in accordance with Specification Section 10400.

B. Static Pressure Gages:
   1. Install gages on control panel for each system.
      a. One (1) gage shall serve each filter while others shall serve as a check on system.
      b. Gages shall be Magnahelic by Dwyer 2000 ASF, flush mounted with signal flag for filter gage.
      c. Install static pressure tips as scheduled under control panel indication points.
      d. Static pressure ranges:
         1) Air-handling systems: 0 to 10.0 IN WC (one (1) per air-handling unit).

2.3 FABRICATION

A. Corrosion Protection:
   1. Protect metal parts of controls, instrumentation and related items from corrosive atmosphere by either protective coatings or select materials.
      a. Aluminum and stainless steel require no further protection.
   2. Provide NEMA 4X fiberglass control enclosures with tempered glass windows and vapor tight gaskets, illustrated in Hoffman Bulletin A-50, for protection of controls from corrosive environment.
      a. Install control instruments inside enclosure and extend remote stainless steel sensing elements through enclosure wall.
      b. Provide vaportight seals for penetrations of enclosure.
   3. Provide in each enclosure industrial corrosion inhibitors, Hoffman Corrosion Inhibitors, as illustrated in Hoffman's technical Bulletin HCI.
   4. Protect metal accessory items such as mounting brackets and fasteners not stainless steel, fiberglass or aluminum by epoxy or phenolic coatings.
   5. Protect electric motor operator with corrosion inhibitors inside enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements of Specification Section 16120 and Specification Section 16130.

B. Identification: See Specification Section 10400.

C. Connect control devices to perform functions indicated and perform in required sequence.

D. Where continuous indication of space temperature is on local control panels, install a thermostat and a temperature transmitter side by side.
   1. Pipe continuous indication signal to a receiver on panel.
   2. A resistance element or thermocouple signal may be used with continuous indicating meter, calibrated in degrees Fahrenheit.

E. In general, locate thermostats for room control immediately inside door, above light switch, unless shown otherwise.
   1. Where light switch is in an entryway to room, locate thermostat on wall within room so it is capable of sensing true space conditions.
   2. Prior to installation, coordinate thermostat location with Engineer.

F. Mount local control panels adjacent to equipment served.

G. Where a temperature indicating gage is used at the panel, a pressure gage indicating transmitter signal is not required.

H. Locate panels so visual observation and adjustment can be accomplished from floor level.

END OF SECTION

SECTION 15990
HVAC SYSTEMS: BALANCING AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Adjusting, balancing, and testing of all heating, ventilating and air conditioning (HVAC) systems, including the following systems:
      a. HVAC systems.
      b. Odor control systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Associated Air Balance Council (AABC):
      a. National Standards for Total System Balance.
   2. American Industrial Hygiene Association (AIHA):
      a. Z9.5, Laboratory Ventilation.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Laboratories."
      b. HVAC Systems and Equipment Handbook, Chapter entitled "Testing, Adjusting, and Balancing."
   4. National Environmental Balancing Bureau (NEBB):
      a. Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

B. Qualifications:
   1. Work of this Section to be accomplished by an independent testing and balancing firm certified by one (1) of the following:
      a. Associated Air Balance Council (AABC).
      b. National Environmental Balancing Bureau (NEBB).
      c. Other certification entity approved by Engineer.
   2. The independent firm shall not be the same firm as the firm installing the HVAC equipment, nor under contract to the firm installing the equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Certifications:
      a. Letter stating the name and qualifications of the firm proposed.
      b. Evidence that relevant subcontractors have been notified of the requirement to coordinate balance and test elements in the work with the testing and balancing firm.
   3. Report forms:
      a. Procedures and forms to be used in calibrating of test instruments, balancing systems, and recording and reporting test data.

B. Informational Submittals:
   1. Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems.
      a. Insert recorded information on report forms required by specifications and approved for use on project.
      b. Additional written verification and other related information clearly identifying project, date and specifics of verification.

c. Utilize report forms similar to those shown in Section V of AABC Standard.
d. Provide forms typed and signed by the testing and balancing firm.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 PREPARATION

A. Secure approved Shop Drawings of all HVAC equipment.

B. Procedures and Forms:
1. Submit procedures and forms to be used in calibration of test instruments, balancing systems, and recording and reporting test data.
2. Obtain approval before beginning balancing and testing.

C. Do not begin balancing and testing until HVAC systems are complete and in full working order.
1. Place HVAC systems into full operation and continue their operation during each working day of balancing and testing.

D. Provide qualified heating and ventilating Engineer(s) to supervise and perform balancing and testing.

E. Review design Drawings, specifications, approved Shop Drawings and other related items to become thoroughly acquainted with the design of HVAC systems.

F. Check all installed systems against Contract Drawings, Specifications and Shop Drawings to see that system is installed as required.
1. Report deficiencies to the Engineer.
2. Report deficiencies to Contractor for remedial action including providing corrective measures required in the function of any part of system to complete balancing.

G. Make necessary adjustments as required to balance the systems.

3.2 FIELD QUALITY CONTROL

A. Balance and Test Air Systems:
1. Adjust equipment RPM to design requirements.
2. Report motor full load amperes.
3. Obtain design CFM at fans.
   a. Make pitot tube traverse of main supply and exhaust ducts within 5 percent.
4. Test and record system static pressures, suction and discharge.
5. Obtain design CFM for recirculated air.
6. Obtain design CFM outside air.
7. Test and record entering air temperatures, (DB, heating and cooling).
8. Test and record leaving air temperatures, (DB, heating and cooling).
9. Test and record leaving air temperatures, (WB, cooling).
10. Adjust dampers in supply, exhaust and return air ducts to design CFM.
11. Test diffusers, grilles, and registers as follows:
    a. Adjust to comply with design requirements within 10 percent.
    b. Identify location and area of each.
    c. Adjust face velocity to establish required CFM.
       1) Retest after initial adjustments.
    d. Adjust to minimize drafts and to ensure uniform air distribution in all areas.
12. Identify and list size, type and manufacturer of diffusers, grilles, registers, and HVAC equipment.
    a. Use manufacturer's ratings on equipment to make required calculations.

13. Adjust and assure that the operation of automatically operated dampers are as specified.
    a. Check and calibrate controls.
14. Prepare and submit reports.

END OF SECTION

SECTION 16010
ELECTRICAL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. American Iron and Steel Institute (AISI).
   3. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ETL Testing Laboratories (ETL).
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C2, National Electrical Safety Code (NESC).
   6. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc. (UL).

B. Where UL test procedures have been established for the product type, use UL or ETL approved electrical equipment and provide with the UL or ETL label.

1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
   2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
   3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
   4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
   5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
   6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of submittal process.

2. See Specification Section 11005 and individual specification sections for submittal requirements for products defined as equipment.
3. General requirements:
   a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
   b. Include data sheets that include manufacturer's name and product model number.
      1) Clearly identify all optional accessories.
   c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
   d. Manufacturer's delivery, storage, handling and installation instructions.
   e. Product installation details.
   f. See individual specification sections for any additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content process of Operation and Maintenance Manuals.

C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01340 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01600.

B. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
   1. Outdoor areas:
      a. Wet.
      b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
   2. Indoor areas:
      a. Dry.
      b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Division 16 Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Submit request for substitution in accordance with Specification Section 01640.

C. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
   1. Approved manufacturers:
      a. Modular strut:
         1) Unistrut Building Systems.
         2) B-Line.
         3) Globe Strut.

4) Or approved equal.

2. Material requirements:
   a. Modular strut:
      1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
      2) Stainless steel: AISI Type 316.
      3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.
      4) Aluminum: AA Type 6063-T6.
   b. Mounting hardware:
      1) Galvanized steel.
      2) Stainless steel.
   c. Anchorage per Specification Section 05505.

B. Field touch-up of galvanized surfaces.
   1. Zinc-rich primer.
      a. One (1) coat, 3.0 mils, ZRC by ZRC Products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
   1. NFPA 70.
   2. IEEE C2.
   3. The manufacturer's instructions.

C. In general, conduit routing is not shown on the Drawings.
   1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
   2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:
   1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
   2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
   3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
   4. See Specification Section 16120 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operating and maintenance requirements of other equipment.

I. Device Mounting Schedule:
   1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
      a. Light switch (to center): 48 IN.
      b. Receptacle in architecturally finished areas (to center): 18 IN.
      c. Receptacle on exterior wall of building (to center): 18 IN.
      d. Receptacle in non-architecturally finished areas (to center): 48 IN.
      e. Telephone outlet in architecturally finished areas (to center): 18 IN.
      f. Telephone outlet for wall-mounted phone (to center): 54 IN.
      g. Safety switch (to center of operating handle): 54 IN.
      h. Separately mounted motor starter (to center of operating handle): 54 IN.
      i. Pushbutton or selector switch control station (to center): 48 IN.
      j. Panelboard (to top): 72 IN.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
   1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments of up to 12 IN in equipment location. Changes in equipment location exceeding those defined above require the Engineer's approval.

K. Provide electrical equipment support system per the following area designations:
   1. Dry areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   2. Wet or corrosive areas:
      a. Stainless steel system consisting of aluminum channels and fittings with stainless steel nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. See Specification Section 05505.
   2. Do not cut, or weld to, building structural members.
   3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas or on walls of liquid containment or processing areas.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

Q. Identify electrical equipment and components in accordance with Specification Section 10400.

3.2 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
   1. See Specification Section 01800 for openings and penetrations in structures.

B. Replace equipment and systems found inoperative or defective and re-test.

C. Cleaning:
   1. See Specification Section 01710.

D. The protective coating integrity of support structures and equipment enclosures shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
   4. Repair surfaces which will be inaccessible after installation prior to installation.
   5. See Specification Section 16130 for requirements for conduits and associated accessories.

E. Replace nameplates damaged during installation.

3.3 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01650.

END OF SECTION

SECTION 16012
SEISMIC BRACING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. The design and installation of seismic bracing and anchorage required for electrical equipment, conduit, cable tray, and bus ducts.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      c. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

1.3 SYSTEM DESCRIPTION

A. Contractor is responsible for design and installation of seismic bracing and anchorage systems.

B. Description of Systems:
   1. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment.
   2. Anchorage of floor and roof mounted electrical equipment.

C. Seismic Design Requirements:
   1. Seismic design criteria: Provide bracing and anchoring for equipment, conduit, cable tray, bust duct, designed, constructed, and installed to resist stresses produced by lateral forces.

D. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 LBS or more and all suspended or wall mounted equipment weighing 20 LBS or more.

E. The following components are exempt from the requirements of this Specification Section:
   1. Electrical components in structures assigned to Seismic Design Category C provided that the importance factor (I_p) is equal to 1.0.
   2. Electrical components in Seismic Design Categories D, E, and F where $I_p = 1.0$ and flexible connections between the components and associated ductwork, piping, and conduit are provided and that are mounted at 4 FT (1.22 m) or less above a floor level and weigh 400 LBS (1780 N)or less.
   3. Electrical components in Seismic Design Categories D, E, and F weighing 20 LBS (95 N) or less where $I_p = 1.0$ and flexible connections between the components and conduit are provided, or for distribution systems, weighing 5 LBS/FT (7 N/m) or less.

F. Seismic forces shall be presumed to act through the center of mass of the equipment in a direction that will produce the largest single anchor force.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Seismic control devices.
   3. Fabrication and/or layout drawings:
      a. Layout and mounting detail drawings showing system and proposed brace locations for all systems including pre-engineered systems.
      b. The specific detail for each type of brace or anchor must be referenced on a plan that identifies the required location.
         1) Supplying a book of details without referencing the proper detail to a specific location on a plan is not acceptable.
      c. Structural calculations for required lateral force level for each component.
      d. All submittals, including pre-approved systems, shall be signed and sealed by a licensed engineer, licensed in the state in which the project is located.

1.5 PROJECT CONDITIONS

A. Seismic (Earthquake) Loads: See Section 11005.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pre-engineered suspended bracing systems:
      a. International Seismic Application Technology (ISAT) “Engineered Seismic Bracing of Suspended Utilities”.
      b. Unistrut.
      c. Tolco.
      d. B-Line.
      e. Or approved equal.
   2. Custom engineered systems designed using specified criteria and common building materials.

2.2 EQUIPMENT ANCHORS AND SUPPORTS

A. Drilled-in-place concrete anchors shall have an approved ICBO Evaluation Services Report.

B. Cast-in-place anchors shall comply with ASTM A36, ASTM A307, or ASTM F1554, 36 ksi.

C. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.

D. Structural steel for supports: ASTM A36.

E. Cold formed metal and connection material: Unistrut.

F. Any details provided are based on assumed equipment and arrangement.
   1. Contractor shall be responsible for design and acquiring approval for support and anchorage of equipment and arrangement which varies from equipment and arrangement assumed in detail provided.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Every run which requires bracing shall have a minimum of two (2) transverse braces and one (1) longitudinal brace.
   1. A "run" is defined as suspended pipe, conduit, cable tray, bus ductor trapeze rack having a minimum 5 FT straight run length.

B. Brace spacing shall not exceed the maximum allowable brace spacing as engineered by the manufacturer or custom bracing designer.

C. Bracing may be omitted from conduit, cable tray and bus duct runs less than 5 FT in length.

D. Bracing may be omitted from conduit, cable tray and bus duct runs where rod hung supports of less than 12 IN. (305mm) in length are required.
   1. All unbraced suspended utility systems having 2 IN conduit and larger or systems weighing more then 5 LBS/FT shall be installed with a minimum 6IN clearance to suspended ceiling vertical hanger wires.
   2. The conduit, cable tray, or bus duct shall be installed such that the lateral motion of the members will not cause damaging impact with other systems or structural members or loss of vertical support.

E. A longitudinal brace at a 90 degree change in direction may act as a transverse brace if it is located within 2 FT of the change in direction.

F. A transverse brace may act as a longitudinal brace if it is located within 2 FT of a change in direction and if the brace arm and anchorage have been sized to meet or exceed the requirements of the longitudinal brace.

G. When bracing equipment or a utility system that is suspended from an overhead deck, brace back to the overhead deck or to the supporting structure supporting the deck.
   1. Do not brace to another element of the structure which may respond differently during a seismic event.

H. Obtain approval from the Structural Engineer prior to attaching any brace elements to structural steel or wood framing.

I. When utilizing cable bracing, tension the cable to remove slack without inducing uplift of the suspended element.
   1. Tension seismic bracing system prior to system start-up and adjust if necessary after equipment start-up.

J. As a general rule, do not mix rigid bracing with cable bracing in the same run.
   1. However, once bracing has transitioned a 90 degree change in run direction, the bracing may switch from rigid to cable or vice versa if required due to a significant change in overhead deck elevation or to provide an implementable bracing scheme in a congested area.

K. Install brace members at an angle of 45 degrees from horizontal within a tolerance of plus 2 1/2 degrees or minus 45 degrees provided the brace length is accounted for in design.
   1. Brace angle may be increased to 60 degrees provided the brace spacing is reduced to 1/2 that required for a 45 degree brace.

L. Seismic bracing may not pass through a building separation joint.
   1. Utility systems that pass through a separation joint must be seismically restrained no greater than 5 FT from the point of connection.
   2. Any hardware designed to accommodate seismic movement across the span of the separation joint shall be installed per manufacturer's installation and listing instructions.

M. With approval of the Structural Engineer, utility systems that are suspended from the overhead deck may be braced to load bearing concrete or CMU (concrete masonry) walls provided that the walls and the overhead decks will respond similarly during a seismic event.

N. Each layer of a multiple layer trapeze rack shall be braced individually based on the weight of the individual layer.

O. Conduit, cable tray, or bus duct constructed of non ductile material (plastic or fiberglass), shall have brace spacing reduced to 1/2 of the spacing allowed for ductile materials.

P. Where brace elements are through-bolted, the mounting hole in the element is to be no more than 1/16 IN in diameter larger then the bolt or threaded rod.

Q. Seismic braces shall directly brace the system and not the hanger.

3.2 SUSPENDED ELECTRICAL SYSTEMS

A. Install seismic bracing for all conduit 2-1/2 IN trade size or greater.

B. All trapeze assemblies supporting conduits, cable trays or bus ducts shall be braced considering the total weight of the elements on the trapeze.
   1. For the purposes of calculating weight, all conduits are to be treated as full.

C. Brace all trapeze racks which support conduit 2-1/2 IN trade size or larger.
   1. Brace all other conduit rack, cable tray or bus duct trapezes having a minimum weight in excess of 10 LBS/LF.
   2. Include a minimum 10 percent additional capacity for future additions.

D. Seismic bracing may be omitted from cable trays, conduit and bus ducts suspended by rod hung supports 12 IN or less in length form the top of the element to the bottom of the structural attachment of the hanger provided lateral motion will not cause damaging impacts to other systems or loss of system vertical support.

E. All vertical risers involving conduit 2-1/2 IN in diameter or larger shall include lateral restraint at maximum 30 FT intervals and at the top and bottom of the riser.

3.3 FLOOR OR ROOF MOUNTED EQUIMENT

A. Provide one (1) anchor on each leg or corner.
   1. Support with a minimum of three (3) 3/8 IN DIA anchors.

B. Friction shall be neglected when designing anchors for shear.

C. Vertical seismic forces, when required, shall be presumed to act concurrently with horizontal seismic forces.

END OF SECTION

SECTION 16060
GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for grounding system(s).

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
         1) Article 250, Grounding and Bonding.
         2) Article 610, Cranes and Hoists.
         3) Article 620, Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts.
   4. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Grounding clamps, terminals and connectors.
         2) Exothermic welding system.
      b. See Specification Section 16010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ground rods and bars and grounding clamps, connectors and terminals:
      a. Burndy.
      b. Harger Lightning Protection.
      c. Heary Brothers.
      d. Joslyn.
      e. Robbins Lightning Protection.
      f. Thomas & Betts (Blackburn).
      g. Thompson.

h. Or approved equal.
2. Exothermic weld connections:
a. Erico Products Inc., Cadweld.
b. Harger Lightning Protection.
c. Thermoweld.
d. Or approved equal.
3. Prefabricated composite test stations:
a. Quazite Composolite.
b. Armorcast Products Company.
c. Or approved equal.

2.2 COMPONENTS

A. Wire and Cable:
1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
2. Insulated conductors: Color coded green, per Specification Section 16120.

B. Conduit: As specified in Specification Section 16130.

C. Ground Bars:
1. Solid copper:
a. 1/4 IN thick.
b. 2 or 4 IN wide.
c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
2. Predrilled grounding lug mounting holes.
3. Stainless steel or galvanized steel mounting brackets.
4. Insulated standoffs.

D. Ground Rods:
1. 3/4 IN x 10 FT.
2. Copperclad:
a. Heavy uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
b. Corrosion resistant bond between the copper and steel.
c. Hard drawn for a scar-resistant surface.

E. Grounding Clamps, Connectors and Terminals:
1. Mechanical type:
a. Standards: UL 467.
b. High copper alloy content.
2. Compression type for interior locations:
a. Standards: UL 467.
b. High copper alloy content.
c. Non-reversible.
d. Terminals for connection to bus bars shall have two bolt holes.
3. Compression type suitable for direct burial in earth or concrete:
a. Standards: UL 467, IEEE 837.
b. High copper alloy content.
c. Non-reversible.

F. Exothermic Weld Connections:
1. Copper oxide reduction by aluminum process.
2. Molds properly sized for each application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
3. Remove paint, rust, or other nonconducting material from contact surfaces before making ground connections.
4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install per Specification Section 01800.
5. Do not splice grounding conductors except at ground rods.
6. Install ground rods and grounding conductors in undisturbed, firm soil.
   a. Provide excavation required for installation of ground rods and ground conductors.
   b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
   c. Unless otherwise specified, connect conductors to ground rods with compressor type connectors or exothermic weld.
   d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
   e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:
   1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
   2. Grounding conductor terminations:
      a. Ground bars mounted on wall, use compression type terminal and bolt it to the ground bar with two bolts.
      b. Ground bars in electrical equipment, use compression type terminal and bolt it to the ground bar.
      c. Piping systems use mechanical type connections.
      d. Building steel, below grade and encased in concrete, use compression type connector or exothermic weld.
      e. At all above grade terminations, the conductors shall be labeled per Specification Section 10400.
   3. Ground ring grounding system:
      a. Ground ring consists of ground rods and a grounding conductor looped around the structure.
      b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
      c. Provide a minimum of four (4) ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
      d. Building/Structure grounding:
         1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
      e. Grounding conductor: Bare conductor, size as indicated on the Drawings.

C. Supplemental Grounding Electrode:
   1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
   2. Metal light poles:
      a. Connect metal pole to a butt ground.
      b. Grounding conductor: Bare #6 AWG minimum.
   3. Equipment support rack and pedestals mounted outdoors:
      a. Connect metallic structure to a ground rod.
      b. Grounding conductor: #6 AWG minimum.

D. Low Voltage Transformer Separately Derived Grounding System:
   1. Ground separately mounted step-down transformers XO terminal to one of the following:
      a. Closest building steel using mechanical type terminal bolted to the steel, compression type connection or exothermic weld.
      b. Closest water pipe using a mechanical type connection.
   2. Ground step-down transformer integrally mounted in motor control center to motor control center ground bus.

E. Raceway Bonding/Grounding:
   1. All metallic conduit shall be installed so that it is electrically continuous.
   2. All conduits to contain a grounding conductor with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
   3. NFPA 70 required grounding bushings shall be of the insulating type.
   4. Provide double locknuts at all panels.
   5. Bond all conduit, at entrance and exit of equipment, to the equipment ground bus or lug.
   6. Provide bonding jumpers if conduits are installed in concentric knockouts.
   7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

F. Equipment Grounding:
   1. All utilization equipment shall be grounded with an equipment ground conductor.

G. Manhole and Handhole Grounding:
   1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
      a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
   2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

B. Acceptance testing:
   1. See Specification Section 16080.

END OF SECTION

SECTION 16080
ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for acceptance testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
      b. 400.3, Guide for Partial Discharge Testing of Power Cable Systems in a Field Environment.
   2. InterNational Electrical Testing Association (NETA):
      a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
   3. Nationally Recognized Testing Laboratory (NRTL).
   4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:
   1. Testing firm qualifications: See Specification Section 11005.
   2. Field personnel:
      a. See Specification Section 11005.
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.
   3. Analysis personnel:
      a. See Specification Section 11005
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:
   1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
      a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 11005 for electrical equipment and connection testing plan submittal requirements.

B. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.

2. Prior to energizing equipment:
   a. Coordinated phasing diagram.
   b. Photocopies of continuity tests.
3. Within two (2) weeks after successful completion of Demonstration Period (Commissioning Period):
   a. Single report containing information including:
      1) Summary of Project.
      2) Information from pre-energization testing.
      3) See testing and monitoring reporting requirements in Specification Section 11005.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

A. Provide Division 16 equipment with all routing factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 11005.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:
   1. See Specification Section 11005.
   2. Complete electrical testing in three (3) phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   3. Perform testing in accordance with this Specification Section and NETA ATS.
   4. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.

B. Equipment Monitoring and Testing Plan: See Specification Section 11005.

C. Instruments Used in Equipment and Connections Quality Control Testing: See Specification Section 11005.

D. Testing and Monitoring Program Documentation: See Specification Section 11005.

E. Electrical Equipment and Connections Testing Program:
   1. See Specification Section 11005.
   2. See individual Division 16 Specification Sections for equipment specific testing requirements.
   3. Test all electrical equipment.
      a. Perform all required NETA testing.
      b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Switchboards:
   1. Perform inspections and tests per NETA ATS 7.1.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

B. Transformers - Small Dry Type:
   1. Perform inspections and tests per NETA ATS 7.2.1.1.
   2. Perform the following additional tests:
      a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
   3. Adjust tap connections as required to provide secondary voltage within 2-1/2 percent of nominal under normal load after approval of Engineer.
   4. Record as-left tap connections.

C. Cable - Low Voltage:
   1. Perform inspections and tests per NETA ATS 7.3.2.

D. Cable - Optical Fiber:
   1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
      a. Optional time domain reflectometer test.
      b. Power attenuation test.
      c. Gain margin test.

E. Busway and Busduct:
   1. Perform inspections and tests per NETA ATS 7.4.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

F. Low Voltage Molded Case Circuit Breakers:
   1. Perform inspections and tests per NETA ATS 7.6.1.1.
   2. Components:
      a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
      b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
      c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
   3. Record as-left settings.

G. Owner Power Metering:
   1. Perform inspections and tests per NETA ATS 7.11.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following additional tests:
      a. Configure all configurable settings.

H. Grounding:
   1. Perform inspections and tests per NETA ATS 7.13.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

I. Ground Fault Protection:
   1. Perform inspections and tests per NETA ATS 7.14.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Control wiring insulation resistance.
   4. Perform the following additional tests for four-wire systems:
      a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current jumper used to simulate unbalanced load and ground fault conditions.
      b. Verify no tripping for unbalanced load on each feeder and each main breaker.
      c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.

d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.
e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

J. Motors:
1. Perform inspections and tests per NETA ATS 7.15.
2. See Specification Section 11005.

K. Motor Controllers:
1. Perform inspections and tests per NETA ATS 7.16.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

L. DC Power Systems:
1. Perform inspections and tests per NETA ATS 7.18 and PG&E/Hercules Municipal requirements.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
a. Cell impedance test.

M. Control System Functional Test:
1. Perform test upon completion of equipment acceptance tests.
2. The test is to prove the correct interaction of all sensing, processing and action devices.
3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
4. Perform the following tests:
a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
b. Verify the correct operation of all sensing devices, alarms and indicating devices.

END OF SECTION

SECTION 16120

WIRE AND CABLE: 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Instrumentation cable.
      e. Fiber optic cable.
      f. Wire connectors.
      g. Insulating tape.
      h. Pulling lubricant.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 1202, Standard for Flame-Propagation Testing of Wire and Cable.
   2. Insulated Cable Engineers Association (ICEA):
      a. S-58-679, Standard for Control Cable Conductor Identification.
   3. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   6. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 568, Commercial Building Telecommunications Cabling Standard.
   7. Underwriters Laboratories, Inc. (UL):
      a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
      b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
      c. 467, Standard for Safety Grounding and Bonding Equipment.
      d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
      e. 486C, Standard for Safety Splicing Wire Connections.
      f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
      g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
      h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
      i. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. The following are specific types of instrumentation cables:
      a. Analog signal cable:
         1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 16 AWG and smaller conductors.
         2) Commonly used types are defined in the following:
            a) TSP: Twisted shielded pair.
            b) TST: Twisted shielded triad.
      b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

E. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Wire connectors.
         2) Insulating tape.
         3) Cable lubricant.
      b. See Specification Section 16010 for additional requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Building wire, power and control cable:
      a. Aetna Insulated Wire.
      b. Alphawire.
      c. Cerrowire.
      d. Encore Wire Corporation.
      e. General Cable.
      f. Okonite Company.
      g. Southwire Company.
      h. Or approved equal.

2. Instrumentation cable:
    a. Analog cable:
        1) Alphawire.
        2) Belden Inc.
        3) General Cable.
        4) Or approved equal.
3. Wire connectors:
    a. Burndy Corporation.
    b. Buchanan.
    c. Ideal.
    d. Ilsco.
    e. 3M Co.
    f. Teledyne Penn Union.
    g. Thomas and Betts.
    h. Phoenix Contact.
    i. Or approved equal.
4. Insulating and color coding tape:
    a. 3M Co.
    b. Plymouth Bishop Tapes.
    c. Red Seal Electric Co.
    d. Or approved equal.
5. Fiber optic cable:
    a. Corning.
    b. Belden.
    c. Or approved equal.
6. Fiber optic patch panel (WIC):
    a. Corning.
    b. Or approved equal.

2.2 MANUFACTURED UNITS

A. Building Wire:
    1. Conductor shall be copper with 600 V rated insulation.
    2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
    3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
    4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
    5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:
    1. Conductor shall be copper with 600 V rated insulation.
    2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
    3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
    4. Number of conductors as required, including a bare ground conductor.
    5. Individual conductor color coding:
        a. ICEA S-58-679, Method 4.
        b. See PART 3 of this Specification Section for additional requirements.
    6. Conform to NFPA 70 Type TC.

C. Control Cable:
    1. Conductor shall be copper with 600 V rated insulation.
    2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
    a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
5. Individual conductor color coding:
    a. ICEA S-58-679, Method 1, Table E-2.
    b. See PART 3 of this Specification Section for additional requirements.
6. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:
1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to UL 44 for Type SIS insulation.
5. Conform to UL 83 for Type MTW insulation.

E. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
2. Analog cable:
    a. Tinned copper conductors.
    b. 600 V insulation with PVC jacket.
    c. Twisted with 100 percent foil shield coverage with drain wire.
    d. Six (6) twists per foot minimum.
    e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
    f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
3. Digital cable:
    a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
    b. Horizontal voice and data cable:
        1) Category 6 per TIA/EIA/ANSI 568.
        2) Cable shall be label-verified.
        3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
        4) Conductors: No. 24 AWG solid untinned copper.
        5) Rated CMP per NFPA 70.
    c. Conform to NFPA 262 and NFPA 70 Type ITC.

F. Fiber Optic Cable:
1. Single mode:
    a. Type: Loose tube with a wet or dry gel water blocking system.
    b. Number of fibers: 12.
    c. Fiber size: 9/125 (core diameter/cladding diameter).
    d. Glass fiber core.
    e. Step index.
    f. Maximum attenuation:
        1) At 850 nm: 0.5 dB/km.
        2) At 1,300 m: 0.4 dB/km.
    g. Minimum bandwidth:
        1) At 850 nm: 160 MHz/km.
        2) At 1,300 m: 500 MHz/km.
    h. Maximum tensile load:
        1) Installation: 600 lbs.
        2) Long term: 200 lbs.

i. Cable jacket material: PVC or Polyethylene approved for wet locations.
j. Cables shall be listed and marked in accordance with the requirements of NFPA 70.
k. Optical fiber cable type utilized shall be in accordance with NFPA 70.
l. Fiber shall confirm to TIA/EIA 492AAAA Class Iva.
m. Fiber color shall confirm to TIA/EIA 598-C.

G. Wire Connectors:
1. Twist/screw on type:
a. Insulated pressure or spring type solderless connector.
b. 600 V rated.
c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
d. Phase and neutral conductors: Conform to UL 486C.
2. Compression and mechanical screw type:
a. 600 V rated.
b. Ground conductors: Conform to UL 467.
c. Phase and neutral conductors: Conform to UL 486A.
3. Terminal block type:
a. High density, screw-post barrier-type with white center marker strip.
b. 600 V and ampere rating as required, for power circuits.
c. 600 V, 20 ampere rated for control circuits.
d. 300 V, 15 ampere rated for instrumentation circuits.
e. Conform to NEMA ICS 4 and UL 486A.

H. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
a. Insulating tape: Black.
b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.

I. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Permitted Usage of Insulation Types: XHHW-2 and THHN/THWN and THHN/THWN-2.
1. Type SIS and MTW:
a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Conductor Size Limitations:
1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

C. Color Code All Wiring as Follows:
   1. Building wire:

	240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

      a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
      b. Conductors larger than No. 6 AWG:
         1) Insulated phase and neutral conductors shall be identified by one (1) of the following methods:
            a) Continuous colored outer finish along its entire length.
            b) 3 IN of colored tape applied at the termination.
         2) Insulated grounding conductor shall be identified by one (1) of the following methods:
            a) Continuous green outer finish along its entire length.
            b) Stripping the insulation from the entire exposed length.
            c) Using green tape to cover the entire exposed length.
         3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.
   2. Power cables ICEA S-58-679, Method 4 with:
      a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
      b. Ground conductor: Bare.
   3. Control cables ICEA S-58-679, Method 1, Table E-2:
      a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
      b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

D. Install all wiring in raceway unless otherwise indicated on the Drawings.

E. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
   1. Where specifically indicated on the Drawings.
   2. Where field conditions dictate and written permission is obtained from the Engineer.
   3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
      a. The combinations shall comply with the following:
         1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
         2) 125 Vdc shall be isolated from all other AC and DC circuits.
         3) AC control circuits shall be isolated from all DC circuits.
   4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
      a. The combinations shall comply with the following:
         1) Analog signal circuits may be combined.
         2) Digital signal circuits may be combined but isolated from analog signal circuits.
   5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.

a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
   1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
   2) The neutral conductor may be shared on sequential circuits (e.g., circuit numbers 1,3,5) if multiple circuit breakers are provided.
   3) Up sizing raceway size for the size and quantity of conductors.

F. Ground the drain wire of shielded instrumentation cables at one (1) end only.
   1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

G. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
         1) Twist/screw on type connectors.
      b. Junction and pull boxes and wireways:
         1) Twist/screw on type connectors for use on No. 8 and smaller wire.
         2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
      c. Motor terminal boxes:
         1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
         2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
      d. Manholes or handholes:
         1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
         2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
   2. Control circuits:
      a. Junction and pull boxes: Terminal block type connector.
      b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
      c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
   3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
      a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
      b. Junction and pull boxes: Terminal block type connector.
      c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.
   4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

H. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

I. Color Coding Tape Usage: For color coding of conductors.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing:
   1. See Specification Section 16080.

END OF SECTION

SECTION 16121
MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Medium voltage cable (601 V and above).
      b. Cable terminations and splices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Association of Edison Illuminating Companies (AEIC).
      a. CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46kV.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 48, Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5kV Through 756kV or Extruded Insulation Rated 2.5 kV through 500 kV.
      b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
      c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V.
   3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 74/S-93-639, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL):
      a. 1072, Standard for Safety Medium Voltage Power Cables.

B. Qualifications:
   1. Cable technician:
      a. Three (3) years experience in handling, terminating and splicing medium voltage cables.
      b. Specifically trained by a factory representative on the terminations and splices to be used on the project.
         1) If not trained on the products to be used, on-site training by the factory representative shall be performed before any terminations or splices are made.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.

3. Fabrication and/or layout drawings:
   a. Cable pulling plan.

B. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Cable pulling tension measurements.
   3. Submit the following before terminating cables:
      a. Cable Technician qualifications.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Wire and cable:
      a. Aetna Insulated Wire.
      b. General Cable.
      c. The Kerite Company.
      d. The Okonite Company.
      e. Prysmian Cable Corporation.
      f. Southwire Company.
      g. Or approved equal.
   2. Lugs, connectors and terminations:
      a. 3M Company.
      b. Elastimold, a Thomas and Betts Company.
      c. Joslyn.
      d. Raychem.
      e. RTE/Cooper Power Products.
      f. Or approved equal.

2.2 MEDIUM VOLTAGE CABLES

A. Ratings: 15kV class unless otherwise indicated on the Drawings.

B. Standards:
   1. NEMA/ICEA WC 74/S-93-639.
   2. AEIC CS8.
   3. UL 1072.

C. Conductor Material:
   1. Compact stranded copper.

D. Insulation:
   1. Temperature rating: Type MV-90 or MV-105 per NFPA 70.
   2. Cross-linked thermosetting polyethylene (XLP).
   3. 133 percent insulation level.

E. Shielding:
   1. Shielding on cables rated above 2 kV consists of:
      a. Semiconductor conductor screen.
      b. Semiconductor insulation screen.

F. Neutrals:
   1. Neutral conductors of grounded neutral systems indicated on the drawings, shall be of the same insulation materials as the phase conductors, except with a 600 V insulation rating.

G. Grounds:
   1. Insulated copper per Specification Section 16120.

H. Jackets:
   1. Jacket: PVC.

2.3 CABLE ACCESSORIES

A. Lugs and Connectors:
   1. Lugs:
      a. Compression type.
      b. Standard: UL 486A for copper cables.
      c. Voltage rating: Up to 35 kV.
      d. Current rating: Continuous operation at the rating of the cable.
      e. Material: Tin-plated copper.
      f. Number of holes: Two (2), except one (1) on motor leads.
   2. Splice connectors:
      a. Standard: UL 486A for copper cables.
      b. Voltage rating: Up to 35kV.
      c. Current rating: Continuous operation at the rating of the cable.
      d. Material: Tin-plated copper.

B. Terminations:
   1. End caps:
      a. Cold or hot shrink.
      b. Used to environmentally seal and mechanically protect exposed cable ends.
   2. Cold shrink kits:
      a. Standard: IEEE 48, Class 1 termination.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One-piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicone rubber.
      e. Suitable for contaminated indoor and outdoor locations.
   3. Molded rubber kit:
      a. Standard: IEEE 48.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One-piece design or modular with stress cone and skirts, where high-dielectric constant stress control is integrated within a skirted insulator made of EPDM rubber.
      e. Suitable for contaminated indoor and outdoor locations.
   4. Elbow connectors:
      a. Standard: IEEE 386.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: 200A.
      d. One-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
      e. Deadfront, loadbreak type with:
         1) Hot stick pulling eye.
         2) Grounding tab.
         3) Test point.
      f. Accessories to be constructed in a similar manner as the elbow connector:
         1) Bushing inserts.
         2) Bushing well plugs.

3) Feed thru inserts.
4) Protective caps.

C. Splices:
1. Cold shrink kits:
a. Standard: IEEE 404.
b. Voltage rating: Same as the cable rating.
c. Current rating: Continuous operation at the rating of the cable.
d. One-piece design, comprised of an insulation shield, insulation layer and a silicone rubber body.
e. Suitable for indoor, direct burial or submersible applications.
2. Molded rubber kit:
a. Standard: IEEE 386 or IEEE 404.
b. Voltage rating: Same as the cable rating.
c. Current rating: Continuous operation at the rating of the cable.
d. One- or multi-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
e. Suitable for indoor, direct burial or submersible applications.
3. Modular separable molded rubber:
a. Standard: IEEE 386.
b. Voltage rating: Same as the cable rating.
c. Current rating: 600A.
d. One-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
e. Deadfront, deadbreak type.
f. Components: T-body, insulating plug with cap, insulating plug with cap and stud, and connecting plug.
g. Suitable for submersible applications.
4. Motor lead kits:
a. Voltage rating: Same as the cable rating.
b. Current rating: Continuous operation at the rating of the cable.
c. Material: EPDM rubber boot with nylon pin.
d. On shielded cables provide and additional EPDM rubber cold shrink sleeve.

D. Cable Shield Grounding Adapters:
1. Type: Molded rubber with constant force spring and solder-blocked tinned copper braid pigtail.
2. Waterproof, providing a positive seal for the cable jacket.
3. May be integral with termination of splice device with Engineer's approval.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install cable during wet conditions.
1. Prior to pulling cables, drain or pump out manholes and other low points if standing water is present.
2. Blow out conduits with dried compressed air if moisture is present in conduits.
3. Install end caps immediately on all cut ends of cable prior to pulling, and maintain end caps while pulling in cable.
a. If end caps are damaged, remove and install new end caps.
b. Do not remove end caps until ready to terminate or splice cable.

B. Cable Installation in Manholes:
1. Provide enough cable slack in each manhole for a complete loop around the manhole.
a. The loop will provide slack to facilitate future cable repairs.

2. Arc-proof all cables in manholes.
    a. Apply in spiral, half-overlap fashion to full exposed length of each cable in manhole.
    b. Secure in place with glass cloth electrical tape.
        1) Apply in reverse spiral to arc-proofing tape, at maximum interval of 9 IN and double wrapped at each end.

C. Do not install conductors when ambient temperature is near minimum as recommended by manufacturer for installation of the type of conductor insulation.

D. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for each shielded cable termination.
    1. Select correct termination to match cable diameter and construction.
    2. Form and install terminations in strict accordance with instructions of cable manufacturer and termination manufacturer.

E. Splices:
    1. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for the type of cable being used.
    2. Prepare cable ends, provide materials and follow all application steps in accordance with manufacturer's instructions.
        a. As a minimum requirement:
            1) The cable ends shall be cut squarely.
            2) The insulation shall be free from nicks or burrs after removal of jacket.
            3) The conductors shall be cleaned and an oxide inhibitor applied.
            4) For splices, connector indents shall be filled with insulating putty to eliminate voids or prepared per manufacture's instructions.
            5) Attach grounding lead to system ground.
    3. Splices shall be avoided whenever possible.
        a. No more than one (1) splice is permitted between termination points without Engineer's approval.
        b. No splices are permitted in runs less than 100 FT long.
        c. Splices will be made only at manholes or other accessible locations.
        d. Do not pull splices into ductbanks or conduits or leave them under tension.

F. The ground shield grounding adaptors shall be grounded:
    1. Shirted and elbow terminators: Grounded to ground bar or cable loop in equipment.
    2. Splices: Grounded to ground bar or rod in manhole.
    3. Connect with insulated, stranded #6 AWG wire.

3.2 FIELD QUALITY CONTROL

A. Provide cable pulling plan showing all proposed splice points and cable pulling direction for each pull.

B. Provide measurement of tensions during the pull.

C. See Specification Section 16080 for acceptance testing requirements.

END OF SECTION

SECTION 16130
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Outlet boxes.
      f. Pull and junction boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI).
   2. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit (IMC).
      c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
      d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   4. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C80.1, Electric Rigid Steel Conduit (ERSC).
      b. C80.3, Steel Electrical Metallic Tubing (EMT).
      c. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Flexible Metal Conduit.
      b. 6, Standard for Electrical Rigid Metal Conduit - Steel.
      c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      d. 360, Standard for Liquid-Tight Flexible Steel Conduit.
      e. 467, Grounding and Bonding Equipment.
      f. 514A, Metallic Outlet Boxes.
      g. 514B, Conduit, Tubing, and Cable Fittings.
      h. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
      i. 797, Electrical Metallic Tubing - Steel.
      j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
      k. 886, Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Conduit fittings.
         2) Support systems.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Identify dimensional size of pull and junction boxes to be used.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rigid metallic conduits:
      a. Allied Tube and Conduit Corporation.
      b. Triangle PWC Inc.
      c. Western Tube and Conduit Corporation.
      d. Wheatland Tube Company.
      e. LTV Steel Company.
      f. Or approved equal.
   2. PVC coated rigid metallic conduits and repair kits:
      a. Occidental Coating Company.
      b. Perma-Cote.
      c. Rob-Roy Ind.
      d. Raychem "GelTek" tape.
      e. Or approved equal.
   3. Rigid nonmetallic conduit:
      a. Carlon.
      b. Cantex.
      c. Osburn Associates.
      d. Or approved equal.
   4. Flexible conduit:
      a. AFC Cable Systems.
      b. Anamet, Inc.
      c. Electri-Flex.
      d. Flexible Metal Hose Company.
      e. International Metal Hose Company.
      f. Triangle PWC Inc.
      g. LTV Steel Company.
      h. Or approved equal.
   5. Wireway:
      a. Hoffman Engineering Company.
      b. Wiegmann.
      c. Square D.
      d. Or approved equal.

6. Conduit fittings and accessories:
    a. Appleton.
    b. Carlon.
    c. Cantex.
    d. Crouse-Hinds.
    e. Killark.
    f. Osburn Associates.
    g. OZ Gedney Company.
    h. RACO.
    i. Steel City.
    j. Thomas and Betts.
    k. Or approved equal.
7. Support systems:
    a. Unistrut Building Systems.
    b. B-Line Systems Inc.
    c. Kindorf.
    d. Minerallac Fastening Systems.
    e. Caddy.
    f. Or approved equal.
8. Outlet, pull and junction boxes:
    a. Appleton Electric Co.
    b. Crouse-Hinds.
    c. Killark.
    d. O-Z/Gedney.
    e. Steel City.
    f. Raco.
    g. Bell.
    h. Hoffman Engineering Co.
    i. Wiegmann.
    j. B-Line Circle AW.
    k. Adalet.
    l. Rittal.
    m. Or approved equal.

2.2 RIGID METALLIC CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):
    1. Mild steel with continuous welded seam.
    2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
    3. Threads galvanized after cutting.
    4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
    5. Standards: NEMA/ANSI C80.1, UL 6.

B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
    1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
        a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
        b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
    2. Nominal 2 mil, minimum, urethane interior coating.
    3. Urethane coating on threads.
    4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
    5. Female Ends:
        a. Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening.
        b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.

6. Standards: NEMA/ANSI C80.1, UL 6, NEMA RN 1.

C. Electrical Metallic Tubing (EMT):
1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.
4. Standards: NEMA/ANSI C80.3, UL 797.

2.3 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
5. Standards: NEMA TC 2, UL 651.

2.4 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):
1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Standard: UL 1.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.
4. Standard: UL 360.

2.5 WIREWAY

A. General:
1. Suitable for lay-in conductors.
2. Designed for continuous grounding.
3. Covers:
   a. Hinged or removable in accessible areas.
   b. Non-removable when passing through partitions.
4. Finish: Rust inhibiting primer and manufacturers standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.

B. General Purpose (NEMA 1 rated) Wireway:
1. 14 or 16 gage steel without knockouts.
2. Cover: Solid, non-gasketed and held in place by captive screws.

C. Watertight (NEMA 4X rated) Wireway:
1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

D. Dusttight (NEMA 12 rated) Wireway:
1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

2.6 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS:
   1. General:
      a. In hazardous locations listed for use in Class I, Groups C and D locations.
   2. Locknuts:
      a. Threaded steel or malleable iron.
      b. Gasketed or non-gasketed.
      c. Grounding or non-grounding type.
   3. Bushings:
      a. Threaded, insulated metallic.
      b. Grounding or non-grounding type.
   4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
   5. Couplings:
      a. Threaded straight type: Same material and finish as the conduit with which they are used on.
      b. Threadless type: Gland compression or self-threading type, concrete tight.
   6. Unions: Threaded galvanized steel or zinc plated malleable iron.
   7. Conduit bodies (ells and tees):
      a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
      b. Standard and mogul size.
      c. Cover:
         1) Clip-on type with stainless steel screws.
         2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
   8. Conduit bodies (round):
      a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
      b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
   9. Sealing fittings:
      a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
      b. Standard and mogul size.
      c. With or without drain and breather.
      d. Fiber and sealing compound: UL listed for use with the sealing fitting.
   10. Hazardous location flexible coupling (HAZ-FLEX):
      a. Liquid tight and arc resistant.
      b. Electrically conductive so no bonding jumper is required.
      c. Dry and wet areas:
         1) Bronze braided covering over flexible brass core.
         2) Bronze end fittings.
         3) Zinc-plated steel or malleable iron unions and nipples.
      d. Corrosive areas:
         1) Stainless steel braided covering over flexible stainless steel core.
         2) Stainless steel end fittings.
         3) Aluminum unions and nipples.
   11. Service entrance head:
      a. Malleable iron, galvanized steel or copper free aluminum.
      b. Insulated knockout cover for use with a variety of sizes and number of conductors.
   12. Expansion couplings:
      a. 2 IN nominal straight-line conduit movement in either direction.
      b. Galvanized steel with insulated bushing.
      c. Gasketed for wet locations.
      d. Internally or externally grounded.
   13. Expansion/deflection couplings:
      a. 3/4 IN nominal straight-line conduit movement in either direction.
      b. 30-degree nominal deflection from the normal in all directions.

c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
d. Internally or externally grounded.
e. Watertight, raintight and concrete tight.

14. Standards: UL 467, UL 514B, UL 886.

B. Fittings for Use with PVC-RGS:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

C. Fittings for Use with EMT:
1. Connectors:
a. Straight, angle and offset types furnished with locknuts.
b. Zinc plated steel.
c. Insulated gland compression type.
d. Concrete and raintight.
2. Couplings:
a. Zinc plated steel.
b. Gland compression type.
c. Concrete and raintight.
3. Conduit bodies (ells and tees):
a. Body: Copper free aluminum with threaded hubs.
b. Standard and mogul size.
c. Cover:
1) Screw down type with steel screws.
2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
4. Standard: UL 514B.

D. Fittings for Use with FLEX:
1. Connector:
a. Zinc plated malleable iron.
b. Squeeze or clamp-type.
2. Standard: UL 514B.

E. Fittings for Use with FLEX-LT:
1. Connector:
a. Straight or angle type.
b. Metal construction, insulated and gasketed.
c. Composed of locknut, grounding ferrule and gland compression nut.
d. Liquid tight.
2. Standards: UL 467, UL 514B.

F. Fittings for Use with Rigid Nonmetallic PVC Conduit:
1. Coupling, adapters and conduit bodies:
a. Same material, thickness, and construction as the conduits with which they are used.
b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

G. Weather and Corrosion Protection Tape:
1. PVC based tape, 10 mils thick.
2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.7 ALL RACEWAY AND FITTINGS

A. Mark Products:
   1. Identify the nominal trade size on the product.
   2. Stamp with the name or trademark of the manufacturer.

2.8 OUTLET BOXES

A. Metallic Outlet Boxes:
   1. Hot-dip galvanized steel.
   2. Conduit knockouts and grounding pigtail.
   3. Styles:
      a. 2 IN x 3 IN rectangle.
      b. 4 IN square.
      c. 4 IN octagon.
      d. Masonry/tile.
   4. Accessories:
      a. Flat blank cover plates.
      b. Barriers.
      c. Extension, plaster or tile rings.
      d. Box supporting brackets in stud walls.
      e. Adjustable bar hangers.
   5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:
   1. Zinc plated cast iron or die-cast copper free aluminum with manufacturers standard finish.
   2. Threaded hubs and grounding screw.
   3. Styles:
      a. "FS" or "FD".
      b. "Bell".
      c. Single or multiple gang and tandem.
      d. "EDS" or "EFS" for hazardous locations.
   4. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
   5. Standards: UL 514A, UL 886.

C. See Specification Section 16140 for wiring devices, wallplates and coverplates.

2.9 PULL AND JUNCTION BOXES

A. NEMA 4X Rated (metallic):
   1. Body and cover: 14 GA Type 304 or 316 stainless steel.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Hinged door and stainless steel screws and clamps.
   6. Door with oil-resistant gasket.

B. NEMA 4X Rated (Nonmetallic):
   1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
   2. No knockouts.
   3. External mounting flanges.
   4. Hinged door with quick release latches and padlocking hasp.
   5. Door with oil resistant gasket.

C. NEMA 7 and NEMA 9 Rated:
   1. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
   2. Drilled and tapped openings or tapered threaded hub.
   3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
   4. External mounting flanges.

5. Grounding lug.
6. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

D. NEMA 12 Rated:
1. Body and cover:
a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
b. Type 5052 H-32 aluminum, unpainted.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
6. Flat door with oil resistant gasket.

E. Miscellaneous Accessories:
1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
2. Split covers when heavier than 25 LBS.
3. Weldnuts for mounting optional panels and terminal kits.
4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

F. Standards: NEMA 250, UL 50.

2.10 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
1. Material requirements.
a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
b. Stainless steel: AISI Type 316.
c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.

B. Single Conduit and Outlet Box Support Fasteners:
1. Material requirements:
a. Zinc plated steel.
b. Stainless steel.
c. Malleable iron.
d. PVC coat malleable iron or steel: 20 mil PVC coating.
e. Steel protected with zinc phosphate and oil finish.

2.11 OPENINGS AND PENETRATONS IN WALLS AND FLOORS

A. Sleeves, smoke and fire stop fitting through walls and floors:
1. See Specification Section 01800.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:
1. NFPA 70.
2. Manufacturer instructions.

B. Size of Raceways:
1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
2. Unless specifically indicated otherwise, the minimum raceway size shall be:
a. Conduit: 3/4 IN.
b. Wireway: 2-1/2 IN x 2-1/2 IN.

C. Field Bending and Cutting of Conduits:
   1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
   2. Do not reduce the internal diameter of the conduit when making conduit bends.
   3. Prepare tools and equipment to prevent damage to the PVC coating.
   4. Degrease threads after threading and apply a zinc rich paint.
   5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
      a. Total nominal thickness: 40 mil.
   4. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.
   1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
   2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
   3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.
   1. See Specification Section 01800.

3.2 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.
   1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
   2. Run in straight lines parallel to or at right angles to building lines.
   3. Do not route conduits:
      a. Through areas of high ambient temperature or radiant heat.
      b. In suspended concrete slabs.
   4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
   5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All rigid conduits within a structure shall be installed exposed except as follows:
   1. As indicated on the Drawings.
   2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
   3. Concealed within stud frame, poured concrete, concrete block and brick walls of an architecturally finished area.

4. Embedded in floor slabs or buried under floor serving equipment in non-architecturally finished areas that are not located on or near a wall or column and the ceiling height is greater than 12 FT.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
1. Between instrumentation and telecommunication: 1 IN.
2. Between instrumentation and 125 V, 48 V and 24 Vdc, 2 IN.
3. Between instrumentation and 600 V and less AC power or control: 6 IN.
4. Between instrumentation and greater than 600 Vac power: 12 IN.
5. Between telecommunication and 125 V, 48 V and 24 Vdc, 2 IN.
6. Between telecommunication and 600 V and less AC power or control: 6 IN.
7. Between telecommunication and greater than 600 Vac power: 12 IN.
8. Between 125 V, 48 V and 24 Vdc and 600 V and less AC power or control: 2 IN.
9. Between 125 V, 48 V and 24 Vdc and greater than 600 Vac power: 2 IN.
10. Between 600 V and less AC and greater than 600 Vac: 2 IN.
11. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
1. See Specification Section 01800.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:
1. Power wire or cables: All raceway types.
2. Control wire or cables: All raceway types.
3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
4. Motor leads from a VFD: RGS, RAC or shielded VFD cables in all other raceways.
5. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:
1. Dry areas:
   a. RGS.
2. Wet and corrosive areas:
   a. PVC-RGS.
3. NFPA 70 hazardous areas:
   a. RGS.
   b. PVC-RGS where wet or corrosive.

C. Permitted Raceway Types Per Routing Locations:
1. In stud framed walls:
   a. EMT.
2. In concrete block or brick walls:
   a. PVC-40.
3. Above acoustical tile ceilings:
   a. EMT.
   b. NEMA 1 rated wireway.
4. Embedded in poured concrete walls and floors:
   a. PVC-40.
   b. PVC-RGS when emerging from concrete.

5. Beneath floor slab-on-grade:
    a. PVC-40.
6. Through floor penetrations, see Specification Section 01800:
    a. PVC-RGS.
7. Concrete encased ductbanks:
    a. PVC-40.
    b. 90 degree elbows for transitions to above grade:
        1) PVC-RGS.
    c. Long sweeping bends greater than 15 degrees:
        1) RGS for sizes 2 IN and larger.

D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
1. The maximum length shall not exceed:
    a. 6 FT to light fixtures.
    b. 3 FT to all other equipment.

E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
1. The maximum length shall not exceed:
    a. 6 FT to light fixtures.
    b. 3 FT to motors.
    c. 2 FT to all other equipment.

F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.
1. The maximum length shall not exceed:
    a. 3 FT to motors.
    b. 2 FT to all other equipment.

G. NEMA 1 Rated Wireway:
1. Surface mounted in electrical rooms.
2. Surface mounted above removable ceilings tiles of an architecturally finished area.

H. NEMA 4X Rated Wireway:
1. Surface mounted in areas designated as wet and or corrosive.

I. NEMA 12 Rated Wireway:
1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

J. Underground Conduit: See Specification Section 16135.

3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Seals:
1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.

B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

C. Install Expansion Fittings:
1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
2. Elsewhere as identified on the Drawings.

D. Install Expansion/Deflection Fittings:
1. Where conduits enter a structure.
    a. Except electrical manholes and handholes.
    b. Except where the ductbank is tied to the structure with rebar.

2. Where conduits span structural expansions joints.
3. Elsewhere as identified on the Drawings.

E. Threaded connections shall be made wrench-tight.

F. Conduit joints shall be watertight:
1. Where subjected to possible submersion.
2. In areas classified as wet.
3. Underground.

G. Terminate Conduits:
1. In metallic outlet boxes:
a. RGS:
1) Conduit hub and locknut.
2) Insulated bushing and two (2) locknuts.
3) Use grounding type locknut or bushing when required by NFPA 70.
b. EMT: Compression type connector and locknut.
2. In NEMA 1 rated enclosures:
a. RGS:
1) Conduit hub and locknut.
2) Insulated bushing and two (2) locknuts.
3) Use grounding type locknut or bushing when required by NFPA 70.
b. EMT: Compression type connector and locknut.
3. In NEMA 12 rated enclosures:
a. Watertight, insulated and gasketed hub and locknut.
b. Use grounding type locknut or bushing when required by NFPA 70.
4. In NEMA 4 and NEMA 4X rated enclosures:
a. Watertight, insulated and gasketed hub and locknut.
5. In NEMA 7 and NEMA 9 rated enclosures:
a. Into an integral threaded hub.
6. When stubbed up through the floor into floor mount equipment:
a. With an insulated grounding bushing on metallic conduits.
b. With end bells on nonmetallic conduits.

H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
1. Dry areas:
a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
2. Wet or corrosive areas:
a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
3. Conduit type shall be compatible with the support system material.
a. Galvanized steel system may be used with RGS.
b. Stainless steel system may be used with RGS and PVC-RGS.
c. PVC coated galvanized steel system may be used with PVC-RGS.

B. Permitted single conduit support fasteners per area designations and conduit types:
1. Architecturally finished areas:
a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
c. Provide anti-rattle conduit supports when conduits are routed through metal studs.

2. Dry areas:
    a. Material: Zinc plated steel, stainless steel and malleable iron.
    b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
3. Wet or corrosive areas:
    a. Material: Stainless steel and PVC coat malleable iron or steel.
    b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
4. Conduit type shall be compatible with the support fastener material.
    a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS.
    b. Stainless steel system may be used with RGS and PVC-RGS.
    c. PVC coated fasteners may be used with PVC-RGS.

C. Conduit Support General Requirements:
1. Maximum spacing between conduit supports per NFPA 70.
2. Support conduit from the building structure.
3. Do not support conduit from process, gas, air or water piping; or from other conduits.
4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
    a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
    b. Conduit hangers:
        1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
    c. Do not use suspended ceiling support systems to support raceways.
    d. Hangers in metal roof decks:
        1) Utilize fender washers.
        2) Not extend above top of ribs.
        3) Not interfere with vapor barrier, insulation, or roofing.
5. Conduit support system fasteners:
    a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
    b. Do not use concrete nails and powder-driven fasteners.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:
1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 16010 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:
1. Permitted uses of metallic outlet boxes:
    a. Housing of wiring devices:
        1) Recessed in all stud framed walls and ceilings.
        2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
    b. Pull or junction box:
        1) Above gypsum wall board or acoustical tile ceilings.
        2) Above 10 FT in an architecturally finished area where there is no ceiling.
2. Permitted uses of cast outlet boxes:
    a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.

b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.

3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 16010.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
   a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
   b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.
8. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.

C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
   a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
3. Permitted uses of NEMA 4X metallic enclosure:
   a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
4. Permitted uses of NEMA 7 enclosure:
   a. Pull or junction box surface mounted in areas designated as Class I hazardous.
      1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
5. Permitted uses of NEMA 12 enclosure:
   a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION

SECTION 16135
ELECTRICAL: EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Manholes.
      b. Handhole.
      c. Underground conduits and ductbanks.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   2. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Society of Cable Telecommunications Engineers (SCTE):
      a. 77, Specification for Underground Enclosure Integrity.

1.3 DEFINITIONS

A. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. Fabrication and/or layout drawings:
      a. Provide dimensional drawings of each manhole indicating all specified accessories and conduit entry locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Quazite Composolite.
      b. Armorcast Products Company.
      c. Synertech.
      d. Or approved equal.

2. Precast manholes and handholes:
    a. Utility Vault Co.
    b. Oldcastle Precast, Inc.
    c. Lister Industries.
    d. Or approved equal.
3. Manhole and handhole and ductbank accessories:
    a. Neenah.
    b. Unistrut.
    c. Condux International, Inc.
    d. Underground Devices, Inc.
    e. Or approved equal.

2.2 HANDHOLES

A. Prefabricated Composite Material Handholes:
1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
2. Minimum load ratings: SCTE 77 Tier 8.
3. Open bottom.
4. Stackable design as required for specified depth.
5. Cover:
    a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
    b. Non-gasketed bolt down with stainless steel penta head bolts.
    c. Lay-in non-bolt down, when cover is over 100 LBS.
    d. One or multiple sections so the maximum weight of a section is 125 LBS.
6. Cover lifting hook: 24 IN minimum in length.

B. Precast Manholes and Handholes:
1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
3. Mating edges: Tongue and groove type.
4. Solid bottom with a 12 IN x 12 IN or 12 IN DIA french drain in the bottom of each manhole.
5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
6. Cover extension rings as required.
7. Cable pulling eyes opposite all conduit entrances.
    a. Coordinate exact location with installation contractor.

2.3 CONCRETE HANDHOLE ACCESSORIES

A. Cover and Frame:
1. Cast ductile iron: ASTM A536.
2. AASHTO live load rating: H-20.
3. Diameter: 30 IN.
4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.

B. Cable Racks and Hooks:
1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
2. Hook loading capacity: 400 LBS minimum.
3. Rack loading capacity: Four (4) hooks maximum.
4. Hook deflection: 0.25 IN maximum.
5. Hooks: Length, as required, with positive locking device to prevent upward movement.
6. Mounding hardware: Stainless steel.

C. Cable Pulling Irons:
1. 7/8 IN DIA hot-dipped galvanized steel.
2. 6000 LB minimum pulling load.

D. Ground Rods and Grounding Equipment: See Specification Section 16060.

2.4 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete: Comply with Division 03 Specifications.

B. Conduit: See Specification Section 16130.

C. Duct Spacers/Supports:
   1. High density polyethylene or high impact polystyrene.
   2. Interlocking.
   3. Provide 2 IN minimum spacing between conduits.
   4. Accessories, as required:
      a. Hold down bars.
      b. Ductbank strapping.

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks.
   1. Field conditions may affect actual routing.

B. Manhole and Handhole Locations:
   1. Approximately where shown on the Drawings.
   2. As required for pulling distances.
   3. As required to keep pulling tensions under allowable cable tensions.
   4. As required for number of bends in ductbank routing.
   5. Shall not be installed in a swale or ditch.
   6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
   7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 02221 for trenching, backfilling and compacting.

3.2 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. For use in areas subjected to occasional non-deliberate vehicular traffic.
   2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
   3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
   4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
   5. Size: As indicated on the Drawings or as required for the number and size of conduits.
   6. Provide cable rails and pulling eyes as needed.

B. Precast Manholes and Handholes:
   1. For use in vehicular and non-vehicular traffic areas.
   2. Construction:
      a. Grout or seal all joints, per manufacturer's instructions.

b. Support cables on walls by cable racks:
   1) Provide a minimum of two (2) racks, install symmetrically on each wall of manholes and handholes.
      a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.
   2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.
c. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
   1) Drill opening in floor for ground rod.
   2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
   3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three (3).
      a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.

3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.
4. Install so that the top of cover is 1 IN above finished grade.
   a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.
5. After installation is complete, backfill and compact soil around manholes and handholes.
6. Handhole size:
   a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
   b. Minimum floor dimension of 2 FT x 4 FT and minimum depth of 2 FT.
7. Manhole size:
   a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
   b. Minimum floor dimension of 6 FT x 6 FT and a minimum depth of 6 FT.

3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:
   1. Ductbank: Concrete encased, 4000 psi.
   2. Do not place concrete until conduits have been observed by the Engineer.
   3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
      a. Low points shall be at manholes or handholes.
   4. During construction and after conduit installation is complete, plug the ends of all conduits.
   5. Provide conduit supports and spacers.
      a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
         1) 1 IN and less: 3 FT.
         2) 1-1/4 to 3 IN: 5 FT.
         3) 3-1/2 to 6 IN: 7 FT.
      b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
         1) 1 IN and less: 10 FT.
         2) 1-1/4 to 2-1/2 IN: 14 FT.
         3) 3 IN and larger: 20 FT.
      c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
   6. Stagger conduit joints at intervals of 6 IN vertically.
   7. Make conduit joints watertight and in accordance with manufacturer's recommendations.

8. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.
    a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
9. Furnish manufactured bends at end of runs.
    a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.
10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
11. After the conduit run has been completed:
    a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
        1) Test mandrel:
            a) Length: Not less than 12 IN
            b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
    b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
12. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.
13. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 16130, prior to entering a structure or going above ground.
    a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.
14. Place warning tape in trench directly over ductbanks in accordance with Specification Section 10400.
15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:
    1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 16130 or as detailed on the Drawings.
    2. Install so that top of concrete encased duct, at any point:
        a. Is not less than 24 IN below grade.
        b. Is below pavement sub-grading.
    3. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.
    4. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 16130 for different cabling types.

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Light switches.
      b. Receptacles.
      c. Device wallplates and coverplates.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. WD 1, General Color Requirements for Wiring Devices.
      c. WD 6, Wiring Devices - Dimensional Requirements.
   2. Underwriters Laboratories, Inc. (UL):
      a. 20, General-Use Snap Switches.
      b. 498, Standard for Attachment Plugs and Receptacles.
      c. 514A, Metallic Outlet Boxes.
      d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
      e. 943, Ground-Fault Circuit-Interrupters.
      f. 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Light switches and receptacles:
      a. Bryant.
      b. Cooper Wiring Devices.
      c. Hubbell.
      d. Leviton.
      e. Pass & Seymour.
      f. Crouse-Hinds.
      g. Appleton Electric Co.
      h. Killark.

i. Or approved equal.

2.2 LIGHT SWITCHES

A. General requirements unless modified in specific requirements paragraph of switches per designated areas or types:
   1. Toggle type, quiet action, Industrial heavy duty Specification Grade.
   2. Self grounding with grounding terminal.
   3. Back and side wired.
   4. Solid silver cadmium oxide contacts.
   5. Rugged urea housing and one-piece switch arm.
   6. Rated 20 A, 120/277 Vac.
   7. Switch handle color: Ivory.
   8. Types as indicated on the Drawings:
      a. Single-pole.
      b. Double-pole.
      c. 3-way.
      d. 4-way.
   9. Standards: UL 20, UL 514A, NEMA WD 6.

B. Wallplate:
   1. Stainless steel.
   2. Single or multiple gang as required.

C. Hazardous Areas:
   1. Rated for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
   2. Switch enclosed in separate sealing chamber.
      a. Sealing chamber has prewired factory sealed pigtail leads.
   3. Coverplate:
      a. Zinc plated malleable iron or copper free aluminum with stainless steel screws utilizing rocker or front mounted toggle type switch.
      b. Single or multiple gang as required.
   4. Standards: UL 894.

2.3 RECEPTACLES

A. General requirements unless modified in specific requirements paragraph of receptacles per designated areas:
   1. Straight blade, Industrial heavy duty Specification Grade, GFCI type.
   2. Brass triple wipe line contacts.
   3. One-piece grounding system with double wipe brass grounding contacts and self grounding strap.
   4. Back and side wired.
   5. Rated 20 A, 125 Vac.
   6. High impact nylon body.
   7. Receptacle body color: Ivory.
   8. Duplex or simplex as indicated on the Drawings.
   9. Configuration: NEMA 5-20R.
   10. Standards: UL 498, UL 514A, UL 943, NEMA WD 1, NEMA WD 6.

B. Wallplate: Stainless steel.

C. Wet Non-architecturally Finished Areas:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

D. Exterior Locations:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

E. Corrosive Areas:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Yellow.
   3. Coverplate:
      a. Zinc plated malleable iron or galvanized steel.
      b. Single or multiple gang as required.

F. Hazardous Areas:
   1. Rated for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups F and G.
   2. Factory-sealed receptacle/switch/coverplate.
      a. Zinc plated malleable iron or copper free aluminum with stainless steel screws and gasketed spring-loaded cover.
   3. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.
      a. Ordinary nonhazardous plug shall not activate the receptacle.
   4. Standard: UL 1010.

G. Special Purpose Receptacles:
   1. NEMA configuration as indicated on the Drawings.
   2. Coverplate: See requirements per area designations herein.

2.4 MISCELLANEOUS WIRING DEVICES

A. Manual Motor Starters: Horsepower rated with or without thermal overloads, see Specification Section 16442.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 16010.

C. See Specification Section 16130 for device outlet box requirements.

D. Where more than one (1) receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

END OF SECTION

SECTION 16230

ENGINE GENERATOR: DIESEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Engine generator set and accessories.
   2. Modification of existing generator for parallel operation with new generator.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Environmental Protection Agency (EPA):
      a. 40 CFR Part 60, Subpart IIII, Protection of Environment, Standards of Performance for New Stationary Sources, Standards for Performance for Stationary Compression Ignition Internal Combustion Engines.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   3. National Fire Protection association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 700, Emergency Systems.
         2) Article 701, Legally Required Standby Systems.
         3) Article 702, Optional Standby Systems.
   4. Underwriters Laboratories, Inc. (UL):
      a. 2200, Standard for Stationary Engine Generator Assemblies.

B. The engine generator set manufacturer or authorized supplier is designated to have single source responsibility for the supply of all components and oversight of the installation of the unit.

1.3 SYSTEM DESCRIPTION

A. The engine generators will be used and rated for:
   1. Optional standby power during a utility power outage, NFPA 70, Article 702.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
      c. Engine/generator performance curves.
   3. Fabrication and/or layout drawings.
      a. Dimensional plan and elevation drawings.
      b. Wire interconnection drawings.
   4. Test reports:
      a. Factory test reports.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 or requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Miscellaneous Submittals:
   1. Unit installation, startup and operational statement.
   2. Field Quality Control test reports.

1.5 SITE CONDITIONS

A. Ambient air temperature:
   1. Minimum: 32 DegF.
   2. Maximum: 100 DegF.

B. Altitude: 100 FT above sea level.

C. Seismic (Earthquake) forces: See Specification Section 11005.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Engine generator unit:
      a. Caterpillar, to match existing unit.
   2. Silencers:
      a. Maxim.
      b. GT Exhaust Systems.
      c. Nelson.
      d. Cowl.
      e. Hapco.
      f. Or approved equal.
   3. Battery charger:
      a. Manufacturer's standard.
   4. Governor:
      a. Manufacturer's standard.
   5. Radiator:
      a. Manufacturer's standard.
   6. Vibration isolators:
      a. Caldyne.
      b. Mason Inds.
      c. Ace.
      d. Korfund Dynamics.
      e. Or approved equal.

2.2 EQUIPMENT

A. Emissions Requirements: EPA Tier 4 interim.

2.3 COMPONENTS

A. Engine Generator Unit General:
   1. Diesel engine direct-connected to alternating current generator mounted on suitable rigid steel skid supports.
   2. Mount unit on skid suitable for installation on concrete foundation.
   3. Base rating on operation at rated RPM when equipped with all operating accessories.

4. Standards: UL 2200.

B. Engine:
1. Four-cycle, full compression ignition, single acting, electronic-injection and turbo charged with inner and after cooling.
2. Fuel supply: No. 2 Diesel.
3. Removable full wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.
4. Capable of operating at idle or light loads for extended periods of time.

C. Electronic Fuel Injection System.

D. Oil Pump:
1. Gear-type lubricating oil pump to supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
2. Spray cool and lubricate pistons.
3. Oil filters so located that lubricating oil is continuously filtered, except during periods when oil is automatically by-passed to protect vital parts when filters are clogged.
4. Filter elements accessible and easily removable.
5. Filter elements: Effective full flow, replaceable resin-impregnated cellulose type.
6. Equip filter system with spring-loaded by-pass valve.
7. Oil cooler: Water-cooled, engine-mounted.

E. Fuel System:
1. Fuel pump: Built-in gear-type, engine-driven fuel transfer pump.
2. Equip fuel system with replaceable fuel filter elements arranged for easy removal without breaking any fuel line connections or disturbing fuel pumps or any other part of engine.
3. Locate all fuel filters in an accessible housing, ahead of injection pumps to thoroughly filter fuel before it reaches the pump.
4. Use no screens or filters requiring cleaning or replacement of injection pumps or valve assemblies.

F. Governor: Fully enclosed electronic type governor with actuator capable of providing accurate speed control within 1 percent of rated speed, complete with panel-mounted electronic assembly with ramp generator and speed-sensing modules.

G. Air Cleaners: Engine-mounted, dry type air cleaners of sufficient capacity.

H. Electric Starting System:
1. Sufficient capacity to crank at speed which will start engine under normal operating conditions.
2. Controls to provide automatic cranking of engine when generator is called to start.
3. Prevent excessive cranking which could damage cranking motor.
4. Automatic stop controls.
5. Starter motors with positive-engagement feature.

I. Cooling System:
1. Capacity for cooling engine at the specified operating conditions.
2. Engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
3. Unit mounted radiator.
   a. Core guard flexible duct adapter.
   b. Site glass at top of unit.
   c. Engine driven blower fan.
   d. Low water level cutoff switch.
4. Provide fan guards.

J. Heater:
   1. Thermostatically controlled jacket water heater(s) to maintain cooling jacket at the manufacturer's recommended temperature at the specified low ambient temperature.
   2. 480 V, single phase.

K. Silencer:
   1. Suitable type for critical silencing.
   2. Seamless, stainless steel, flexible, exhaust adapter for exhaust outlet to silencer.

L. Engine Instruments and Controls:
   1. Engine-mounted instruments:
      a. Oil pressure gage.
      b. Water temperature gage.
      c. Run time meter.
      d. Battery voltage meter.
   2. Automatic cycle cranking and over-crank protection.
   3. Safety controls: Equip engine with automatic safety controls to shut down engine in event of low lubricating oil pressure, high jacket water temperature, overspeed or overcrank.
   4. Auxiliary control devices: Either integral with specified engine instruments, control, and safety devices or as separate devices as required to operate various signal circuits specified for remote annunciator panel.

M. Fuel Day Tank:
   1. Double wall sub-base day tank mounted underneath engine generator unit.
   2. Steel construction, top and bottom baffles, steel channel side supports, weatherproof secondary containment, rust preventive interior coating, rust proofed and finish painted exterior.
   3. Tank connections: Fuel level gauge, fuel lines to generator, fill, vent, drain and pressure relief.
   4. Manual overfill protection.
   5. Low level warning with contacts for remote alarm.
      a. Set to alarm at 50 percent of capacity.
   6. Critical low level shutoff with contacts for remote alarm.
   7. Leak detection alarm with contacts for remote alarm.
   8. Capacity: 17 HRS at full load.

N. Batteries:
   1. Lead acid type.

O. Battery Charger:
   1. Output current rating of at least 1/20th of ampere hour capacity of battery and capable of automatically switching between low rate (float) mode and high rate (equalize) mode.
   2. Solid state rectifiers, DC voltmeter and ammeter, fuse input and output, and 115 Vac input.
   3. Malfunction alarm contacts (minimum): low and high battery voltage, weak battery and charger failure.

P. Generator:
   1. Brushless, 6-pole drip-proof revolving field type with permanent magnet, 2/3 pitch stator, direct-coupled rotor, Class H insulation.
   2. Minimum continuous standby ratings:
      a. Specified herein, substantiated by manufacturer's standard published curves and conform to NEMA MG 1 specification.
      b. Special ratings or maximum ratings are not acceptable.
   3. Rated to serve up to 50 percent non-linear load without exceeding rated temperature rise.
   4. Minimum efficiency: 92 percent at 50 to 110 percent of nominal standby rating, less than 30 percent instantaneous voltage dip at full load and rated power factor and suitable for simultaneous operation with other future units connected in parallel.

5. Stator and rotor: 125 DegC temperature rise with minimum Class F insulated with 100 percent epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration.
6. Directly connect stator to engine flywheel housing.
7. Drive rotor through semiflexible driving flange to ensure permanent alignment.
8. Self ventilating with suitable blower, air inlet and outlet openings.
9. Provide terminal box of adequate size for entrance of conduit and termination of conductors.
10. Generator drive free from critical torsional vibration within operating range.
11. Provide generator mounted main circuit breaker:
    a. Solid state molded case type.
    b. Ratings as indicated.

Q. Voltage Regulator:
1. SCR type, to maintain 2 percent voltage regulation from 0 to full load with steady state modulation not exceeding plus 1/2 percent including cross-current compensation to provide maximum of 5 percent unbalance in kVA load sharing between this unit and possible future generators.
2. Automatic protection against short circuits on system.
3. Permit unit to operate at no load below rated frequency for engine start up and shut down procedures.
4. Provide voltage level and gain controls for normal operating adjustments.
5. Provide voltage level control with minimum range of plus or minus 5 percent from rated voltage.
6. Mount regulator, volts per hertz type, in generator housing on suitable vibration isolators.

R. Generator Instruments and Controls:
1. Generator mounted NEMA 1 type, illuminated vibration isolated digital instrument and control panel(s).
2. AC voltmeter and phase selector switch.
3. AC ammeter and phase selector switch.
4. Frequency meter.
5. Run-off-auto engine, start-stop control switch.
6. Emergency stop.
7. Run time meter.
8. Governor control rheostat.
9. Voltage level adjustment rheostat.
10. Cool down time delay 0-15 minute adjustable.
11. Cycle cranking control.
12. Minimum red shut down indicating lights as follows:
    a. Overcrank.
    b. Overspeed.
    c. Low lubricating oil pressure.
    d. High engine water temperature.
13. Minimum amber alarm indicator lights as follows:
    a. Control switch not in auto position.
    b. Low engine water temperature (less than 70 DegF).
    c. Low fuel in day tank.
    d. Day tank leak.
    e. Battery charger malfunctioning.
    f. Low battery voltage.
14. Minimum amber prealarm indicator lights as follows:
    a. High engine water temperature.
    b. Low lubricating oil pressure.
15. Common dry contacts:
    a. Common alarm.
    b. Running.
    c. Low fuel.

d. Fuel leak.
e. Battery failure.
f. Ready.

S. Vibration Isolators: Vibration system shall consist of engine and generator mount isolators with or without additional mechanical spring isolators rubber pads to control both high and low frequency vibrations between major components, sub-base and structural foundation and to provide required vibration isolation for the seismic zone of the Project.

2.4 ACCESSORIES

A. Synchronizing:
1. Provide synchronizing control panel to allow synchronizing the new generator under this contract with existing 800 KW Caterpillar generator Serial No. AFR03723, Control Panel EMCP3.2.
2. Sequence:
   a. User shall be able to select "#1-#2-Both" to run.
   b. If #1 or #2 is selected no synchronization is required and the selected generator shall be started and placed on the generator bus when generator is called to start by the automatic transfer switch.
   c. If "Both" is selected each generator shall start when generator is called to start. The first generator ready shall be placed on the generator bus and the second generator shall be synchronized onto the generator bus with the first generator. If either generator fails to start or synchronize on line the other generator shall remain on the bus and an alarm shall be generated. The generator(s) will be transferred on line by the automatic transfer switch.
3. Make all modifications to the existing 800 KW generator and generator controls necessary for parallel operation and synchronization.

B. Generator set non-walk-in weather protective enclosure:
1. 14 gauge sheet steel with side servicing panels, air intake louvers and rear control panel access door.
2. Side servicing panels shall have two (2) locking points; all panels and doors are key lockable.
3. Pitched roof with silencing exhaust muffler mounted inside the enclosure air discharge section.
4. Completely install enclosure on generator set mounting base.
5. Highly corrosion resistant construction:
   a. Polyester powder baked coating.
   b. Stainless hardware and hinges.
6. 75 dBA at 7 meters.

2.5 SOURCE QUALITY CONTROL

A. Individually test each prime mover.
1. Continuously test for a period no less than 2 HRS.
2. Test procedure shall be as follows:
   a. Start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating at rated power factor in one (1) step.
   b. Observe and record the cranking time(s) required to start and run.
   c. Observe and record the time required to come up to operating speed.
   d. Record voltage and frequency overshoot.
   e. Record voltage, frequency and amperes.
   f. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter.

2.6 MAINTENANCE MATERIALS

A. Spare Parts:
   1. Provide manufacturer's recommended spare parts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all components as indicated and in accordance with manufacturer's recommendations and instructions.

B. Fill cooling system with solution of 50-50 water and ethylene glycol anti-freeze to prevent freezing at temperatures as low as minus 30 DegF.

C. Provide fuel for a full day tank prior to load test.

D. Install all wiring to engine in conduit.
   1. Control wiring on engine may be factory installed in high temperature loom.

E. Provide control wiring in conduit between generator control panel and remote devices as described under generator instrument and controls paragraph and remote annunciator paragraph of this Specification.

F. Mount on concrete pad utilizing vibration/seismic isolators, see structural drawings for pad detail.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-startup adjustments and installation checks.
   3. Conduct initial startup of equipment and perform operational checks.
   4. Provide Owner written statement that manufacturer's equipment has been installed properly, started up, tested, and is ready for operation by Owner's personnel.
   5. Demonstrate satisfactory operation of generator start and synchronization system and correct any deficiencies.
   6. Provide 4 HRS of the manufacturer's technical representative's time for on-site training of Owner's personnel.

B. Provide on-site testing:
   1. Engineer and Owner shall be notified seven (7) days prior to testing.
   2. Load test:
      a. Start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating in one (1) step using portable load bank.
         1) Unity power factor is acceptable for on-site testing.
         2) Run generator for a minimum of 3 hours.
      b. Observe and record the cranking time(s) required to start and run.
      c. Observe and record the time required to come up to operating speed.
      d. Record voltage and frequency overshoot.
      e. Observe and record time required to achieve steady-state condition.
      f. Record voltage, frequency and amperes at 15 minute intervals.
      g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.
   3. Furnish load bank of required rating necessary for test.
   4. Record engine fuel consumption by measuring fuel level at start and completion of test.
   5. Test all safeties specified for generator instruments and controls as recommended by manufacturer and as required to verify proper operation.

3.3 SCHEDULE OF GENERATOR SETS

Minimum standby KW rating	800
Minimum kVA rating	1,000
Base fuel tank size, gallons	1,000
Outdoor enclosure	Yes
Conduit size and quantity	4 – 3 IN
Feeder size and number per conduit	3 – 350 kcmil
Neutral size per conduit	3/0
Ground size per conduit	3/0

END OF SECTION

SECTION 16265
VARIABLE FREQUENCY DRIVES: LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Variable frequency drives (VFDs) for operation of inverter duty motors.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ETL Testing Laboratories (ETL).
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
      b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
      c. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   4. National Electrical Manufacturer's Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 430, Motors Motor Circuits, and Controllers..
   6. Occupational Safety and Health Administration (OSHA).
   7. Underwriters Laboratory, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
      b. 508A, Standard for Industrial Control Panels.

B. Qualifications:
   1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
   2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
   3. VFD Supplier shall maintain an authorized service organization within 100 miles of the Project Site.

C. Coordination:
   1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.
      a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.
   2. Motor and VFD coordination: See Specification Section 11005.
   3. VFD shall be supplied complete with all required control components.
      a. Provide control as indicated:
         1) On the electrical drawings.
         2) As specified in this Specification Section.
         3) As specified in the process control system loop descriptions.

a) See Specification Section 13441.

b. VFD manufacturer shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.

1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.

c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, leak detectors, etc.

4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.

a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.

b. Equipment which reduces clear work space below the minimums established by the NFPA 70 will not be acceptable.

1.3 DEFINITIONS

A. Variable Torque (VT):

1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.

B. Constant Torque (CT):

1. Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.
2. This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.

C. Constant Horsepower:

1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.
2. This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.

D. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

E. Standard Motor: An AC induction motor that fails to comply with one (1) or more requirements of NEMA MG 1 Part 31.

F. Low Voltage: 600 Vac or less.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
2. Provide a schedule for each VFD including the following information:

a. Equipment Tag Number.
b. VFD Complete Catalog Number.
c. VFD Amp Frame Size.
d. Variable or Constant Torque Rating Basis.
e. Rated Input Current.
f. Rated Continuous Output Current.
g. Rated Short Circuit Current.
h. VFD Maximum Motor Lead Length.
i. Motor Manufacturer.
j. Motor Frame Size.
k. Motor Full Load Amps.
l. Motor Service Factor.

m. As installed motor Lead Length.
n. VFD options provided to meet harmonic or motor protection specifications.

3. Product technical data:
   a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.
   b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.
   c. Manufacturer's installation instructions.
   d. Manufacturer's programming and operating instructions.
   e. See Specification Section 16010 for additional requirements.
4. Fabrication and/or layout drawings:
   a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.
   b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.
   c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.
   d. Interior layout drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.
   e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.
5. Certifications:
   a. Submit with Shop Drawings:
      1) Identification and location of closest authorized service organization.
      2) Harmonic analysis at each PCC per Harmonic Protection Requirements Article.
   b. Submit prior to shipment:
      1) Certified factory test reports confirming compliance with specified requirements.
   c. Submit after installation and startup:
      1) Certified field service reports showing:
         a) Each VFD is operational.
         b) Each VFD and its driven equipment motor are compatible.
         c) Each VFD responds correctly to the input control signals.
         d) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
         e) Measured harmonic levels per Harmonic Protection Requirements Article.
         f) VFD is ready for operation by Owner.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Approved copy of VFD schedule per Submittals Article.
   3. Manufacturer's instruction manuals.
   4. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
   5. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
   6. Recommended spare parts list.
   7. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen Bradley.
   2. ASEA Brown Bovari (ABB).
   3. Eaton.
   4. Danfoss.
   5. General Electric Company.
   6. Siemens.
   7. Square D Company.
   8. Toshiba.
   9. Yaskawa.
   10. Or approved equal.

2.2 GENERAL

A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

B. VFDs, whether installed in motor control center (MCC) construction or separately-mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.
   1. Motor control.
   2. Motor overload protection.
   3. Motor and motor branch circuit short circuit and ground fault protection.
   4. Motor and controller disconnecting means.

C. It is the intent of this Specification that VFDs shall be an “engineered” or “configured” drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Application:
   1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100 percent of base speed of the driven equipment.
   2. VFDs shall be compatible with:
      a. Inverter duty induction motors.
   3. VFDs shall be suitable for Constant Torque (CT) or Variable Torque (VT) applications as scheduled.
   4. VFDs shall be designed to operate successfully under the following site conditions:
      a. Ambient:
         1) Temperature: 0-50 DegC.
         2) 95 percent non-condensing relative humidity.
      b. Elevation: Less than 3,300 FT above MSL.
      c. Power supply characteristics:
         1) 480Vac, 3 PH, 60 Hz, 3 wire, (+/- 10 percent).
         2) Effectively grounded.

B. Ratings and Performance Specifications:
   1. Voltage rating:
      a. Nominal: 460 or 480 Vac, 3 PH, 60 Hz.

b. Range for continuous full load operation: +/-10 percent of nominal.
c. Voltage imbalance tolerance for full load operation: 3 percent minimum.

2. Current ratings:
   a. Continuous:
      1) Equal to or greater than 1.15 times the motor nameplate full load.
   b. Short-term overload:
      1) VT: 110 percent for 1 minute.
      2) CT: 150 percent for 1 minute.
      3) Permissible for 1 minute every 10 minutes continuously.
   c. Short circuit:
      1) As indicated on the Drawings.
      2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.
      3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance specifications or not.
3. Efficiency:
   a. 97 percent, minimum, at full speed and full load.
   b. 93 percent, minimum at 1/2 speed and full load.
4. Displacement power factor:
   a. 95 percent, minimum from 50 percent to 100 percent speed and load.
5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.
6. Frequency drift:
   a. +0.5 percent of set frequency.
7. Speed regulation (motor dependent): 3 percent.
8. Speed range: 10:1.
9. Control type:
   a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
      1) When operating under voltage boost.
      2) At frequencies over 60 Hz.
10. Type: 6 or 18 pulse as scheduled.

C. Operational Features:
1. Insensitive to input phase sequence.
2. Continued operation with momentary voltage dips of 25 percent of rated voltage, or single phase condition: 4 second, minimum.
3. Controls power loss ride-through: 500 msec, minimum.
4. Electronic reversing.
5. DC injection braking.
6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
7. Critical frequency band lockout:
   a. Minimum of three (3) settings.
   b. Adjustable bandwidth, 1 - 5 Hz.
8. Capable of operating without the motor connected for start-up and troubleshooting.

D. The VFD shall be provided with the following minimum user-programmable parameters:
1. Carrier frequency.
2. Independent maximum and minimum speeds for forward and reverse operation.
3. Start frequency and hold time.
4. Independent linear acceleration and deceleration time.
5. Preset “jog” speed.
6. Three (3) critical frequency bands.
7. One (1) preset speed selectable by logic input.
8. Volts/Hertz ratio.

9. Voltage boost, magnitude and frequency range.
10. Process controller gain, offset and bias.
11. Current limit.
12. Overcurrent pickup.
13. Overcurrent delay.
14. Ground fault pickup.
15. DC injection level and time.

E. The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:
   1. General:
      a. Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:
         1) Input under voltage.
         2) Input over voltage.
         3) Input under frequency.
         4) Input over frequency.
         5) Input Phase loss.
         6) DC Bus under voltage.
      b. Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.
         1) Over temperature.
         2) Blown fuse.
         3) Component failure.
         4) Overload.
         5) Short circuit.
         6) Ground fault.
         7) DC Bus over voltage.
         8) External safety input (e.g., motor thermal protection).
         9) Logic fault.
      c. When automatic shutdown occurs, VFD shall restart immediately upon reset, whether automatic or manual.
      d. VFD shall hold cause of trip data for a minimum of four (4) shutdowns in memory.
         1) Data to be accessible through the keypad, local communication link and remotely.
   2. Input protection:
      a. Input circuit breaker or current-limiting fuses with externally operable disconnect.
         1) Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.
         2) Handle padlockable in the OFF position.
      b. Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.
      c. Incoming line transient suppression.
         1) 6000V peak per IEEE C62.41.
         2) Phase-to-phase and phase-to-ground protection.
      d. Sustained over voltage trip.
   3. Internal protection:
      a. Surge suppression and power device snubbers.
      b. Power devices rated at 2.5 times line voltage.
      c. Instantaneous over current trip.
      d. DC bus over voltage trip.
      e. Power device over temperature trip.
      f. Control logic circuit malfunction trip.

4. Output protection:
    a. Inverse-time overload trip:
        1) UL Class 10 characteristic.
    b. Over voltage trip.
    c. Over frequency trip.
    d. Short circuit trip.
        1) Line to line and line to ground.
    e. Ground fault trip.

2.4 OPERATOR AND REMOTE CONTROL INTERFACE

A. Drive controls shall be microprocessor-based with on-board human machine interface and both local and remote digital communications capability.
    1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available both locally and remotely.

B. Control circuits shall be 120 Vac or 24 Vac or 24 Vdc.
    1. 120 Vac supplied by CPT in the VFD.
        a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.
        b. CPT shall have two (2) fuses on the primary side and one (1) fuse on the secondary side.
        c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.
    2. 24 Vac or 24 Vdc supplied by Class 2 power supply in the VFD.
        a. Power supply shall have minimum additional capacity of 33 percent greater than that required by control devices.
        b. Provide two (2) current-limiting fuses on the AC supply to the power supply.
        c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.

C. Operator Interface:
    1. Door mounted sealed keypad, membrane type with LED or LCD display.
        a. Messages shall be in English and engineering units.
        b. Drive operating parameters shall be programmable.
        c. Menu driven.
        d. Password security.
        e. Display fault and diagnostic data.
        f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.
        g. Gold plated plug-in contacts.
    2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.
        a. Minimum indications:
            1) Run.
            2) Stop.
            3) Ready.
            4) Alarm.
            5) Fault.
            6) Local control.
            7) Remote control.
            8) Control source local.
            9) Control source remote.
            10) Speed indication.
        b. Minimum control functions:
            1) Local/Remote switch.
            2) Stop button.

3) Start button.
4) Reset button.
5) Speed control buttons.

3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.
   a. On occurrence of more than one (1) condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:
1. Local portable computer interface via RS232/RS242 serial communications port:
   a. Capability to:
      1) Start-Stop VFD.
      2) Control VFD Speed.
      3) Access fault and diagnostic data.
2. Analog and discrete inputs:
   a. Speed reference (setpoint) signal 4-20 mA DC.
   b. Isolated process PID controller with user-programmable setpoint, gain, rate, reset and span for accepting a remote 4-20 mA DC process variable signal.
3. Analog and discrete outputs:
   a. 4-20 mA DC output for remote speed indication, as a function of frequency, calibrated 0 to 100 percent.
   b. Drive FAULT contacts.
   c. Drive RUNNING contacts.
   d. Drive in REMOTE MODE status contacts.
4. Contacts:
   a. Contacts shall be rated 2 A inductive at 120 Vac.
   b. All contacts shall be wired to field wiring terminal boards.
5. Drive shutdown on external fault input:
   a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
   b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.
6. Network communications capability:
   a. Provide VFD with communication card, protocol and required programming for digital communication of all VFD program and operational parameters to plant control system via:
      1) Ethernet IP.

2.5 HARMONIC PROTECTION REQUIREMENTS

A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a “dedicated system” in IEEE 519 Table 10.2.

B. With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from the utility, the VFDs shall not produce harmonic effects in excess of the following limits at the point of common coupling (PCC).
1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
2. Current distortion: IEEE 519 Table 10.3 based on $I_{SC}/I_L < 20$.

C. PCC shall be considered:
1. Building service entrance switchboard.

D. The Engineer has performed preliminary calculations based on typical VFD data which indicate that the minimum mitigation measures required to meet the specified harmonic criteria are the following topologies:
1. 6-pulse rectifier topology with input line reactors or DC link reactors, minimum impedance 5 percent on drive kVA base.
2. 18-pulse rectifier topology for certain VFD’s as indicated.

3. Active harmonic filters where shown.

E. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.

F. Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at the PCC according to the requirements of IEEE 519 Section 9.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.6 MOTOR PROTECTION REQUIREMENTS

A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.

B. Provide motor overload, short circuit and ground fault protection integral to drive electronics.

2.7 EQUIPMENT CONSTRUCTION

A. Fabrication and Assembly:
   1. Each VFD system shall be factory-assembled for installation in an MCC or in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
      a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.
      b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.
      c. Indicated VFDs shall be mounted within standard motor control center sections, and included as part of the overall motor control center.
   2. Reactors, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Engineer's permission may be mounted in a separate enclosure.
   3. Cooling fans, as required, shall be provided to run when drive is running.
   4. Enclosures for separately mounted VFD's:
      a. NEMA Type 1 for installation in Electrical Rooms.
      b. NEMA Type 12 for installation in other unclassified areas.

B. Wiring:
   1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
      a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
      b. Bases with a self-sticking back will not be allowed.
   2. All plug-in contacts shall be gold-plated.
   3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
      a. Provide terminals for shield continuity where required.
   4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
      a. Non-brittle, interlocking, track-mounted type.
      b. Screw terminals will not be allowed.
      c. For free-standing panels, 8 IN of clearance shall be provided between terminals and the panel base for conduit and wiring space.
      d. Not less than 25 percent spare terminals shall be provided.
      e. Terminals shall be labeled to agree with identification indicated on the suppliers submittal drawings.

f. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
   a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
   a. Markings or color code shall match the manufacturer's drawings.
7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.

C. Nameplates:
1. All devices mounted on the face of the drive shall be provided with a suitable nameplate as specified in Specification Section 10400.
2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.
3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.

D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

2.8 COMPONENTS AND ACCESSORIES

A. Reactors: Provide input and output reactors for all 6-pulse VFD's and output reactors for all (18-pulse VFD's).
1. Impedance: 5 percent.
2. Continuous current: Not less than drive rating.
3. Current overload: 150 percent for 1 minute.
4. Insulation temperature rating: 180 DegC.
5. Copper windings.
6. Saturation current rating: 3.5 to 5 times rated current.
7. Hi-potential rating: 2500 Vac line to ground and line to line, for 1 minute.
8. Noise reduction features:
   a. Epoxy over cast coil.
   b. Extra dips and bakes of varnish over continuous wound coil.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.
2. Prior to final assembly:
   a. Inspect incoming components.
   b. Test and inspect power devices.
   c. Circuit cards:
      1) Component and functional tests:
      2) Burn-in chamber or temperature cycling test.
      3) System test after burn-in or temperature cycling.
3. After final assembly:
   a. Continuity and insulation test of 480 power control circuits.
   b. Drive tests:
      1) Burn-in complete drive at full load for 24 HRS.
      2) Verify all auxiliary circuits operation.
      3) Monitor output variables.

c. Systems test:
   1) Provide inputs to field connections and simulate on-site operation.
   2) Test all auxiliary equipment.

2.10 MAINTENANCE MATERIALS

A. Provide manufacturer's recommended renewable power and control fuses.

B. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.

B. Verify the installed motor nameplate electrical requirements do not exceed 0.86 of the VFD capacity.

C. Provide services of manufacturer's representative to perform start-up services.

D. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.
   1. The space available on the Drawings shall not be exceeded.

3.2 START UP

A. Pre-start-up Services:
   1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period described in Specification Section 01650.
   2. Shall consist of:
      a. Physical and electrical installation check.
      b. Final adjustments and calibration of drive parameters.
      c. VFD operation from simulated input signals.
   3. Shall be complete when VFD(s) are fully operational.

B. Field Quality Control:
   1. Perform field measurement of harmonics at PCC per Harmonic Protection Requirements Article.
      a. For the maximum number of VFDs that will be operational at the same time.
   2. Record all data necessary for the preparation of required test reports.

C. Start-up and Demonstration Services:
   1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests. Configure all configurable settings.
      a. Perform all work in the presence of the Owner's designated representatives.
   2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Engineer of carrier frequencies set in excess of 5 kHz and reason for setting.
   3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
      a. Ensure compatibility of VFD with associated control and instrumentation signals.
   4. Simulate VFD failures and demonstrate troubleshooting aids.

D. Instruct Owner's designated personnel:
   1. Minimum of 8 HRS at the jobsite.
   2. Include both field and classroom instruction.
   3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
      a. Troubleshooting.

b. Repair and replacement.
c. Parts inventory.
d. Maintenance records.

3.3 SCHEDULES

A. Some motors may have full load amps (FLA) greater than that listed in NFPA 70.
   1. The following table is an estimate for the FLA of the motors based on preliminary Shop Drawings.

EQUIPMENT TAG	HP	VFD AMP RATING (MIN)	6 PULSE	18 PULSE
Effluent Pump 1, 91 PMP 001	400	550		√
Effluent Pump 2, 91 PMP 002	400	550		√
Effluent Pump 3, 91 PMP 003	400	550		√
Influent Pump 1, 12 PMP 301	60	89		√
Influent Pump 2, 12 PMP 302	60	89		√
Influent Pump 3, 12 PMP 303	60	89		√
Influent Pump 4, 12 PMP 304	60	89		√
ML Pump 1, 31 PMP 103	10	16	√	
ML Pump 2, 31 PMP 203	10	16	√	
RAS Pump 1, 42 PMP 001	10	16	√	
RAS Pump 2, 42 PMP 002	10	16	√	
RAS Pump 3, 42 PMP 003	10	16	√	
RAS Pump 4, 42 PMP 004	10	16	√	
RAS Pump 5, 42 PMP 011	7.5	13	√	
RAS Pump 6, 42 PMP 012	7.5	13	√	
RAS Pump 7, 42 PMP 013	7.5	13	√	
RAS Pump 8, 42 PMP 014	7.5	13	√	
RAS Pump 9, 42 PMP 031	7.5	13	√	
RAS Pump 10, 42 PMP 032	7.5	13	√	
Thickened Sludge Pump 1, 61 PMP 003	5	9	√	
Thickened Sludge Pump 2, 61 PMP 013	5	9	√	
GT Sludge Pump 1, 61 PMP 024	5	9	√	
GT Sludge Pump 2, 61 PMP 025	5	9	√	

END OF SECTION

SECTION 16410
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Safety switches.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a table that associates safety switch model number with connected equipment tag number.
      c. See Specification Section 16010 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Or approved equal.

2.2 SAFETY SWITCHES

A. General:
   1. Non-fusible or fusible as indicated on the Drawings.
   2. Suitable for service entrance when required.
   3. NEMA Type HD heavy-duty construction.

4. Switch blades will be fully visible in the OFF position with the enclosure door open.
5. Quick-make/quick-break operating mechanism.
6. Deionizating arc chutes.
7. Manufacture double-break rotary action shaft and switchblade as one (1) common component.
8. Clear line shields to prevent accidental contact with line terminals.
9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
   a. Red and easily recognizable.
   b. Padlockable in the OFF position
   c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
1. Horsepower rated of connected motor.
2. Voltage and amperage: As indicated on the Drawings.
3. Short circuit withstand:
   a. Non-fused: 10,000A.
   b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
1. Neutral kits.
2. Ground lug kits.
3. Auxiliary contact kits with 1 N.O. and 1 N.C. contact.

D. Enclosures:
1. NEMA 1 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. With or without knockouts, hinged and lockable door.
2. NEMA 4X rated (metallic):
   a. Body and cover: Type 304 or 316 stainless steel.
   b. No knockouts, external mounting flanges, hinged and gasketed door.
3. NEMA 7 and NEMA 9 rated:
   a. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
   b. Drilled and tapped openings or tapered threaded hub.
   c. Gasketed cover bolted-down with stainless steel bolts.
   d. External mounting flanges.
   e. Operating handle padlockable in the OFF position.
4. NEMA 12 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:
1. Fuses.
2. See Specification Section 16490 for overcurrent and short circuit protective device requirements.

F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
   1. The VFD is to be disabled with the switch is in the open position.

D. Permitted uses of NEMA 1 enclosure:
   1. Surface or flush mounted in areas designated dry in architecturally finished areas.

E. Permitted uses of NEMA 4X metallic enclosure:
   1. Surface mounted in areas designated as wet and/or corrosive.

F. Permitted uses of NEMA 7 enclosure:
   1. Surface mounted in areas designated as Class I hazardous.
   2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

G. Permitted uses of NEMA 9 enclosure:
   1. Surface mounted in areas designated as Class II hazardous.
   2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

H. Permitted uses of NEMA 12 enclosure:
   1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

SECTION 16411
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 GENERAL

A. Section Includes:
   1. Manual transfer switches.
   2. Automatic transfer switches.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches.
      b. 1008, Standard for Safety Switch Equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 16010 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 16010.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
   1. Automatic transfer switches:
      a. Automatic Switch Company.
      b. Kohler.
      c. Onan.
      d. Russelectric.
      e. Eaton.
      f. Zenith Products.
      g. Or approved equal.

2. Manual transfer switches:
    a. Automatic Switch Company.
    b. Eaton.
    c. General Electric Company.
    d. Russelectric.
    e. Square D Company.
    f. Siemens.
    g. Zenith Products.
    h. Or approved equal.

2.2 MANUAL TRANSFER SWITCH

A. Double throw load break rated with:
    1. Quick-make/quick-break operating mechanism.
    2. Deionizating arc chutes.
    3. Double-break rotary action shaft and switchblade shall be manufactured as one (1) common component.
    4. Clear line shields to prevent accidental contact with line terminals.

B. Operating handle: Easily recognizable and padlockable in both positions.

C. Wiring configuration to allow single load to be supplied by a normal or alternate source.

D. Ratings:
    1. Voltage and amperage: As indicated on Drawings.
    2. Short circuit withstand: Equal to or greater than the upstream equipment.

E. Enclosure:
    1. NEMA 1 rated:
        a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
        b. With or without knockouts, hinged and lockable door.
    2. NEMA 4X rated:
        a. Body and cover: Type 304 or 316 stainless steel.
        b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.

F. Standards: NEMA KS 1, UL 98.

2.3 AUTOMATIC TRANSFER SWITCH

A. Construction:
    1. Electrically operated mechanically held, double throw, air-break type.
    2. Silver-surface main contacts and protect by arcing contacts.
    3. Switch shall have provisions for visual inspection of switch blades and contacts.
    4. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source.
    5. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative.
    6. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
    7. Ratings:
        a. Continuous duty in both normal and emergency.
        b. Three-phase, three-pole, four-wire.
        c. Voltage and current ratings as indicated on the Drawings.
        d. Short circuit withstand rating equal to or greater than the normal source electrical gear.
    8. Standards: UL 1008.

B. Operation:
    1. Microprocessor based control module.

2. Open transition.
3. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.
4. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed.
5. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.
   a. Normal source voltage sensing.
      1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
      2) Adjustable dropout from 75-98 percent of pickup setting, factory set 85 percent.
   b. Emergency source voltage and frequency sensing:
      1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.
      2) Fixed voltage dropout at 85 percent of pickup setting.
      3) Adjustable pickup from 90-100 percent of rated frequency, factory set 95 percent.
      4) Fixed frequency dropout at 88 percent of pickup setting.
6. Time delays:
   a. Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.
   b. Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.
   c. Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source.
      1) Automatically bypassed when emergency source fails and normal source is available.
   d. Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.
7. Exerciser timer:
   a. Enable and disable function.
   b. Selectable to exercise with or without transferring load.
   c. Adjustable exercise duration from 1 minute to 24 HRS, factory set at 15 minutes.
   d. Adjustable day of the week exercise setting, factory set for Monday.
8. Inphase monitor:
   a. Compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency differences.
   b. Inphase transfer accomplished if both sources are within 2 Hz of rated frequency and 70 percent or more of rated voltage.

C. Enclosure:
   1. NEMA 1 rated.
   2. Body and cover: Sheet steel finished with a rust inhibiting primer and manufacturers standard paint inside and out.
   3. No knockouts, hinged and lockable door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Connect as indicated in one-line diagram.

C. Mounting of manual transfer switches: Wall-mounted.

D. Mounting of automatic transfer switches:
   1. Floor mounted on 4 IN high concrete pad, lined up with switchboard.

E. Manual Transfer Switch Enclosure:
   1. Permitted uses of NEMA 1 rated enclosure:
      a. Surface mounted in areas designated as dry.
   2. Permitted uses of NEMA 4X rated enclosure:
      a. Surface mounted in areas designated as wet and/or corrosive.

3.2 FIELD QUALITY CONTROL

A. Automatic Transfer Switch Testing:
   1. Simulate power outage by opening normal source overcurrent device.
      a. Verify engine generator starts and switch transfers in the specified time.
   2. Close normal source overcurrent device to simulate the return of normal power.
      a. Verify the switch retransfers and engine generator shuts down in the specified time.
   3. Perform a manual transfer and retransfer.
   4. Verify the indicator lights function properly.

END OF SECTION

SECTION 16412
SEPARATELY MOUNTED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Separately mounted circuit breakers.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 489, Standard for Safety Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
      b. 877, Standard for Safety Circuit Breakers and Circuit Breaker Enclosures for Use in Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a table that associates equipment model number with equipment tag number.
      c. See Specification Section 16010 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Appleton Electric Company.
   6. Or approved equal.

2.2 COMPONENTS

A. NEMA 1 rated:
   1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. With or without knockouts, hinged or unhinged cover.
   3. Breaker is front operable and padlockable in the OFF position.
   4. Suitable for service entrance.

B. NEMA 4X rated:
   1. Body and cover: Type 304 or 316 stainless steel.
   2. No knockouts, external mounting flanges, hinged and gasketed door.
   3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
   4. Suitable for service entrance.

C. NEMA 7 and 9 rated:
   1. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
   2. Drilled and tapped openings or tapered threaded hub.
   3. Gasketed cover bolted-down with stainless steel bolts.
   4. External mounting flanges.
   5. Front operating handle padlockable in the OFF position.
   6. Suitable for service entrance.
   7. Accessories: 40 mil PVC exterior coating.

D. NEMA 12 rated:
   1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. No knockouts, external mounting flanges, hinged and gasketed door.
   3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
   4. Suitable for service entrance.

E. Standards: UL 489 and UL 877 for hazardous locations.

F. Overcurrent and short circuit protective devices:
   1. Molded case circuit breaker.
   2. See Section 16490 for overcurrent and short circuit protective device requirements.
   3. Factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Permitted uses of NEMA 1 enclosure:
   1. Surface or flush mounted in areas designated dry in architecturally finished areas.

C. Permitted uses of NEMA 4X enclosure:
   1. Surface mounted in areas designated as wet and/or corrosive.

D. Permitted uses of NEMA 7 enclosure:
   1. Surface mounted in areas designated as Class I hazardous.
      a. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

E. Permitted uses of NEMA 9 enclosure:
   1. Surface mounted in areas designated as Class II hazardous.
      a. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

F. Permitted uses of NEMA 12 enclosure:
   1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

SECTION 16440
SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage switchboards.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 2, Deadfront Distribution Switchboards.
   2. Underwriters Laboratories, Inc. (UL):
      a. 891, Standard for Safety Dead-Front Switchboards.

B. Verify the space required for the switchboard is equal to or less than the space allocated.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   3. See Specification Section 16010 for additional requirements.
   4. Fabrication and/or layout drawings:
      a. Switchboard layout with alphanumeric designation, protective devices size and type, as indicated in the one-line diagram or switchboard schedule.
      b. Front elevation and plan drawing of the assembly.
      c. Three-line or single line and schematic diagrams.
      d. Conduit space locations within the assembly.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Fabrication and/or layout drawings updated with as-build conditions

C. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Ground fault protection system test report signed by the projects supervising electrical foreman.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.

2. General Electric Company.
3. Square D Company.
4. Siemens.
5. Or approved equal.

2.2 SWITCHBOARDS

A. Ratings:
1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.
2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
3. Service Entrance Equipment rated when indicated on the Drawings.
4. 100 percent rated when 100 percent rated breakers are installed.

B. Construction:
1. Standards: NEMA PB 2, UL 891.
2. Completely enclosed, dead-front, self-supporting metal structure.
3. Vertical panel sections bolted together.
4. Frames bolted together to support and house bus, cables and other equipment.
5. Frames and insulating blocks to support and brace main buses for short circuit stresses up to ratings indicated on the Drawings.
6. All sections front aligned.
7. Devices front removable and load connections front accessible for mounting switchboard against a wall.
8. NEMA 1 rated enclosure.
9. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturers standard paint.

C. Buses:
1. Material: Tin-plated aluminum or copper.
2. Main horizontal bus:
   a. Fully rated and continuous over length of switchboard with all three (3) phases arranged in the same vertical plane.
   b. Sufficient size to limit temperature rise to 65 DegC over average air temperature outside the enclosure of 40 DegC.
3. Neutral bus: Fully rated and continuous over length of switchboard.
4. Ground bus: 1/4 x 2 IN copper, continuous over length of switchboard and solidly grounded to each vertical section structure.
5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.

D. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
   a. Individually mounted molded case circuit breaker.
2. Feeder overcurrent protective devices:
   a. Group mounted molded case circuit breaker.
3. Generator breakers:
   a. Low voltage power circuit breaker.
4. See Specification Section 16490 for overcurrent and short circuit protective device requirements.
5. Factory installed.
6. Means to padlock all main and feeder devices in the open position.

E. Surge Protective Device: Integrally mounted, see Specification Section 16491.

F. Metering:
1. Power monitor:
   a. Through cabinet mounting.
   b. See Specification Section 16492 for meter requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards in accordance with manufacturer's instructions.

B. Arrange switchboard as shown on the Drawings.

C. Indoor Locations:
   1. NEMA 1 enclosure.
   2. Install on concrete housekeeping pad, align front of switchboard with top edge of pad chamfer and securely fasten to pad.

D. Miscellaneous:
   1. Provide circuit protective devices and other associated equipment as indicated on the Drawings.
   2. All control wiring shall be neatly laced and have flexibility at hinge locations.

3.2 FIELD QUALITY CONTROL

A. Test the ground fault protection system as indicated in Specification Section 16490.

END OF SECTION

SECTION 16441
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lighting and appliance panelboards.
   2. Power distribution panelboards.
   3. Panelboards mounted in motor control centers, and switchboards and switchgear.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      b. 67, Standard for Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Panelboard schedules with as-built conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Or approved equal.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating or as indicated in the schedule.
   3. Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating or as indicated in the schedule.
   4. Service Entrance Equipment rated when indicated on the Drawings.

C. Construction:
   1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
   2. Multi-section panelboards: Feed-through or sub-feed lugs.
   3. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
   1. Main bus bars:
      a. Tin plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC.
      b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
   2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
   3. Neutral bus bars: Insulated 100 percent rated or 200 percent rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Enclosure:
   1. Boxes: Code gage galvanized steel, furnish without knockouts.
   2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
   3. Lighting and appliance panelboard:
      a. Trims supplied with hinged door over all circuit breaker handles.
      b. Trims for surface mounted panelboards, same size as box.
      c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
      d. Doors lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.
      e. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
      f. Clear plastic cover for directory card mounted on the inside of each door.
      g. NEMA 3R or NEMA 12 rated: Door gasketed.
   4. Power distribution panelboard:
      a. Trims cover all live parts with switching device handles accessible.
      b. Less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
      c. Clear plastic cover for directory card mounted front of enclosure.
      d. NEMA 3R or NEMA 12 rated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.

F. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Molded case circuit breaker.
   2. Branch overcurrent protective devices:
      a. Mounted molded case circuit breaker.
   3. See Section 16490 for overcurrent and short circuit protective device requirements.
   4. Factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 16010.

C. Provide NEMA 1, NEMA 3R or NEMA 12 rated enclosure as indicated on the Drawings.

D. Provide each panelboard with a typed directory:
   1. Identify all circuit locations in each panelboard with the load type and location served.
   2. Mechanical equipment shall be identified by Owner-furnished designation if different than designation indicated on the Drawings.
   3. Room names and numbers shall be final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings.

END OF SECTION

SECTION 16442
MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Motor control centers.
   2. Separately mounted motor starters (including those supplied with equipment).
   3. Manual motor starters.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. International Electrotechnical Commission (IEC).
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
      b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
      c. ICS 3, Medium-Voltage Controllers Rated 2001 to 7200 V AC.
   3. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
      b. 845, Motor Control Centers.

B. Miscellaneous:
   1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
   2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Motor control center:
         1) Elevation drawing with overall dimensions.
         2) Starter and component schedule.
         3) Identification of units and their location in the MCC.
         4) Location of incoming line terminals.
         5) Mounting dimensions.
         6) Available conduit entrance areas.
         7) Nameplate schedule.
         8) Assembly ratings (amps, volts, short circuit, etc.).
         9) Unit ladder logic wiring for each unit depicting electrical interlocking and wiring between units (NEMA ICS 3 Class II) and identification of terminals where field devices or remote control signals are to be terminated (NEMA ICS 3 Class II-S) as indicated on the Drawings and/or loop descriptions.

b. Separately mounted combination starters:
   1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated as indicated on the Drawings and/or loop descriptions.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
      c. Fabrication and/or layout drawings updated with as-built conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen-Bradley.
   2. Eaton.
   3. General Electric Company.
   4. Square D Company.
   5. Siemens.
   6. Or approved equal.

2.2 MOTOR CONTROL CENTERS

A. Ratings:
   1. 600 V class, 3 PH, 60 Hz with operating voltage and number of wires as indicated on the Drawings.
   2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
   3. Service Entrance Equipment rated when indicated on the Drawings.

B. Construction:
   1. Standards: UL 845.
   2. Totally enclosed, dead front, free standing assemblies, bolted together to form a single assembly.
   3. Fabricate of not less than 14 GA steel with 16 GA steel doors in standardized units.
   4. Nominal size per section: 20 IN wide, 20 or 21 IN deep, and 90 IN high.
   5. Enclosure:
      a. NEMA 1 gasketed.
      b. NEMA 12:
         1) Dust-tight and drip-proof.
         2) Gasketed material round all doors, door cutouts, cover plates, side, top and back sheets.
         3) Gasketed bottom plate.
      c. NEMA 3R non-walk-in:
         1) Rainproof and sleet resistant.
         2) NEMA 1 gasketed enclosure with an outdoor NEMA 3R enclosure.
         3) MCC-M to have roof top sun/rain shield extending at least 30 IN beyond front of enclosure.
   6. Horizontal wireways:
      a. At the top, isolated from the main bus
      b. At the bottom.
      c. Easily accessible.
      d. Full length of the MCC.
   7. Vertical wireway:
      a. Located in each MCC section that accepts plug-in units.

b. Connect to top and bottom wireways.
c. Isolated from the unit interiors.
d. Accessible through a separate hinged door.
e. Cable tie supports to hold wiring in place.

8. Unit doors:
   a. Formed round corners and rolled edges.
   b. Minimum of two (2) heavy-duty hinges or continuous piano hinge.
   c. Held closed by means of captive fasteners.
   d. Fabricate to be a part of the structure and not part of the starter.
9. Unit cubicles:
   a. Draw-out type for motor starters through NEMA Size 5.
   b. Guide rails for supporting and aligning starters.
   c. Operating handle:
      1) With the unit stabs engaged and door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
      2) Circuit breaker and MCP operators includes a separate TRIPPED position.
      3) Mechanical interlock to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism.
      4) Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism.
      5) Non-defeatable interlock to prevent the installation or removal of a unit unless the disconnect is in the OFF position.
      6) Padlockable in the OFF position.
   d. Control panel:
      1) Provide control devices (selector switch, indicating devices, etc.) as indicated on the Drawings per Specification Section 16493.
   e. Control power:
      1) Control power transformer:
         a) 120 V secondary.
         b) Fused on primary and secondary side.
         c) Sized for 140 percent of required load.
   f. Minimum of one (1) full size space unit (12 IN) for any combination magnetic motor starter or starter without overload relay.
   g. One-half full size space unit (6 IN) for circuit breakers 100 A and less.
   h. Effectively baffled to isolate any ionized gases which may occur within unit starter.
10. Externally mounted overload relay pushbutton.
11. Assemblies effectively ventilated to allow relocation of starters and other components:
    a. Within the assembly and with the same load.
    b. Without having to compensate for changes in location.
12. Finish: Rust inhibited primer and manufacturer's standard paint inside and out.
13. Provide ample unrestricted space for conduit entry from the bottom.
14. Wiring: NEMA ICS 3 Class II, Type B-D.

C. Buses:
   1. Material: Tin-plated copper.
   2. Main horizontal bus:
      a. 600 A unless otherwise indicated on the Drawings.
      b. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
   3. Vertical buses:
      a. 300 A minimum.
      b. Securely bolted to the horizontal main bus with joint easily accessible for maintenance.
      c. Completely isolated and insulated by means of a barrier.
      d. Extended full length of vertical section to distribute incoming power to each circuit breaker and starter in structure.

1) Starters NEMA Size 5 and larger and certain other components may be cable connected to the main bus with the approval of the Engineer.

e. Extend Vertical bus to spaces provided for future equipment.

4. Ground bus:
   a. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
   b. 300 A tin-plated copper.
   c. Solidly grounded to each structure.
   d. Locate near bottom of structure.
   e. Provide for lug connection of equipment ground wires.

D. Overcurrent and Short Circuit Protective Devices:
   1. Main device:
      a. Molded case circuit breaker.
   2. Feeder devices:
      a. Molded case circuit breaker.
   3. Motor protection with full voltage starters:
      a. Motor circuit protector.
   4. Motor protection with reduced voltage starters:
      a. Molded case circuit breaker.
   5. See Specification Section 16490 for overcurrent and short circuit protective device requirements.
   6. Factory installed.

E. Motor Starters: See requirements within this Specification Section.

F. Surge Protective Device: Integrally mounted, see Specification Section 16491.

G. Power Monitor Metering:
   1. Separate compartment.
   2. See Specification Section 16492 for meter requirements.

H. Miscellaneous:
   1. See Drawings for items provided by other but factory installed (e.g., submersible motor temperature/leak controller, control system gateways or switches).

2.3 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Enclosure:
   1. NEMA 4 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   2. NEMA 4X rated:
      a. Body and cover: Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   3. NEMA 7 and NEMA 9 rated:
      a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
      b. Drilled and tapped openings or tapered threaded hub.
      c. Gasketed cover bolted-down with stainless steel bolts.
      d. External mounting flanges.
      e. Front operating handle padlockable in the OFF position.
      f. Accessories: 40 mil PVC exterior coating.

4. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

C. Operating Handle:
1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
2. Circuit breaker and MCP operators includes a separate TRIPPED position.
3. Mechanical interlock to prevent to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
5. Padlockable in the OFF position.
6. Exceptions: NEMA 7 and NEMA 9 enclosures.

D. External mounted overload relay pushbutton.

E. Control Devices:
1. Provide control devices as indicated on the Drawings per Specification Section 16493.
2. Devices will be accessible with the door closed.

F. Control Power Transformer:
1. 120V secondary.
2. Fused on primary and secondary side.
3. Sized for 140 percent of required load.

G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.

H. Motor Starters: See requirements within this Specification Section.

I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:
1. Motor circuit protector.
2. See Specification Section 16490 for overcurrent and short circuit protective device requirements.
3. Factory installed.

2.4 MOTOR STARTERS

A. Standards:
1. NEMA ICS 2.
2. UL 508.

B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:
1. NEMA full size rated contactor.
    a. NEMA half sizes and IEC contactors are not permitted.
2. Double-break silver alloy contacts.
3. Overload relays:
    a. Ambient compensated, bimetallic type with interchangeable heaters, 24 percent adjustability, single phase sensitivity, an isolated arm contact and manual reset.
4. Interlock and auxiliary contacts, wired to terminal blocks:
    a. Holding circuit contact, normally open.
    b. Overload alarm contact, normally open.
    c. Normally open auxiliary contact, for remote run status.
    d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.
    e. Two (2) additional normally open spare field replaceable auxiliary contacts.

C. Full Voltage Reversing (FVR) Magnetic Starters:
1. Two (2) FVNR starters with one (1) overload relay assembled together.

2. Mechanically and electrically interlocked to prevent line shorts and the energizing of both contactors simultaneously.
3. See FVNR paragraph for additional requirements.

D. Full Voltage Two-Speed (FV2S) Magnetic Starters:
1. Two (2) FVNR starters with two (2) overload relays assembled together.
2. Configured for two (2) winding or one (1) winding consequent pole motors.
3. See FVNR paragraph for additional requirements.

E. Variable Frequency Drives: See Specification Section 16265.

2.5 MANUAL MOTOR STARTERS

A. Standards:
1. NEMA 250, NEMA ICS 2.
2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:
1. Horsepower rated, for ON/OFF control.
2. Horsepower rated, for ON/OFF control and thermal overload protection.
a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:
1. NEMA 1 rated:
a. Galvanized steel or steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
b. With or without concentric knockouts.
2. NEMA 4X rated:
a. Type 304 or 316 stainless steel.
b. No knockouts, external mounting flanges.
3. NEMA 7 and NEMA 9 rated:
a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
b. Drilled and tapped openings or tapered threaded hub, external mounting flanges.
c. Accessories: 40 mil PVC exterior coating.
4. NEMA 12 rated:
a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
b. No knockouts, external mounting flanges.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.

B. Mounting height for surface mounted equipment: See Specification Section 16010.

C. Mount MCC on 4 IN high concrete pad:
1. Install two (2) 4 IN wide channel sills flush in pads to support and maintain alignment of the MCC.
2. Align front of MCC with top edge of pad chamfer.

D. Overload Heaters:
1. Size for actual motor full load current of the connected motor.

2. For motors with power factor correction capacitors, size to compensate for the capacitors effect on load current.

E. Combination and Manual Starter Enclosures:
1. Permitted uses of NEMA 1 enclosure:
   a. Surface or flush mounted in architecturally finished areas.
   b. Surface mounted above 10 FT in areas designated as dry in architecturally and non-architecturally finished areas.
2. Permitted uses of NEMA 4X enclosure:
   a. Surface mounted in areas designated as wet and/or corrosive.
3. Permitted uses of NEMA 7 enclosure:
   a. Surface mounted in areas designated as Class I hazardous.
   b. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
4. Permitted uses of NEMA 9 enclosure:
   a. Surface mounted in areas designated as Class II hazardous.
   b. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
5. Permitted uses of NEMA 12 enclosure:
   a. Surface mounted in areas designated as dry.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 16080.

END OF SECTION

SECTION 16460
DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dry-type transformers, 1000 kVA and less.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ST 20, Dry-Type Transformers for General Applications.
      c. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
   3. Underwriters Laboratories, Inc. (UL):
      a. 506, Standard for Safety Specialty Transformers.
      b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings.
      a. Nameplate drawing.
   4. Certifications:
      a. Sound level certifications.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.
   5. Sola/Hevi-Duty.
   6. Or approved equal.

2.2 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Ventilated or non-ventilated, air cooled, two (2) winding type.

B. Cores:
   1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
   2. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous wound with electrical grade aluminum.

D. Ventilated Units:
   1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
   2. Dripproof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.

E. Furnish Taps for Transformers as follows:
   1. 1 PH, 2 kVA and below: None.
   2. 1 PH, 3 to 25 kVA: Two (2) 5 percent FCBN.
   3. 1 PH, 25 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.
   4. 3 PH, 3 to 15 kVA: Two (2) 5 percent FCBN.
   5. 3 PH, 15 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.

F. Sound Levels:
   1. Manufacturer shall guarantee not to exceed the following:
      a. Up to 9 kVA: 40 dB.
      b. 10 to 50 kVA: 45 dB.
      c. 51 to 150 kVA: 50 dB.
      d. 151 to 300 kVA: 55 dB.

G. Efficiency:
   1. Ventilated, 15 kVA and larger: Energy efficient meeting NEMA TP 1 requirements.

H. Insulating Material (600 V and below):
   1. 3 to 15 kVA units: 185 DegC insulation system with a 115 DegC rise.
   2. 15 kVA and above units: 220 DegC insulation system with a 150 DegC rise.

I. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.

J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.

K. Standards: IEEE C57.96, NEMA ST 20, NEMA TP 1, UL 506, UL 1561.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Indoor Locations:
   1. Provide ventilated type for 15 kVA units and above.
   2. Provide non-ventilated type for 9 kVA units and below and were indicated on the Drawings.
   3. Mount 9 kVA units and below on wall.
   4. Mount 15 kVA units and above on chamfered 4 IN high concrete housekeeping pad or from wall and/or ceiling, at 7 FT above finished floor, using equipment support brackets per Section 16010.
   5. Provide rubber vibrations isolation pads.

C. Enclosures: Painted steel in all areas except stainless steel in highly corrosive areas.

D. Ground in accordance with Section 16060.

END OF SECTION

SECTION 16490
OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage circuit breakers.
   2. Coordinated power system protection.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures. (Equivalent to UL 489)
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
      b. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
      c. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 16010 for additional requirements.

B. Operation and Maintenance Manual:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Miscellaneous Submittals:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Reports:
      a. As-left condition of all circuit breakers that have adjustable settings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Circuit breakers:
    a. Eaton.
    b. General Electric Company.
    c. Square D Company.
    d. Siemens.
    e. Or approved equal.

2.2 CIRCUIT BREAKERS

A. Molded Case Type:
1. General:
    a. Standards: NEMA AB 1, UL 489.
    b. Unit construction.
    c. Over-center, toggle handle operated.
    d. Quick-make, quick-break, independent of toggle handle operation.
    e. Manual and automatic operation.
    f. All poles open and close simultaneously.
    g. Three (3) position handle: On, off and tripped.
    h. Molded-in ON and OFF markings on breaker cover.
    i. One-, two- or three-pole as indicated on the Drawings.
    j. Current and interrupting ratings as indicated on the Drawings.
    k. Bolt on type.
2. Thermal magnetic type:
    a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
    b. Frame size 150 amp and below:
        1) Non-interchangeable, non-adjustable thermal magnetic trip units.
    c. Frame sizes 225 to 400 amp (trip settings less than 400A):
        1) Interchangeable and adjustable instantaneous thermal magnetic trip units.
    d. Ground Fault Circuit Interrupter (GFCI) Listed:
        1) Standard: UL 943.
        2) One- or two-pole as indicated on the Drawings.
        3) Class A ground fault circuit.
        4) Trip on 5 mA ground fault (4-6 mA range).
3. Solid state trip type:
    a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.
    b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
        1) Standard rating.
        2) Interchangeable current sensor or rating plug.
        3) Adjustable long time pick-up setting.
            a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
        4) Adjustable short time pick-up setting.
        5) Adjustable instantaneous pick-up.
        6) Fixed ground fault pick-up, when indicated on the Drawings.
    c. Frame size 1600 amp and above:
        1) 100 percent rated.
        2) Interchangeable current sensor or rating plug.
        3) Adjustable long time pick-up setting.
            a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
        4) Adjustable long time delay setting.
        5) Adjustable short time pick-up setting.
        6) Adjustable instantaneous pick-up setting.
        7) Adjustable ground fault pick-up setting, when indicated on the Drawings.
        8) Adjustable ground fault delay setting, when indicated on the Drawings.

4. Motor circuit protector:
    a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
    b. Sized for the connected motor.

B. Low Voltage Power Type:
1. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and two-step stored energy trip mechanism.
2. Standards: IEEE C37.13, IEEE C37.16, IEEE C37.17, UL 1066.
3. 100 percent rated.
4. Electrically operated.
5. Electrically operated breakers:
    a. Close/open pushbuttons.
    b. Red and green indicators to indicated breaker position.
    c. Trip unit power: Internal CPT of the electrical gear.
    d. Trip/close signal: External isolated contact closure.
    e. Charging motor power: Internal CPT of the electrical gear.
    f. Charge springs after a close.
    g. Provide handheld remote operating station with cord and connection to breaker.
6. Motor driven operator for charging mechanism with open, close and charge push button.
7. Stored energy mechanism position indicator.
8. Contact position indicator: Reversible 52a/52b contacts, quantity as indicated on the Drawings.
9. Truck operated cell switch (52TOC) when indicated on the Drawings.
10. Draw out construction:
    a. Roll out type operated by removable crank handle and interlocked with the door.
    b. Four (4) positions: Connected, test, disconnected and removed.
    c. Cell switches to short out ground fault relay when breaker is drawn out.
11. Current and interrupting ratings as indicated on the Drawings and a 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings, regardless of whether equipped with instantaneous trip protection or not.
12. Current limiters:
    a. Integrally mounted.
    b. Coordinated with the trip unit to avoid unnecessary blowing of the current limiters.
    c. Anti-single-phasing device to trip breaker in the event of a blown limiter, indicator to indicate which limiter is blown and prevent breaker from being re-closed on a single-phase condition.
    d. Current limiting fuses: 200,000 amp RMS symmetrical interrupting capacity.
13. Other features:
    a. Interchangeable current sensor or rating plug:
    b. Adjustable long time pick-up setting.
        1) Adjustable from 50 to 100 percent of the current sensor or rating plug.
    c. Adjustable long time delay setting.
    d. Adjustable short time pick-up setting.
    e. Adjustable instantaneous pick-up setting.
    f. Adjustable ground fault pick-up setting.
    g. Adjustable ground fault delay setting.
    h. Unit status indicator.
    i. Cause of trip indicator.
    j. Current display.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:
   1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
      a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
      b. Frame sizes 600 amp and larger shall be solid state trip type.
      c. Frame sizes 1000 amp and above shall include integral ground fault protection, when indicated on the Drawings.
      d. Motor circuit protectors sized for the connected motor.

3.2 FIELD QUALITY CONTROL

A. Coordinated Power System Protection:
   1. A study shall be prepared to demonstrate that the equipment and system constructed within the scope of these Contract Documents, meet the specified requirements for equipment ratings, coordination and protection.
   2. The studies shall be performed in accordance with IEEE 242, IEEE 399 and PG&E requirements.
   3. Computer generated studies shall include the information about the software: name of the developer and software package and version number.
   4. System short circuit study report:
      a. The study shall begin at the main 12 kV PG&E service point and extend to and including each breaker or disconnect for each 480 Volt switchboard and MCC feeder breaker 400 amps and larger.
         1) A balanced three-phase fault, bolted line-to-line fault and line-to-ground fault study shall be performed.
      b. A one-line diagram shall be prepared to show the electrical system buses, transformers and all sources of fault current including generators and motors.
      c. Manufacturer's data for the actual proposed equipment shall be utilized (e.g., transformer impedance).
      d. The available utility fault current shall be coordinated with the power utility company (PG&E).
      e. Input data shall be shown in tabular form in the report and/or on the one-line diagram.
         1) Input data shall include but is not limited to:
            a) Utility fault current or mVA and X/R ratio.
            b) Bus voltages.
            c) Conductor sizes and type of conduit.
            d) Generator and motor sizes and contributions.
            e) Transformer sizes and impedances.
      f. Available fault current at each bus shall be shown in tabular form in the report and/or on the one-line diagram.
      g. Perform studies for both normal power and emergency/standby power scenarios.
   5. System protective coordination study report:
      a. The study shall begin at the main 12 kV PG&E service point and include each 480 volt switchboard feeder and MCC breaker 400 amp and larger.

b. The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified for the protection of equipment and conductors from damage from overloads and fault conditions and that downstream protective devices shall clear prior to upstream devices.
   1) Where necessary an appropriate compromise shall be made between system protection, service continuity and arc flash intensity.
c. A one-line diagram shall be prepared to show the electrical system buses, transformers and protective devices.
d. Manufacturer's data for the actual proposed protective devices shall be utilized.
e. Summarize the coordination study, conclusions and recommendations.
   1) As a minimum, include the following:
      a) The manufacturer's information used to prepare the study.
      b) Assumptions made during the study.
      c) Recommended taps and settings of all adjustable devices in tabulated form.
      d) Composite coordination time-current curves on log-log paper showing:
         (1) That the settings for each protective device will provide protection and selectivity.
         (2) Identify each curve.
         (3) Cable and equipment damage points.
         (4) Circuit interrupting device operating and interrupting times.
         (5) One-line sketch of the part of the system being investigated.
         (6) Include as many curves as possible on a graph while maintaining readability.
      e) Position time-current curves for each device to provide for maximum selectivity to minimize system disturbances during fault clearing.
      f) Advise the Engineer of potential coordination problems discovered during the study and include recommendations to resolve the problem.
      g) Submit the report for approval 90 days prior to equipment energization. This report is subject to review and approval by PG&E.

B. System arc flash report:
   1. The report shall begin at the 12 kV PG&E main service point and include the 480 Volt switchboard and all MCC's.
   2. The report shall include the following at a minimum:
      a. Arcing fault clearing time.
      b. Arc flash protection, prohibited, restricted and limited approach boundaries per NFPA 70E.
      c. Individual arcing current contributions.
   3. The report shall assign hazard categories based on NFPA 70E.
   4. Arc flash labels shall be provided and affixed to all equipment showing hazard category and PPE requirements.
   5. Arc flash warning labels shall be provided and affixed to all other panels containing 120 VAC or higher.

C. Adjustable Circuit Breakers:
   1. Set all circuit breaker adjustable taps as defined on the Drawings, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

D. Ground Fault Protection System:
   1. Single source system:
      a. Main and feeder breakers: Utilize four (4) individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.

E. Testing:
   1. Acceptance testing: See Specification Section 16080.

END OF SECTION

SECTION 16491
LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Type 1 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), integrally mounted.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
      b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
      c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
      d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
   2. Military Standard:
      a. MIL-STD-220B, Method of Insertion-Loss Measurement.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. LS 1, Low Voltage Surge Protective Devices.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL):
      a. 1283, Standard for Electromagnetic Interference Filters.
      b. 1449, Standard for Safety Transient Voltage Surge Suppressors.

B. Qualifications:
   1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
      a. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may very by mode.

E. MCC: Motor Control Center.

F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

G. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
      a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      b. The N-G mode is not included in the per phase calculation.

H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Manufacturer's qualifications.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Testing procedures and testing equipment data.
      e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
         1) Data in the Product Data Sheet heading:
            a) SPD Type Number per PART 2 of the Specification.
            b) Manufacturer’s Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer’s certified value confirming the product meets the specified value/feature.
            c) Name of the nationally recognized testing laboratory that preformed the tests.
            d) Warranty information.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer’s official (printed and signed).
            b) Title of the official.
         4) Date of signature.

B. Operation and Maintenance Manual:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of submittal process.
      b. The content of the Operation and Maintenance Manuals.

2. Warranty.

1.5 WARRANTY

A. Minimum of a five (5) year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, NEMA LS 1, MIL-STD 220B, UL 1283, UL 1449.

2.2 TYPE 1 SPD

A. Product:
   1. Integrally mounted in switchgear, switchboards or MCCs.
   2. Hybrid solid-state high performance suppression system.
      a. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   3. Do not connect multiple SPD modules in series to achieve the specified performance.
   4. Designed for parallel connection.
   5. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   6. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.
      b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10 percent deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

SYSTEM VOLTAGE	TEST MODE	IEEE C62.41 C HIGH V & I WAVE	IEEE C62.41 B COMBINATION WAVE	UL 1449
L-L < 250 V	L-L	1470 V	1000 V	800 V
L-N < 150 V	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V	L-L	2700 V	2000 V	1800 V
L-N > 150 V	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.3 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:
   1. Integral unit level and/or component level fusing.
   2. Neutral and ground shall not be bonded during testing.
   3. 6 IN lead lengths.
   4. Integral disconnect switch when provided.

C. The “as installed” SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:
   1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
   2. Single pulse surge current capacity test.
   3. Repetitive surge current capacity testing.
   4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Type 1 SPD:
   1. Connected in parallel to the equipment.
   2. Install in dedicated electrical equipment compartment, bucket or panelboard box at the factory before shipment.
   3. Provide leads that are as short and straight as possible.
   4. Maximum lead length: 12 IN.
   5. Minimum lead size: #2 stranded AWG or bus bar.
   6. Connect leads to the equipment to be protected by one (1) of the following means:
      a. Through a circuit breaker or molded case switch mounted in the equipment.
      b. Use manufacturer recommended circuit breaker size.
      c. Circuit breaker or switch to be operable from the equipment exterior or from behind a hinged door.

END OF SECTION

SECTION 16492
ELECTRICAL METERING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Digital metering equipment.
   2. Analog metering equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C12.20, For Electricity Meter - 0.2 and 0.5 Accuracy Classes.
   3. National Fire Protection Association (NFPA):
      a. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   4. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 16010 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. Electro Industries.
   3. General Electric Company.
   4. Power Measurement.
   5. Square D Company.
   6. Siemens.
   7. Or approved equal.

2.2 DIGITAL METERING DEVICES

A. General:
   1. Direct reading metered or calculated values.
   2. Microprocessor based.
   3. Integral LED or LCD display.
   4. Current and potential transformers as required.
   5. Integral fusing.
   6. Operating temperature: 0 DegF to 150 DegF.
   7. Standards:
      a. NEMA/ANSI C12.20.
      b. UL 508.

B. Type 'B' Midrange Meter:
   1. Display the following minimum electrical parameters (accuracy):
      a. RMS current per phase (+0.3 percent full scale).
      b. RMS voltage line-to-line and line-to-neutral (+0.3 percent full scale).
      c. Real power (W): 3 PH total (+0.6 percent full scale).
      d. Apparent power (VA): 3 PH total (+0.6 percent full scale).
      e. Reactive power (VAR): 3 PH total (+0.6 percent full scale).
      f. Power factor (+1.0 percent).
      g. Frequency (+0.17 percent).
      h. Percent current total harmonic distortion (31st).
      i. Percent voltage total harmonic distortion (31st).
   2. Communication ports and protocols: As specified herein and/or as required for a functioning system.
   3. Supply voltage: 120 Vac.

2.3 ACCESSORIES

A. Communication Cable:
   1. As recommended by manufacturer.
   2. Standard: NFPA 262.

B. Software:
   1. Power management and control software.

C. Any current or potential transformers required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
   1. Provide all equipment as necessary to provide a compete and functioning system.
   2. Coordinate with the Owner on final computer screen layouts, trending requirements and printouts.

B. Meter Types:
   1. Type B meters: .Connected to 480V feeder breakers, unless otherwise indicated on the Drawings.

C. Communication Configuration:
   1. Feeder breaker meters shall communicate with its associated main breaker meter.
   2. The main breaker meter shall be connected to the nearest plant control system Ethernet switch.

3. Configure one (1) of the computers provided by the control system with the power management and control software.
    a. Provide technical assistance to the system integrator as necessary to provide a functioning system.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Section 16080.

3.3 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 4 HRS of on-site training in the operation and maintenance of the metering system and its components.

END OF SECTION

SECTION 16493
CONTROL EQUIPMENT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
   2. Control devices (timers, relays, contactors, etc.).
   3. Control panels and operator stations.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.
      b. 508A, Standard for Safety Industrial Control Panels.

B. Miscellaneous:
   1. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01340 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. Control panel bill of material.
      c. See Section 16010 for additional requirements.
   3. Fabrication and/or layout drawings.
      a. Control panel interior and exterior layout.
      b. Control panel wiring diagrams.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01340 for requirements for:
      a. The mechanics and administration of submittal process.
      b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pilot devices and relays:
      a. Idec.

b. Potter & Brumsfield.
c. Time Mark.
d. ATC Diversified Electronics.
e. Or approved equal.

2. Contactors:
a. Automatic Switch Company (ASCO).
b. Eaton.
c. General Electric Company.
d. Square D Company.
e. Siemens.
f. Allen Bradley.
g. Or approved equal.

3. Photocells and time clocks:
a. Grasslin.
b. Tork.
c. Intermatic.
d. Paragon.
e. Or approved equal.

4. Alarm devices:
a. Edwards Signaling.
b. Federal Signal Corp.
c. Or approved equal.

5. Terminal blocks:
a. Phoenix Contact.
b. Allen-Bradley.
c. Or approved equal.

6. Enclosures:
a. Hoffman Engineering Co.
b. Wiegmann.
c. B-Line Circle AW.
d. Adalet.
e. Or approved equal.

2.2 PILOT DEVICES

A. General Requirements:
1. Standards: NEMA ICS 2, UL 508.
2. Heavy-duty NEMA 4/13 watertight/oiltight.
3. Heavy-duty NEMA 4/4X corrosion resistant.
4. Heavy-duty factory sealed, explosion-proof and dust ignition-proof (Class I and II).
5. Mounting hole: 30.5 mm.
6. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
7. Legend plate marked as indicated on Drawings or specified.

B. Selector Switches:
1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
2. Maintained contact type.
3. Knob or lever type operators.

C. Pushbuttons:
1. Non-illuminated type:
a. Protective boot.
b. Momentary contact.
c. Standard flush and mushroom operators.
d. Green colored buttons for START or ON and red color for STOP or OFF.
e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.

2. Illuminating type:
    a. Protective boot.
    b. Momentary contact.
    c. Standard flush operator.
    d. Serves as both pushbutton control and indicating light.
    e. Green colored lenses for START or ON and red color for STOP or OFF.
    f. LED-type full voltage light unit with lens and panel gasket.

D. Indicating Lights:
1. Allowing replacement of bulb without removal from control panel.
2. Lamp: LED, 120 V or 24 V as required.
3. Full voltage type.
4. Push-to-test indicating lights.
5. Glass lens.
6. Color code lights as follows:
    a. Green: ON or running; valve open.
    b. Amber: Standby; auto mode; ready.
    c. Red: OFF or stopped; valve closed.

2.3 RELAYS

A. General Requirements:
1. Standards: NEMA ICS 2, UL 508.

B. Control Relays:
1. General purpose (ice cube) type:
    a. Plug-in housing.
    b. Clear polycarbonate dust cover with clip fastener.
    c. Coil voltage: 120 Vac or as required.
    d. Contacts:
        1) 10 amp continuous.
        2) Silver cadmium oxide.
        3) Minimum of 3 SPDT contacts.
    e. Sockets: DIN rail mounted.
    f. Internal neon or LED indicator is lit when coil is energized.
    g. Manual operator switch.
2. Industrial type:
    a. Coil voltage: 120 Vac or as required.
    b. Contacts:
        1) 10 amp, NEMA A600 rated.
        2) Double break, silver alloy.
        3) Convertible from normally open to normally closed or vice versa, without removing any wiring.
        4) Expandable from 2 poles to 12 poles.
    c. Provide contacts for all required control plus two spares.

C. Time Delay Relays:
1. General purpose type:
    a. Timing modes: On and Off delay, interval, one shot and repeat cycle.
    b. Plug-in housing.
    c. Polycarbonate dust cover with clip fastener.
    d. Coil voltage: 120 Vac or as required.
    e. Contacts:
        1) 10 amp continuous.
        2) Silver cadmium oxide.
        3) Two normally open and two normally closed DPDT contacts.
    f. Sockets: DIN rail mounted.
    g. External timing adjustment knob.

h. Timing ranges: 0.05 seconds to 16.65 HRS.
i. Repeat accuracy: +1 percent.

2. Solid State industrial type:
   a. Timing modes: On and Off delay and repeat cycle.
   b. Industrial housing.
   c. Coil voltage: 120 Vac or as required.
   d. Contacts:
      1) 5 amp, NEMA B150 rated.
      2) Silver alloy.
      3) Convertible On Delay and Off Delay contacts.
      4) One normally open and one normally closed timed contacts.
      5) One normally open and one normally closed instantaneous contacts.
   e. Furnish with "on" and "timing out" indicators.
   f. External timing adjustment knob.
   g. Timing ranges: 0.05 seconds to 10 HRS.
   h. Repeat accuracy: +1 percent.
3. Mechanical industrial type:
   a. Timing modes: On and Off delay.
   b. Coil voltage: 120 Vac or as required.
   c. Contacts:
      1) 10 amp, NEMA A600 rated.
      2) Double break, silver alloy.
      3) Convertible On Delay and Off Delay contacts.
      4) Convertible normally open and normally closed timed contacts.
      5) Convertible normally open instantaneous contacts.
   d. External timing adjustment knob.
   e. Timing ranges: 0.2 - 60 sec or 5 - 180 sec.
   f. Repeat accuracy: Greater than +10 percent.

2.4 CONTACTORS

A. General Requirements:
   1. Standards: NEMA ICS 2, UL 508.

B. Lighting and Remote Control Switches:
   1. Electrically operated, electrically held.
   2. Coil voltage: 120 Vac or as required.
   3. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
   4. Rated for ballasted lighting, tungsten and general use loads.
   5. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
   6. Auxiliary control relays, as indicated on Drawings or as specified.
   7. Auxiliary contacts, as indicated on Drawings or as specified.

C. Definite Purpose:
   1. Coil voltage: 120 Vac or as required.
   2. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
   3. Resistive load and horsepower rated.
   4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
   5. Auxiliary contacts, as indicated on Drawings or as specified.

2.5 PHOTOCELLS

A. Photocells:
   1. Weatherproof enclosure.
   2. Adjustable turn-on range, initially set at 1.0 footcandles.
      a. Turn-off level approximately three times turn-on.

3. Provide time delay device to eliminate nuisance switching.
4. Voltage, amperage and/or wattage ratings as required for the application.

2.6 ALARM DEVICES

A. Alarm Horns:
1. Vibrating horn type.
2. PLC compatible as required.
3. Heavy-duty die cast housing with corrosion resistant finish.
4. Adjustable volume: 78 to 103 dB at 10 FT.
5. Voltage: 120 Vac or as required.
6. Enclosures/mountings:
   a. Flush wall or panel mounting in dry areas.
   b. NEMA 4X panel mounting in wet areas.
   c. Surface mounting in dry areas.
   d. NEMA 4X surface mounting in wet areas.
   e. NEMA 4X, hazardous location surface mounting in wet and hazardous areas.
      1) Fixed volume: 97 dB at 10 FT.

B. Alarm Lights:
1. Panel mounted:
   a. Strobe type.
   b. Shatter resistant polycarbonate lens and base.
   c. Lens color as indicated on Drawings.
   d. NEMA 4X enclosure.
   e. PLC compatible.
   f. Voltage: 120 Vac.
2. Wall mounted:
   a. Heavy-duty strobe type.
   b. Weatherproof shatter resistant polycarbonate lens and cast base.
   c. Optically designed fresnel lens with color as indicated on Drawings.
   d. Immune to shock and vibration, no moving parts.
   e. Xenon flash tube providing a minimum of 65 single flashes per minute.
   f. Mounting: Wall or corner wall brackets.
3. Hazardous and corrosive locations:
   a. Heavy-duty strobe type.
   b. Weatherproof and rated for the indicated hazardous location.
   c. Body: Zinc plated cast iron or cast copper free aluminum and/or coated with 20 mils of PVC.
   d. High impact glass dome with guard.
   e. Shatter resistant polycarbonate lens with color as indicated on Drawings.
   f. Immune to shock and vibration, no moving parts.
   g. Xenon flash tube providing a minimum of 65 single flashes per minute.
   h. Mounting: Wall bracket or pendant.

2.7 MISCELLANEOUS DEVICES

A. Run Time Meters:
1. Six-digit wheels including a 1/10 digit.
2. Non-reset type.
3. Time range in hours.
4. Automatic recycle at zero.
5. Accuracy: 1 percent.
6. Sealed against dirt and moisture.
7. Tamperproof.

2.8 TERMINATION EQUIPMENT

A. General Requirements:
   1. Modular type with screw compression clamp.
   2. Screws: Stainless steel.
   3. Current bar: Nickel-plated copper alloy.
   4. Thermoplastic insulation rated for -40 to +90 DegC.
   5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
   6. End sections and end stops at each end of terminal strip.
   7. Machine-printed terminal markers on both sides of block.
   8. Spacing: 6 mm.
   9. Wire size: 22-12 AWG.
   10. Rated voltage: 600 V.
   11. DIN rail mounting.

B. Standard-type block:
   1. Rated current: 30 A.
   2. Color: Gray body.

C. Bladed-type disconnect block:
   1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
   2. Rated current: 10 A.
   3. Color:
      a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
      b. Foreign voltage entering enclosure: Orange body, orange switch.

D. Grounded-type block:
   1. Electrically grounded to mounting rail.
   2. Terminal ground wires and analog cable shields.
   3. Color: Green and yellow body.

E. Fuse Holders:
   1. Blocks can be ganged for multi-pole operation.
   2. Spacing: 9.1 mm.
   3. Wire size: 30-12 AWG.
   4. Rated voltage: 300 V.
   5. Rated current: 12 A.
   6. Fuse size: 1/4 x 1-1/4.
   7. Blown fuse indication.
   8. DIN rail mounting.

2.9 ENCLOSURES

A. Control Panels:
   1. NEMA 4X rated:
      a. Body and cover: 14 GA Type 304 or 316 stainless steel.
      b. Seams continuously welded and ground smooth.
      c. No knockouts.
      d. External mounting flanges.
      e. Hinged door and stainless steel screws and clamps.
      f. Door with oil-resistant gasket.
   2. NEMA 7 and 9 rated:
      a. Cast gray iron alloy or copper-free aluminum.
      b. Drilled and tapped openings or tapered threaded hub.
      c. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
      d. External mounting flanges.
      e. Grounding lug.

f. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

3. NEMA 12 enclosure:
   a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts.
   c. External mounting flanges.
   d. Non-hinged stainless steel cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   e. Flat door with oil resistant gasket.
4. Control panel miscellaneous accessories:
   a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless steel.
   b. Interiors shall be white or light gray in color.
   c. Wire management duct:
      1) Bodies: PVC with side holes.
      2) Cover: PVC snap-on.
      3) Size as required.
   d. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
   e. Split covers when heavier than 25 LBS.
   f. Floor stand kits made of same material as the enclosure.
   g. Weldnuts for mounting optional panels and terminal kits.
   h. Ground bonding jumper from door, across hinge, to enclosure body.
5. Standards: NEMA 250, UL 508.

B. Operator Control Stations:
1. NEMA 4/13 rated:
   a. Die cast aluminum body with manufacturers standard finish.
   b. Gasketed die cast aluminum cover with manufacturers standard finish.
   c. Number of device mounting holes as required.
2. NEMA 4X rated:
   a. Type 304 or 316 stainless steel body.
   b. Gasketed Type 304 or 316 stainless steel cover.
   c. Number of device mounting holes as required.
3. NEMA 7 and 9 rated:
   a. Zinc plated cast iron or die-cast copper free aluminum, with threaded hubs, grounding screw and with manufacturers standard finish.
   b. "EDS" or "EFS" style.
   c. Single or multiple gang or tandem.
   d. Accessories: 40 mil PVC exterior coating and two (2) mil urethane interior coating.

2.10 MAINTENANCE MATERIALS

A. Provide 10 percent replacement lamps for indicating lights.

B. Provide 10 percent replacement caps for indicating lights.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Control Panels:
1. Size as required to mount the equipment.
2. Permitted uses of NEMA 4X enclosure:
   a. Surface mounted in areas designated as wet and/or corrosive or highly corrosive.
3. Permitted uses of NEMA 7 enclosure:

a. Surface mounted in areas designated as Class I hazardous.

4. Permitted uses of NEMA 12 enclosure:
   a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas.

C. Operator Control Stations:
1. Permitted uses of NEMA 4/13 enclosure:
   a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas and wet.
2. Permitted uses of NEMA 4X enclosure:
   a. Surface mounted in areas designated as wet and/or corrosive or highly corrosive.
3. Permitted uses of NEMA 7 enclosure:
   a. Surface mounted in areas designated as Class I hazardous with PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

3.2 FIELD QUALITY CONTROL

A. See Section 16010.

END OF SECTION

SECTION 16500
INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Interior building lighting fixtures.
      b. Exterior building and site lighting fixtures.
      c. Lamps.
      d. Ballasts.
      e. Light poles.
      f. Lighting control.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. Certified Ballast Manufacturers (CBM).
   3. Federal Communications Commission (FCC):
      a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.
   4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000Volts Maximum).
      b. LE 4, Recessed Luminaires, Ceiling Compatibility.
   6. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C82.1, Lamp Ballasts - Line Frequency Fluorescent Lamp Ballast.
      b. C82.4, Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).
      c. C82.11, High-Frequency Fluorescent Lamp Ballasts - Supplements.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 101, Life Safety Code.
   8. Underwriters Laboratories, Inc. (UL):
      a. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
      b. 924, Standard for Emergency Lighting and Power Equipment.
      c. 935, Standard for Fluorescent-Lamp Ballasts.
      d. 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
      e. 1598, Luminaires.
   9. United States Department of Energy (USDOE):
      a. EPAct, the National Energy Policy Act.
   10. California energy Code, Title 24.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Subcontract Agreement for requirements for the mechanics and administration of the submittal process.
   2. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.
b. Identify fixtures by Fixture Schedule number.
c. Fixture data sheet including:
   1) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
   2) Fixture effective projected areas for pole mounted fixtures.
d. Pole data shall include:
   1) Pole wind loading.
   2) Anchor bolt template.
e. Complete wiring diagrams including equipment designations for all lighting control.

3. Certifications:
   a. Submit all required California Title 24 certifications upon completion of lighting system commissioning.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Lighting fixtures: See Fixture Schedule.
   2. Lamps:
      a. Osram/Sylvania.
      b. General Electric.
      c. Philips.
      d. Venture.
      e. Or approved equal.
   3. Ballasts: Fixture manufacturer's standard.
   4. Emergency ballasts: Bodine or approved equal.
   5. Emergency transfer devices: Bodine or approved equal.
   6. Poles: Fixture manufacturer's standard.

2.2 GENERAL REQUIREMENTS

A. All lighting fixtures and electrical components:
   1. UL labeled.
   2. Fixtures complete with lamps and ballasts.
   3. Rated for area classification as indicated on the Drawings.

B. Provide all recessed fixtures with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.
   1. Provide recessed fixtures with trim gaskets cemented in proper position.

C. Provide standard plaster frame for all recessed lighting fixtures installed in plaster walls or ceilings.
   1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.

D. No live parts normally exposed to contact.

E. When intended for use in wet areas: Mark fixtures "Suitable for wet locations."

F. When intended for use in damp areas: Mark fixtures "Suitable for damp locations" or "Suitable for wet locations."

2.3 LIGHT FIXTURES

A. Incandescent:
   1. UL 1598.

2. Lamp base.
   a. Less than or equal to 300W: Medium base.
   b. Greater than 300W: Mogul base.
3. Visibly marked to indicate maximum lamp wattage that can be used with the fixture.

B. Fluorescent:
1. UL 1598.
2. NEMA LE 4 for recessed locations.
3. Lenses: As indicated in Fixture Schedule, with the following minimums:
   a. Troffer: 100 percent virgin acrylic, conical shaped, female 0.1875 IN, square based prisms, aligned 45 degrees to the length and width, 0.125 IN nominal thickness.
4. Finish:
   a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.
   b. Manufacturer's standard color or special color specified in Fixture Schedule.
5. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.

C. High Intensity Discharge:
1. UL 1598.
2. Finish:
   a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.
   b. Manufacturer's standard color or special color specified in Fixture Schedule.
3. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.
4. Provided with safety chain.

D. Exit Signs and Emergency Lighting Units:
1. UL 924, NFPA 101.

E. LED:
1. Fixtures shall be as shown in fixture schedule or approved equal complete with all mounting and control accessories.
2. Fixtures shall be equipped with controls such as dimming where required for the specific area.

2.4 LAMPS

A. Fluorescent:
1. T8 (265 mA) instant or rapid-start medium bipin lamps.
   a. Correlated color temperature of 3500 degrees Kelvin.
   b. Minimum color rendering index (CRI) of 70.
   c. Minimum initial lumen ratings for each lamp type shall be:
      1) 1300 lumens for 24 IN, 17 watt F17T8 lamp.
      2) 2025 lumens for 36 IN, 25 watt F25T8 lamp.
      3) 2800 lumens for 48 IN, 32 watt F32T8 lamp.
      4) 5700 lumens for 96 IN, 59 watt F96T8 lamp.
      5) 2725 lumens for 22.5 IN, 32 watt F32T8/U/6 lamp (U-shaped 6 IN leg spacing).

B. High Intensity Discharge (HID) Lamps:
1. Metal halide lamps:
   a. Metal halide lamps shall be pulse-start type.
      1) If used in an open luminaire, the lamp shall be rated for use in an open fixture and incorporate a protective arc tube shroud design.
   b. Clear lamps:
      1) Correlated color temperature of 4000 degrees Kelvin.
      2) Minimum color rendering index (CRI) of 65.

c. Minimum initial lumen ratings for metal halide lamps with a medium base in a vertical position shall be:
   1) 3200 lumens for 50 watt, ED-17 (ANSI M110) clear lamp.
   2) 5600 lumens for 70 watt, ED-17 (ANSI M98) clear lamp.
   3) 8500 lumens for 100 watt, ED-17 (ANSI M90) clear lamp.
   4) 14250 lumens for 150 watt, ED-17 (ANSI M102) clear lamp.
   5) 17500 lumens for 175 watt, ED-17 (ANSI M137) clear lamp.

d. Minimum initial lumen ratings for metal halide lamps with a mogul base in a vertical position shall be:
   1) 14250 lumens for 150 watt, ED-28 (ANSI M102) clear lamp.
   2) 17500 lumens for 175 watt, ED-28 (ANSI M137) clear lamp.
   3) 20000 lumens for 200 watt, ED-28 (ANSI M136) clear lamp.
   4) 25000 lumens for 250 watt, ED-28 (ANSI M138) clear lamp.
   5) 32300 lumens for 320 watt, ED-28 or ED-37 (ANSI M132) clear lamp.
   6) 36000 lumens for 350 watt, ED-28 or ED-37 (ANSI M131) clear lamp.
   7) 42000 lumens for 400 watt, ED-28 or ED-37 (ANSI M135) clear lamp.
   8) 47500 lumens for 450 watt, ED-37 (ANSI M144) clear lamp.

2. High pressure sodium lamps:
   a. Correlated color temperature of 2100 degrees Kelvin.
   b. Minimum color rendering index (CRI) of 21.
   c. High pressure sodium lamps are designated on the lighting Fixture Schedule by the prefix HPS.
3. Uncoated (clear) unless identified as coated in the fixture schedule.
4. The specified fixture in the fixture schedule shall dictate the required lamp operating position and base type.
5. Provide lamps that have the correct bulb shape for the fixture specified.

2.5 BALLASTS

A. Fluorescent High Frequency Electronic Ballasts:
   1. UL 935.
   2. "High Frequency" electronic operating lamps at a frequency of 20 KHz or higher without visible flicker.
   3. Power factor: Greater than 90 percent.
   4. Input current total harmonic distortion (THD) of less than 20 percent.
   5. Lamp current crest factor: Less than 1.7, in accordance with lamp manufacturer's recommendations and NEMA/ANSI C82.11.
   6. Instant start with lamps wired in parallel.
   7. Support a sustained short to ground or open circuit of any output leads without damage to the ballast.
   8. Ballast Factor: Greater than 0.85 per NEMA/ANSI C82.11.
   9. Audible noise rating: Class A or better.
   10. Operation in ambient temperatures up to 40 DegC (105 DegF) without damage.
   11. Light output to remain constant for a line voltage fluctuation of +5 percent.
   12. Meet the requirements of the FCC 47 CFR 18, for non-consumer equipment for EMI and RFI.
   13. Meet NEMA/ANSI C82.11 standards regarding harmonic distortion.
   14. Meet IEEE C62.41 Cat. A for transient protection.
   15. Comply with all applicable state and federal efficiency standards.
   16. UL listed, Class P.
   17. Contain no Polychlorinated Biphenyls (PCB's).

B. High Intensity Discharge Ballasts:
   1. NEMA/ANSI C82.4, UL 1029.
   2. Metal halide:
      a. Input voltage variation: +10 percent.
      b. Maximum lamp regulation spread: 20 percent.

c. Minimum power factor: 90 percent.
d. Starting current: Not greater than operating current.
e. Maximum input voltage dip: 40 percent.
f. Crest factor: 1.5 to 1.8.
g. Types:
1) Lead-type regulators: Constant wattage autotransformer (CWA) and pulse start.
2) Lag-type regulators: Magnetic regulator and pulse start.
h. Contain no Polychlorinated Biphenyls (PCB's).

3. High pressure sodium:
a. Input voltage variation: +10 percent.
b. Maximum lamp regulation spread: 30 percent.
c. Minimum power factor: 90 percent.
d. Starting current: Not greater than operating current.
e. Maximum input voltage dip: 20 percent.
f. Crest factor: 1.6 to 1.8.
g. The Volts-Watts trace shall be within the lamp manufacturer's trapezoid.
h. Types:
1) Lead-type regulators: Constant wattage autotransformer (CWA).
2) Lag-type regulators: Magnetic regulator and regulated lag.
i. Ballast shall not contain Polychlorinated Biphenyls (PCB's).

4. Ballasts for interior use:
a. Encased and potted type.
b. Audible noise rating of B or better.
c. Built-in automatic resetting thermal protection switch.

5. Ballasts for exterior use:
a. Starting temperature: -20 DegF.

2.6 LIGHTING CONTROL EQUIPMENT

A. General:
1. Provide wall switches, occupancy sensors, dimming photocells, power supplies/relays, wiring, cabling and all accessories for complete lighting control appropriate for each controlled space on a network basis.
2. System to be combination low voltage, digital and line voltage using a combination of CAT 5e/6 cabling and line voltage wiring.
3. All equipment and control shall be Title 24 compliant.

B. Wall switches/Control:
1. Low voltage to mount in standard wall box and contain wall controls for the area including auto and manual switching, occupancy detection, dimming control and be fully adjustable to meet required switching requirements.
2. Network ports.

C. Ceiling mounted dimming photo cell:
1. Low voltage, on-off and automatic dimming and designed to control lighting levels to a setpoint.
2. Network ports.

D. Ultrasonic Ceiling Sensor:
1. Detection of Doppler shifts in transmitted ultrasound to detect human movement.
2. Ultrasonic sensing is volumetric in coverage to automatically adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled areas.
3. Temperature and humidity resistant.
4. Fully configurable.
5. Cover 360 degrees and halfway and corridor sensors shall cover up to 90 linear feet.
6. Network ports.

E. Power Pack:
   1. Self contained transformer and relay module.
   2. Dry contacts capable of switching up to 16 amps loads.
   3. Low voltage, D.C. output.
   4. Capable of parallel wiring without regard to AC phases on primary.
   5. Used as a stand alone, low voltage switch or wired to sensor for auto control.
   6. Low voltage Teflon coated leads, rated for 300 V, suitable for use in plenum applications.
   7. Network ports.

2.7 LIGHT CONTROL

A. Indoor plant process areas:
   1. Lighting shall be controlled by line voltage switches as shown on Drawings.

B. Outdoor wall washer fixtures at entry doors.
   1. Lighting shall be controlled by line voltage switches with automatic photocell over ride in each fixture.

C. Outdoor process area post lighting:
   1. Lighting shall be controlled by line voltage switches with automatic photocell override in each fixture.

D. Architecturally finished areas:
   1. Small offices:
      a. Low voltage control with manual on, auto off on occupancy and auto dimming, single or dual zone as shown.
   2. Large offices, conference rooms, laboratories, lunch rooms and similar areas.
      a. Low voltage control with manual on, auto off on occupancy and multi zone as shown.
   3. Egress areas such as corridors and stairwells:
      a. Low voltage control with manual on, auto off on occupancy to an adjustable minimum lighting (typically 50 percent) and single zone.
   4. Restrooms:
      a. Low voltage control with manual on, auto off on occupancy and single zone.
   5. Utility rooms such as janitor, electrical, mechanical and similar areas:
      a. Low voltage control with manual on, auto off on occupancy, single zone and provisions for manual off and override of auto off.

E. Configuration:
   1. Low voltage systems shall be configured for optimum operation and to meet Title 24 requirements for the area. Auto off delay shall be typically set for 20 minutes and the light level in each area appropriate for the task.

2.8 POLES

A. As scheduled or noted on the Drawings.

2.9 MAINTENANCE MATERIALS

A. Furnish a minimum of 2 or 10 percent of total of each type and wattage of lamps, whichever is greater.

B. Furnish a minimum of 10 percent of total of each type and amperage of fuses for fixtures indicated to be fused.

C. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate fixture types with ceiling construction.
   1. Provide mounting hardware for the ceiling system in which the fixture is to be installed.

B. Fasten lighting fixtures supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted fixtures.
   1. Do not support fixture from conduit system.
   2. When fixtures are supported from outlet boxes, install per NFPA 70.
   3. Supports for fixtures mounted on exterior walls shall not be attached to exterior face of the wall.

D. Provide pendant incandescent, compact fluorescent, and/or HID fixtures with swivel hangers which will allow fixture to swing in any direction but will not permit stem to rotate.
   1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
   2. Swivel hangers for fixtures in mechanical equipment areas: Shock absorbing type.
   3. Secure HID fixtures with safety chain.

E. Pendant mounted, open, industrial fluorescent fixtures:
   1. Not in continuous rows, shall be supported by conduit or by approved chains:
      a. Hardwired to ceiling mounted junction box.
   2. In continuous rows, shall be rigidly supported with conduit and fasten fixtures to each other or mount on continuous metal channel per Specification Section 16010.
      a. Hardwired to ceiling mounted junction box.
      b. Provide reflector alignment clips.

F. Locate fixtures in accordance with reflected ceiling plans.

G. Locate in exact center of tile when indicated.
   1. Relocate misplaced fixtures and replace damaged ceiling materials.

H. Mount lighting fixtures at heights indicated in Specification Section 16010 or per fixture schedule or as indicted on the Drawings.

I. Install exterior fixtures so that water can not enter or accumulate in the wiring compartment.

J. Where indicated provide two-level control of three (3) and/or four (4) lamp fluorescent fixtures.
   1. Provide two (2) ballasts per fixture and control inside lamp(s) in each fixture by one (1) switch or set of switches and the outside two (2) lamps by a second switch or group of switches.

K. Ground fixtures and ballasts.

3.2 POLE INSTALLATION

A. Drawings indicate the intended location of light pole.
   1. Field conditions may affect actual location.
   2. Coordinate location with all existing or new utilities and pavement.

B. Steel Poles:
   1. Mounted on cast-in-place foundations, as detailed on the Drawings.
      a. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.
   2. Protect pole finish during installation.
      a. Repair damage to pole finish with manufacturer approved repair kit.

C. Ground poles as indicated on the Drawings.

D. Conductors:
   1. See Specification Section 16120 for required underground conductors.
   2. Use interior building wire, as specified in Specification Section 16120, from pole base to fixture, #12 AWG minimum.

E. Overcurrent and Short Circuit Protection:
   1. Protect each phase with a UL Class CC fuse:
      a. Size: Three (3) times load current.
      b. Standard: UL 248-4.
   2. Fuseholder:
      a. Watertight, in-line and break-a-way style.
      b. Accept up to a 30 A, 600 V fuse.
      c. Neutral conductor shall utilize a fuseholder with a solid copper rod.
      d. Conductor terminal: Adequate size for the installed conductors.

3.3 FIELD SERVICES

A. See Subcontract Agreement, clean and adjust all fixtures.

B. Replace all inoperable lamps with new lamps prior to final acceptance.

C. Aim all emergency lighting units, so that, the path of egress is illuminated.

D. Provide start up and commissioning services for all lighting controls and for all controlled lighting systems to assure proper adjustment and operation.

E. Prepare all certifications required by California Title 24 and submit as a complete package.

END OF SECTION