Orange County Utilities

Eastern Water Reclamation Facility
Phase V Improvements

Bid Package A

Technical Specifications
Volume I of II

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Bid Set
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EASTERN WATER RECLAMATION FACILITY
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SECTION 01010 SUMMARY OF WORK

PART 1 - GENERAL

A. Work Under This Contract

The Phase V Improvements will provide facilities to enable rerating the EWRF from 19 MGD to 24 MGD, based upon an annual average daily flowrate (AADF). Construct the following improvements as shown on the drawings and technical specifications:

1. New Preliminary Treatment Structure and Odor Control – Process 500

2. Aeration and Supplemental Carbon improvements to Phase I/II, III, and IV Biological Nutrient Removal trains, including but not limited to the following processes; Process 210-230, 310-330, 420 and 520.

3. Clarifiers 1 to 4 Rehabilitation including WAS/RAS/SCUM pumping improvements and improvements to provide waste sludge pumping for Clarifiers 7 to 9, including but not limited to the following processes; Process 251-253 and 352.

4. New Clarifier 11 and improvements to the Clarifier 10 and 11 RAS/WAS/SCUM pumping station– Process 450 and 540

5. Conversion of the Existing Phase III Effluent Flocculation Basin into a New Filter Splitter Box – Process 360

6. Relocate existing Disk Filter – Process 470

7. New Chlorine Contact Tank – Process 580

8. Improvements to Existing Phase III Effluent and In-Plant Reuse Pump Stations – Processes 390 and 395

9. New Secondary Effluent Reject Pump Station and Diversion Structures – Process 560-565

10. Improvements to the Reject Storage Pond and Rapid Infiltration Basins (RIBs)

11. Improvements to the Phase IV In-Plant Lift Station – Process 495

12. New Supplemental Carbon Feed and Storage System – Process 520

13. New West Electrical Building – Process 575

14. Improvements to the Existing Main Electrical/Blower and North Control Building

15. Improvements to the Existing SCADA Control Room

16. Miscellaneous Hydraulic Capacity Improvements

17. Construct miscellaneous site improvements and yard piping associated with the new facilities, as shown on the drawings and specified herein, including yard piping, electric ductbanks and wiring, transformers, grading modifications, concrete slabs, drainage ditches, sidewalks, and other items shown on the drawings or specified herein, or as necessary to provide a complete operating system.

18. Electrical and Control system improvements.

19. The Contractor shall furnish all labor, superintendence, materials, plant, power, light, heat, fuel, water, tools, appliances, equipment, supplies, and other means of construction necessary or proper for performing and completing the work.

B. Work Performed by Others

1. All existing valves, equipment and facilities are to be operated only by the County. The Contractor shall coordinate and schedule operation and shutdown control of existing valves and facilities with the County at least seven (7) days in advance by processing a C.A.R. (Construction Assistance Request) unless otherwise noted.

2. Internal Secondary Clarifier 1-4 Mechanism Replacement: The improvements to Clarifiers 1 through 4 are planned to be constructed under two separate contracts. OCU will contract separately for the “internal” clarifier improvements, including mechanism/drives, walkway, weirs, baffles, launder covers and scum beach. Coordination will be required to integrate these improvements with the overall Phase V clarifier, RAS, WAS and scum pumping systems improvements. For instance, if the clarifiers need to be operated on an interim basis (after the OCU contract improvements are complete but before the Phase V improvements are complete), the scum beach would be located to match the existing scum

pump and then relocated to the new scum wetwell location as part of the Phase V construction. Similarly if interim operation is necessary, the clarifier walkway within the clarifier would be constructed under the OCU contract and terminated (and supported) at the launder wall. Phase V construction would then include the pumping improvements between the clarifiers, including extension of the walkways to access stairs.

3. The Sodium Hypochlorite Storage and Metering Improvements are constructed by Others. The Contractor will be responsible to connect piping and instrumentation to the Process being provided by Others.

4. Existing Generator Building Storage Improvements – The County is administering a contract to improve the North Electrical Building (Process 150) for demolition and provide additional internal storage facilities. The Work by Others will be primarily performed outside the Electrical Room, where this Work is primarily being performed.

C. Training

1. Submit a construction submittal with the format, trainers and course material and specify whether training will be hands on or in a classroom setting for review and acceptance by the Owner and Engineer.

2. Contractor shall prepare a list of all equipment and electrical installations for owner to review and choose training.

3. Unless otherwise specified, a minimum of 2 days of training shall be provided for each piece of equipment supplied, including all electrical installations and testing equipment. Contractor shall video and audio record to a DVD all training given to operations staff, a copy of the DVD will be supplied to the County. The Contractor shall submit a C.A.R (Construction Assistance Request) form seven days prior to beginning of training. Coordinate training schedule with Owner. Owner shall approve training schedule to ensure critical staff is available during training. Video equipment shall be accompanied with independent microphone for instructor to speak into for audio recording.

D. Intended Mode of Operation

Raw sewage flow received by the new Preliminary Treatment Structure will split three-way among Phase I/II, III, and IV treatment trains. Flow will then be directed into respective

Clarifiers (including the new Clarifier 11), filters (existing ABW and existing (relocated disk filter), and chlorine contact basins (existing and new). The existing Phase I/II reuse and modified Phase III Effluent Pump Station (EPS) will continue transferring effluent to the permitted discharge sites.

E. Demolition

1. Perform demolition as designated within the Contract Documents.

2. Unless otherwise noted, remove all materials and equipment from areas indicated for demolition.

3. Cap abandoned utilities and conduit that remain in place.

4. Utilities to be abandoned in place are to be capped and grout filled.

5. Dispose of all removed materials and equipment as required by the appropriate jurisdictional authority, or as directed by the County, to an acceptable disposal site.

6. Disconnect existing electrical services and controls to items being removed by others as a requirement of this section. Conduit is to be cut down to finished floor elevation and capped or sealed. Unless otherwise noted, cables are to be removed to their source.

F. Mutilation

All damage or mutilation of concrete structures, equipment, pipes, ducts, fixtures, etc., shall be properly repaired by the Contractor at no expense to the County.

G. Electrical Interlocks

Where equipment motors are to be electrically interlocked with other equipment for simultaneous operation, the Contractor shall provide wiring diagrams and coordinate between the various subcontractors and suppliers so that proper wiring of the equipment involved is effected.

H. Disturbed Areas

Restore all areas disturbed by construction to a condition at least equal to the preconstruction condition including, but not limited to, all landscaping, driveways, roads, sprinkler systems, and other improvements. Grassed areas shall be sodded. Maintain ingress and egress to all

properties adjacent to the construction and minimize inconvenience to abutting property occupants.

I. Permits

1. The County has obtained Domestic Wastewater Facility Operating permits for this project from the Florida Department of Environmental Protection (FDEP).

2. The County has obtained an Environmental Resource permits for this project from the Florida Department of Environmental Protection (FDEP).

3. The County will also apply for and pay for the General Commercial Building Permit as issued by the Orange County Division of Building Safety. As set forth in the General Conditions and Section 01065, the Contractor shall obtain the General Commercial Building Permit.

4. The Contractor shall pay for and obtain all the Sub-trade Commercial Building Permits associated with the General Building Permit as administered and issued by the Orange County Division of Building Safety. The Contractor shall be responsible for scheduling and paying for all inspection services associated with the Building Permit in order to obtain final approval.

5. The Contractor shall pay for and obtain a permit from the Orange County Division of Building Safety for the fire alarm systems associated with the Work.

6. The Contractor shall pay for and obtain a permit from the Orange County Division of Building Safety for the chain link fence surrounding the proposed improvements.

7. The Contractor shall pay for and obtain a Notice of Intent to use the Generic Construction NPDES permit from the Florida Department of Environmental Protection (FDEP).

8. The Contractor shall pay for and obtain a St. John’s River Water Management District Dewatering Permit.

9. The Contractor shall pay for and obtain all other permits as required to perform the Work.

J. Containers for Spare Parts

1. Spare parts shall be packaged in sealed, rotationally moulded LLDPE military grade storage containers that can be stacked. Storage containers shall have exterior metallic hinges, clasps and handles. The Contractor shall produce a construction submittal for type of

containers intended to be supplied for review and acceptance by the Owner and Engineer.

2. Pertaining to general inventory of all containers, the Contractor shall provide a general ascending alpha-numerical numbering convention to label all individual containers supplied. Labeling shall be provided in consistent location on all bins such that inventory can be reviewed when stacked.

3. Pertaining to contents, the containers shall include exterior labeling that shall include the following at a minimum; Process description and Process number, equipment description, equipment tag, Manufacturer's information. Labeling shall be provided in consistent location on all bins such that inventory can be reviewed when stacked.

4. The Contractor shall provide an electronic log in MS Excel of all containers which include the following at a minimum; container alpha-numerical designation, content description, site storage location, O&M Manual volume subsection reference.

5. A copy of all inventory and manufactures product information data sheets shall be provided within a file pocket attached within the container.

6. Containers shall be positioned on site as designated by the Owner's Representative

PART 2 - PRODUCTS

A. Manufacturers and Materials

At a minimum, all manufacturers and materials shall conform to the current Orange County Utilities List of Approved Manufacturers and Materials.

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01015 PROJECT REQUIREMENTS

A. General Description of Work

The Work to be performed under these Contract Documents is presented in the drawings and specifications. The Work is generally described as follows:

Phase V Improvements:

The Phase V Improvements will provide facilities to enable rerating the EWRF from 19 MGD AADF to 24 MGD AADF. Construct the following improvements as shown on the drawings and technical specifications:

1. New Preliminary Treatment Structure and Odor Control - Process 500

2. Aeration and Supplemental Carbon improvements to Phase I/II, III, and IV Biological Nutrient Removal trains, including but not limited to the following processes; Process 210-230, 310-330, 420 and 520.

3. Clarifiers 1 to 4 Rehabilitation including WAS/RAS/SCUM pumping improvements and improvements to provide waste sludge pumping for Clarifiers 7 to 9, including but not limited to the following processes; Process 251-253 and 352.

4. New Clarifier 11 and improvements to the Clarifier 10 and 11 RAS/WAS/SCUM pumping station- Process 450 and 540

5. Conversion of the Existing Phase III Effluent Flocculation Basin into a New Filter Splitter Box- Process 360

6. New Chlorine Contact Tank – Process 580

7. Relocate existing Disk Filter – Process 470

8. Improvements to Existing Phase III Effluent Pump Station – Process 390

9. New Secondary Effluent Reject Pump Station and Diversion Structures – Process 560-565

10. Improvements to the Reject Storage Pond and Rapid Infiltration Basins (RIBs)

11. Improvements to the Phase IV In-Plant Lift Station – Process 495

12. New supplemental Carbon Feed and Storage System – Process 520

13. New West Electrical Building

14. Improvements to the Existing Main Electrical/Blower and North Control Building

15. Improvements to the Existing SCADA Control Room

16. Miscellaneous Hydraulic Capacity Improvements

17. Construct miscellaneous site improvements including yard piping associated with the new facilities, as shown on the drawings and specified herein, including yard piping, electric ductbanks and wiring, loop switches, transformers, grading modifications, concrete slabs, drainage ditches, sidewalks, and other items shown on the drawings or specified herein, or as necessary to provide a complete operating system.

18. Electrical and Control system improvements.

B. Site Administration

CONTRACTOR shall be responsible for all areas of the Site used by it and by all Subcontractors in the performance of the Work. CONTRACTOR shall exert full control over the actions of all employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to OWNER or others. CONTRACTOR shall have the right to exclude from the Site all persons who have no purpose related to the Work or its inspection, and may require all persons on the Site (except OWNER's employees) to observe the same regulations as CONTRACTOR requires of its employees.

Access to the Site during construction will be limited to Contractor’s and/or Subcontractor’s employees, agents, and vendors (hereinafter “Representatives”) for the sole purpose of performing the Work. Contractor/Subcontractor Representative’s identity and business purpose will be subject to verification by Owner's security representative. Access to the Site will be limited to the main gate off Alafaya Trail unless specific alternate arrangements are made with the Owner. Contractor will supply list, and

periodically update it, which will contain the names of all personnel with driver licenses numbers and license plate numbers of all vehicles that will be on-site during construction.

OWNER reserves the right to direct CONTRACTOR to permanently remove any subcontractor or subcontracted employee from the site for breach of security, policy, unsafe working practice, unprofessional behavior, or failure to comply with access restrictions.

C. Working Hours

Normal Working hours shall be defined as the period occurring between the hours beginning at 7:00 a.m. and ending at 7:00 p.m. Work during other than normal Working hours may be scheduled by CONTRACTOR with notice to Owner. The County Resident Project Representative shall be notified a minimum of 48-hrs in advance in anticipation of working on the weekends, Holidays or durations outside of the 7:00 a.m. to 7:00 p.m. period.

D. County Resident Project Representative (RPR) Working Hours

The normal daily work period for the County's RPR(s) is any 10 hour period between the hours of 7:00 A.M. and 7:00 P.M. on the weekdays of Monday through Friday. County's RPR(s) work outside the 10 hour period shall be paid for by the Contractor and is to be requested, in writing, 48 hours in advance. Any County's RPR(s) weekend work required on Saturday or Sunday shall be paid for by the Contractor and is to be requested, in writing, 48 hours in advance.

E. County RPR Overtime and Weekend Work Pay Rate

All overtime and weekend work by the County's RPR(s) shall be paid for by the Contractor at the overtime work pay rate of $47.00 per hour. This rate is subject to adjustment by the County.

F. Method of Payment

Contractor agrees that the County shall deduct charges for the County's RPR's work outside normal work hours and for overtime pay from payments due the Contractor.

G. Communication with Owner

All communication with Owner personnel for any purpose shall be administered solely though the County R.P.R. Any other communication with the Owner personnel that is not initiated through the County R.P.R. will be null and void.

H. Security

CONTRACTOR shall be responsible for protection of the Site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons. Contractor shall comply with Orange County's security requirements to protect the Eastern Water Reclamation Facility (EWRF) site.

The OWNER is implementing special security measures to protect the public wastewater system and the CONTRACTOR shall provide the same level of security. The CONTRACTOR shall provide the following security measures:

1. Contractor will supply list of all personal that will on EWRF site each morning to OWNER's R.P.R.

2. All personnel, employees and or subcontractors and suppliers that pass through the security perimeter shall wear Contractor issued photo identification badges.

3. Contractor will supply list with names, driver license, and license plate numbers of all personnel.

4. Contractor shall perform background checks to identify any historical crimes dealing with terrorism, sabotage, or other government related illegal activities for all personnel passing through the security perimeter.

5. All project deliveries shall be inspected prior to entering the security perimeter of the Facility in order to verify contents. All delivery personnel and delivery vehicles shall be under supervision while within the security perimeter of the Facility in lieu of issuance of photo identification badges. The Contractor shall maintain staff to accept all deliveries to the site, the Owner will not be responsible for receipt of any deliveries.

6. If access other than the main gate off Alafaya Trail is utilized, a full time guard shall be provided at the construction gate during contractor working hours. All arrangements for alternative access shall be pre-

arranged with the Owner. All alternative access must be secured and locked when not in use.

No Claim shall be made against OWNER by reason of any act of an employee or trespasser, and CONTRACTOR shall make good all damage to OWNER's property resulting from CONTRACTOR's failure to provide security measures as specified.

I. Construction Administration Request (CAR) Form

The Contractor is responsible to submit a CAR to the Owner's Representative for any interaction requiring the involvement of the Owner's Operational Staff for the EWRF, including but not limited to the following examples; existing valve actuation, process interruptions, equipment operation interruption, power interruption, flow diversions, training. The Contractor will not have contact with the Operations Staff without Owner's Representatives' knowledge. The Owner's Representative reserves the right to direct the Contractor to provide a CAR at his discretion. Unless otherwise noted by the Owner's Representative, a CAR shall be submitted a minimum of seven (7) calendar days in advance of the intended operation noted within the CAR. Unless otherwise noted within the Contract Documents, for all activities affecting treatment process operation, a CAR shall be submitted a minimum of thirty (30) days in advance of the scheduled activity. Unless otherwise noted within the Contract Documents, the schedule for performing work which will require shutting down a unit process must be coordinated with the Owner by CAR submittal a minimum of sixty (60) days in advance of the scheduled activity. Reference a blank copy of the form within this section.

J. Smoking Policy – Smoke Free Campus

In order to protect the public health, safety and welfare of citizens and employees, smoking tobacco, or any other substance, is prohibited in County owned or operated facilities and vehicles. Contractor's personnel will not be permitted to smoke tobacco products on County property, including County parking lots, break areas, and worksites. Smoking means the lighting of any cigarette, cigar or pipe, or the possession of any lighted cigarette, cigar or pipe, regardless of its composition. This requirement shall be enforced from the beginning of construction and violators will be removed from the property.

K. Operator Training

A minimum of 2 days of training shall be provided for each piece of equipment supplied, including all electrical installation, instruments and testing equipment. The Contractor shall video and audio record each training session. The Contractor shall provide the County with a DVD compiling all of the training sessions on the project. The DVD shall be able to be indexed per respective piece of equipment. The DVD shall be accompanied by an electronic compilation (.PDF format) of all the handout materials provided to Operators during those training sessions. At a minimum of 7 days in anticipation of scheduling a training session, the Contractor is responsible to submit a CAR Form to the County RPR. The purpose of the submittal of the CAR Form is to request if the Contractor may conduct a training session with the Operations Staff on an anticipated date. The CAR is to be accompanied by the training agenda and all handouts to be provided. The County reserves the right to reject the date submitted in instances where Operations staff is unable to accommodate that date because of a scheduling conflict. From the training materials submitted, the County reserves the right to request additional materials to enhance the training. At a minimum, the training and those materials provided shall be based upon the Manufacturer's recommendations and the Manufacturer's Operations and Maintenance manuals.

CONTRACTOR'S ASSISTANCE REQUEST
FOR ACCESS TO COUNTY FACILITIES

PROJECT: EWRF Phase V Improvements

DATE: _____ **NUMBER:** _____

LOCATION/STRUCTURE: _____

_____

PURPOSE: _____

_____

_____

ADDITIONAL ASSISTANCE REQUESTED _____

_____

_____

_____

DATE ACCESS NEEDED: _____

DURATION OF WORK: _____

_____ _____

Contractor **O.C.U. Construction**

COMMENTS/RESTRICTIONS: _____

_____

_____

_____

_____

_____

_____

PLANT SUPERVISOR

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SECTION 01025 MEASUREMENT AND PAYMENT

A. Payment

1. Work under this contract will be paid for on both a unit priced and lump sum basis as described on the Bid Schedule. The amount of payment will be as defined in the Construction Contract.

2. The quotations for the work are intended to establish a total price cost for completing the work in its entirety.

3. Additions, deletions, modifications or changes to the work as defined by this contract will be performed by change order according to the General Conditions.

B. General

1. All work under this contract shall be included in the lump sum amount listed on the Bid Schedule.

2. Any items not shown or omitted that are required for a complete installation shall be furnished and installed by the Contractor at no additional cost to the County.

3. The prices shall include all labor, materials, tools, and equipment required to complete the work.

4. Payment for repair and replacement of existing utilities will be included in the lump sum bid amount for the new construction.

5. Payment for lump sum items shall be on a percentage of completion of the particular item basis.

C. Partial Pay Request

1. The installation of pipe and fittings includes backfilling, compacting, hydrostatic testing, fine grading, property restoration, clean up, and placing the facilities in operation. When measurements of the amount of work constructed each month are made, for the purpose of partial payment, the following will be considered:

   a. In addition to the retainage as set out in the Construction Contract, 10% of the amount of footage of pipe shall be withheld if the trench has not been backfilled, compacted, and tested.

   b. In addition to the above, 10% of the amount of footage of pipe shall be withheld if the area has

not been fine graded, properly restored to its previous condition, cleaned up, sodded, pressure tested, and ready to be placed in operation.

2. No less than 2% of the contract price shall be retained until the record drawings, specifications, addenda, modifications, and shop drawings are delivered and reviewed by the County.

3. The Contractor will provide the following with each Partial Pay Request:

   a. Current record drawings for the County's review.

   b. Partial release of liens from all Vendors and Subcontractors.

   c. Photos of work completed.

   d. Consent of Surety Company for Partial Payment.

D. Description of Lump Sum Pay Items – Bid Package A

Described below is a brief summary of the work to be accomplished for the amount in the Bid Schedule. The amount will include shop drawings, sample submittals, record drawing submittals, O&M manual submittals, clean-up, start-up, testing, and placing in operation. The summary is not intended to describe all items in detail, but to clarify the items on which the price is to be based. The summary does not relieve the Contractor of his responsibility to supply all items complete.

1. Description of Base Bid Pay Items - Bid Package A:

   a. Bid Package A - Base Bid Item No. 1A (The Phase V Improvements) - This lump sum bid item is for the following elements as generally defined within the Contract Documents;

      (1) New Preliminary Treatment Structure, Process 500. This includes all labor, materials, supplies and equipment for constructing the new preliminary treatment structure including but not limited to hydraulically cleaned band screens with sluice, screw presses, odor control facilities, flow meters, piping, weirs, slide gates, valves, reinforcement, concrete, grating, coating, pipe supports, testing, electrical & control improvements, and any other elements associated with this process. It shall also include all labor, materials, supplies and services in order to

install the Grit Removal System that is identified in Base Bid Item No. 2A (Hydro-International Inc. Grit Removal System)

(2) Aeration improvements to Phase I/II, III, and IV Biological Nutrient Removal trains, including but not limited to the following processes; Process 210-230, 310-330, 420 and 520. This includes all labor, materials, supplies and equipment for the addition of supplemental aeration consisting of new blowers, fine bubble membrane disk diffusers, new air piping, reaeration channel modification, for the Phase I/II train, replacement of existing blowers, reaeration channel modifications, for the Phase III train, adding blower, for the Phase IV train, weirs, slide gates, valves, reinforcement, concrete, grating, coating, pipe supports, testing, electrical & control improvements, and any other elements associated with this process.

(3) Clarifiers 1 to 4 Rehabilitation including WAS/RAS/SCUM pumping improvements and improvements to provide waste sludge pumping for Clarifiers 7 to 9, including but not limited to the following processes; Process 251-253 and 352. This includes all labor, materials, supplies and equipment for the Clarifiers 1 to 4 Rehabilitation including WAS/RAS/SCUM pumping improvements and improvements to provide waste sludge pumping for Clarifiers 7 to 9 including but not limited to RAS pumps, WAS pumps, VFDs, valves, piping, slabs, above grade RAS & WAS flow meters, replacement of Clarifier 9 flow meters, WAS, & RAS pumps, exterior concrete scum wet wells with a dedicated scum pump at each clarifier, sludge blanket level indicator, scum spray system, lighting along the mechanism walkway, and electrical and control components and any other elements of this process.

The improvements to Clarifiers 1 through 4 are planned to be constructed under two separate contracts. The County will contract separately for the "internal" clarifier improvements, including mechanism/drives, walkway, weirs, baffles, launder covers and scum beach.

Coordination will be required to integrate these improvements with the overall Phase V clarifier, RAS, WAS and scum pumping systems improvements.

(4) New Clarifier 11 and improvements to the Clarifier 10 and 11 RAS/WAS/SCUM pumping station, Process 450 and 540. This includes all labor, materials, supplies and equipment for the secondary clarifier (Clarifier 11) including but not limited to energy dissipating inlet, spiral blade scraper, sludge blanket indicator, density current baffles, FRP launder covers, RAS pump on VFD, exterior concrete scum wet wells with a submersible scum pump, valves, piping, coating, testing, concrete, electrical & control components, and any other elements associated with this process.

(5) Conversion of the Existing Phase III Effluent Flocculation Basin into a New Filter Splitter Box – Process 360. This includes all labor, materials, supplies and equipment for Conversion of the Existing Phase III Effluent Flocculation Basin into a New Filter Splitter Box including but not limited to weir gates, concrete, slide gates, motorized actuators, piping/concrete demolition & cleanup, modification to existing disk filter piping, electrical and control components and any other elements of this process.

(6) Chlorine Contact Tank, Process 580. This includes all labor, materials, supplies and equipment for the chlorine contact tank including but not limited to valves, piping, concrete structures, grating, chemical mixer, weirs, electrical and control components and any other elements of this process.

(7) Relocate Existing Disk Filter, Process 470. This includes all labor, materials, supplies and equipment for demolition and relocation of the existing disk filter including but not limited to valves, piping, electrical and controls, concrete slab, staircases and any other elements of this process.

(8) Improvements to Existing Phase III Effluent and In-Plant Reuse Pump Stations – Processes 390 and 395. This includes all labor,

materials, supplies and equipment for the improvements to the existing EPS including but not limited to demolition of pumps, piping, canopy, and pump pedestals and construction of new pumps, valves, piping, fittings, air release valves, pipe supports, electrical and control components and any other elements of this process.

(9) New Secondary Effluent Reject Pump Station and Reject Diversion Boxes, Process 560 – 565. This includes all labor, materials, supplies and equipment for the new secondary effluent reject pump station including but not limited to submersible pumps with guide rails, valves, reject pond outfall/intake structures, piping, slabs, wet well, flow meters, motor operated valves, electrical and control components and any other elements of this process.

(10) Improvements to the Reject Storage Pond and Rapid Infiltration Basins (RIBs). This includes all labor, materials, supplies and equipment to the existing reject storage pond and Rapid Infiltration Basins including but not limited to the following; demolition, excavation, grading, liner and overflow installation.

(11) Improvements to the Phase IV In-Plant Lift Station, Process 495. This includes all labor, materials, supplies and equipment for the improvements to the existing in-plant lift station including but not limited to a new submersible pumps with guide rails, limit switch on existing check valves, electrical and control components and any other elements of this process.

(12) New Supplemental Carbon Feed and Storage System, Process 520. This includes all labor, materials, supplies and equipment for the new supplemental carbon source feed and storage system including but not limited to prefabricated metal building, concrete slab, chemical feed skids with pumps, storage tanks, piping, fittings, valves, miscellaneous appurtenances, electrical and control components and any other elements of this process.

(13) New West Electrical Building, Process 575. This includes all labor, materials, supplies and equipment for the new main electrical building including but not limited to masonry block with foam insulation, hollow core plank membrane roof with sloped insulation, concrete, structural members, motor control centers, electrical switchgears, PLCs, fire alarm system tied to SCADA, civil, architectural, structural, electrical, instrumentation components, and any other elements associated with this building.

(14) Improvements to the Existing Main Electrical/Blower Building and the North Control Building, Processes 185 and 155 respectively. This includes all labor, materials, supplies and equipment for the existing main electrical/blower building including but not limited to salvage of existing 150 Hp blowers supplying process air to Phase III BNR, install larger blowers in the existing main electrical/blower room. This includes all labor, materials, supplies and equipment for the existing north control building including but not limited to demolition and architectural, structural, electrical and HVAC improvements.

(15) Improvements to the Existing SCADA Control Room - This includes all labor, materials, supplies and equipment for the existing SCADA control room but not limited to PC services, PC workstations, electrical improvements, integrate existing/proposed projects (Biosolids Handling System Modifications, Wetland Outfall Stage Recorder, Phase IV-C, and proposed Centrifuge Dewatering) into Phase V new open-architecture using Siemens S7 series PLCs, include automatic report generation, and any other elements associated with this building.

(16) Miscellaneous Hydraulic Capacity Improvements - This includes all labor, materials, supplies and equipment for the miscellaneous hydraulic capacity improvements but not limited to construction of secondary effluent reject diversion boxes and any other elements associated with this building.

(17) Miscellaneous site improvements and yard piping - This includes all labor, materials, supplies and equipment for the miscellaneous site improvements including grading modifications, concrete slabs, drainage ditches, sidewalks, process yard piping (raw sewage, MLSS, WAS, RAS, SCUM, secondary effluent, reject, drainage, potable water, reuse, NPW etc.) manholes, stormwater conveyance & treatment, existing roadway & storm drain repairs, cleanouts, valve boxes, valves, concrete, reinforcement, excavation, sheeting/shoring, dewatering, backfilling, restoration, testing, and other items shown on the drawings or specified herein, or as necessary to provide a complete operating system.

(18) HVAC and Plumbing Improvements - This includes all labor, materials, supplies and equipment for construction of the HVAC and plumbing components associated with the Preliminary Treatment Structure, West Electrical Building, and Existing North Control Building including but not limited to piping, ducts, fittings, valves, air compressors and air handling units, fans, pumps, meters, concrete pads, supports, condensers and other respective appurtenances.

(19) Electrical Site Improvements - This includes all labor, materials, supplies and equipment for the various external electrical improvements associated with the Phase V expansion including but not limited to ductbanks, wiring, substations, transformers, pull boxes, vaults, pedestals, reinforcement, concrete pads, and other elements associated with the electrical system.

(20) Grading, Landscaping and Miscellaneous Site Improvements - This includes all labor, materials, supplies and equipment for the various site improvements associated with the Phase V expansion, including but not limited to hauling, mass grading, masonry block walls, relocation of equipment storage (crushed stone and geogrid fabric) open are south of Basin 7, bollards, watering, excavation, storm water best management practices, compaction, fine grading and landscaping.

(21) General Requirements/ Mobilization/Demobilization – This includes all costs associated with mobilization, temporary control facilities, utilities, permits and demobilization as specified herein.

(22) Bonds/Permits/Indemnification – This includes all costs associated with bonds and permits as specified herein. The item shall include an amount for indemnifications specified in the Contract Documents and any addenda and modifications made thereto.

2. Bid Package A - Base Bid Item No. 2A (Hydro-International Grit Removal System)

   a. The Bid Item shall include the equipment cost of the Grit Removal System and manufacturer's services as provided by Hydro-International Inc. The Grit Removal System is described within Specification Sections 11314 and 11320 and illustrated within the Drawings, including but not limited to the Headcell®, Grit Pumps, SlurryCup™, Grit Snail® and associated auxiliary materials and equipment. The Bid Item shall include all manufacturer's services, including the 3-year warranty, as specified under Sections 11320 and 11314. The manufacturer's additive 2-year warranty shall be included within the Additive Bid Item No.1A (Additive Equipment Warranty). The cost for the labor, materials, supplies and all services to install and test the Grit Removal System shall be included in Base Bid Item No. 1A, including but not limited to the electrical, mechanical, structural and instrumentation disciplines. Reference Attachment C for the manufacturer's proposal regarding the Grit Removal System.

3. Bid Package A - Base Bid Item No. 3A (Material and Debris Removal from Existing Structures):

   a. Material Removal and Disposal from Existing Structures - This unit cost pay item includes all labor, materials, supplies, equipment, fuel, and disposal fees for all material and debris and material removal from existing tanks and structures encountered during execution of the Work. Note that the quantity of **1,000 tons** is only to obtain a unit cost for the items and may vary significantly from what is identified herein. The quantity noted is based upon the weight of material as it is weighed

when it is disposed of at an authorized jurisdictional disposal location. No adjustments in the unit costs will be made to reflect changes in the quantities. Actual quantities for billing purposes shall be documented by the submittal of load tickets from the authorized jurisdictional disposal location.

4. Bid Package A - Base Bid Item No. 4A (Unforeseen Leakage Repair to Existing Structures)

   a. This unit cost pay item includes all labor, materials, supplies, equipment for the repair of leaking cracks discovered in existing structures encountered during execution of the Work. The unit cost pay item is to encompass those unforeseen leaking cracks discovered after the structure is taken out of service to execute the Work. This unit cost pay item shall include, but not be limited to, the following; cracks, seeps, and areas of leakage. The repair procedure shall be performed as specified within the Contract Documents. Note that the quantity of **200 lineal feet** of cracked structure is only to obtain a unit cost for the items and may vary significantly from what is identified herein. Note that the quantity shown is only to obtain a unit cost for the items and may vary significantly from what is identified herein. No adjustments in the unit costs will be made to reflect changes in the quantities.

5. Bid Package A - Base Bid Item No. 5A (Unforeseen Concrete Repair to Existing Structures)

   a. This unit cost pay item includes all labor, materials, supplies, equipment for the repair of structural deficiencies discovered in existing structures encountered during execution of the Work. The unit cost pay item is to encompass those unforeseen structural deficiencies discovered after the structure is taken out of service to execute the Work. This unit cost pay item shall include, but not be limited to, the following; spauled concrete, deteriorated concrete, chipped concrete, reinforcement deterioration, etc… The repair procedure shall be performed as specified within the Contract Documents. Note that the quantity of **1,000 square feet** of damaged concrete is only to obtain a unit cost for the items and may vary significantly from what is identified herein. Note that the quantity shown is only to obtain a unit cost for the items and may vary significantly from what is

identified herein. No adjustments in the unit costs will be made to reflect changes in the quantities.

E. Bid Package A - Additive Bid Items

1. Bid Package A - Additive Bid Item No.1A (2 Year Additive Equipment Warranty increasing the Base Bid 3 Year Equipment Warranty up to 5 Years):

   a. Additive Equipment Warranty – This lump sum alternative bid item shall be for a two (2) year extension of the equipment warranty supplied on the project. For the equipment identified within the Contract Documents for a warranty duration of three (3) years from the date of substantial completion of the respective process from which the equipment is installed, the alternative bid item shall encompass an additional two (2) years for extension of the warranty and preventative maintenance service duration, providing total of five (5) years from the date of substantial completion of the respective process from which the equipment is installed within.

END OF SECTION

SECTION 01027 APPLICATIONS FOR PAYMENT

PART 1 GENERAL

A. Requirement

1. This Section specifies administrative and procedural requirements governing the Contractor's Applications for Payment.

2. Prior to submitting a monthly payment application, the Contractor’s progressive As-Built Drawings and As-Built Asset Attribute Data, Gravity Main, and Pipe Deflection Tables shall be accepted by the County.

3. Progressive As-Built Drawings shall indicate the horizontal and vertical locations of all current constructed improvements with sufficient information and notes to easily determine if the improvements were constructed in conformance with the Contract Documents. The progressive As-Built Asset Attribute Data, Gravity Main, and Pipe Deflection Tables shall include a Surveyor’s certified statement regarding the constructed improvements being within the specified accuracies or if not, indicating the variances as described in specification Section 01050 "Surveying and Field Engineering", Table 01050-1 Minimum Survey Accuracies.

B. Format

Format and Content: Use the accepted Schedule of Values.

1. Arrange the Schedule of Values in a tabular form with separate columns to indicate the following for each item listed:

   a. Generic name

   b. Related Specification Section

   c. Name of Subcontractor

   d. Name of manufacturer or fabricator

   e. Name of supplier

f. Dollar value

2. Round amounts off to the nearest whole dollar. The total shall equal the Contract Amount.

C. Preparation of Application

1. Each Application for Payment shall be consistent with previous applications and payments as certified and paid for by the County.

   a. The initial Application for Payment: The Application for Payment at time of Substantial Completion and the final Application for Payment involve additional requirements.

2. Payment Application Times: As stated in the General Conditions, Payment applications are to be submitted monthly on a day of the month to be established by the County at the Pre-Construction conference.

3. Application Preparation: Complete every entry on the form, including notarization and execution by person authorized to sign legal documents on behalf of the Contractor. Incomplete applications will be returned without action.

   a. Submit applications typed on forms provided by the County.

   b. Use data on Bid Form and approved Schedule of Values. Provide dollar value in each column for each line item for portion of Work performed and for stored products.

   c. List each authorized Change Order and an extension or continuation sheet, listing Change Order number and dollar amount as for an original item of work.

   d. Each item shall have an assigned dollar value for the current pay period and a cumulative value for the project to-date.

   e. Submit stored material log, partial waivers of claims and mechanic liens, and consent of surety with each application, as further explained below.

4. Submit a stored material log with each application for

payment which identifies the type, quantity and value of all stored material, and that tracks when the stored materials are installed and deducts them from stored quantity at that time. Include original invoices for all stored materials that payment is requested.

5. Waivers of Claims and Mechanics Lien: With each Application for Payment submit waivers of claims and mechanics liens from Subcontractors or Sub-subcontractors and suppliers for the construction period covered by the previous applications.

    a. Submit partial waivers on each item for the amount requested, prior to deduction for retainage, on each item.

    b. When an application shows completion of an item, submit final or full waivers.

    c. The County reserves the right to designate which entities involved in the Work must submit waivers.

    d. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of work covered by the application that could lawfully be entitled to a payment claim or lien.

    e. Waiver Forms: Submit waivers of claims and lien on forms and executed in a manner acceptable to the County.

6. Transmittal: Submit four (4) executed copies of each Application for Payment to the County by means ensuring receipt within 24-hours. One (1) copy shall be complete, including waivers of lien and similar attachments when required.

    a. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the County.

    b. The Contractor shall include a certification with each application stating that all previous payments received from the County under the Contract have been applied by the Contractor to

discharge in full all obligations of the Contractor in connection with the Work by prior applications for payment, and all materials and equipment incorporated into the Work are free and clear of all liens, claims, security interest and encumbrances.

7. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:

   a. List of Subcontractors

   b. List of principal suppliers and fabricators

   c. Schedule of Values

   d. Contractor's Construction Progress Schedule (accepted)

   e. List of Contractor's staff assignments

   f. Copies of building permits

   g. Copies of authorizations and licenses from governing authorities for performance of the Work

   h. Certificates of insurance and insurance polices

   i. Performance and Payment bonds (if required)

   j. Data needed to acquire County's insurance

8. Monthly Application for Partial Payment: Administrative actions and submittals that must precede or coincide with submittal of Monthly Partial Payments include the following:

   a. Relevant tests

   b. Progressive As-builts (one (1) paper copy and electronic copy)

   c. Table 01050-2 Asset Attribute Data Form Examples (one (1) paper copy and electronic copy)

   d. Table 01050-3 Pipe Deflection Table Example (one (1) paper copy and electronic copy)

e. Table 01050-4 Gravity Main Table (one (1) paper copy and electronic copy)

f. An electronic copy of all survey field notes

g. Partial Release of lien

h. Partial consent of surety

i. Site photographs

j. Updated Progress Schedule: submit one (1) electronic copy and five (5) copies

k. Summary of Values

l. Pay Request

m. On-Site Storage

9. Substantial Completion Application for Payment: Following issuance of the Certificate of Substantial Completion, submit an Application for Payment. This application shall reflect any Certificates of Partial Substantial Completion issued previously for County occupancy of designated portions of the Work.

   Administrative actions and submittals that shall precede or coincide with this application include:

   a. Occupancy permits and similar approvals

   b. Warranties (guarantees) and maintenance agreements

   c. Test/adjust/balance records

   d. Maintenance instructions

   e. Meter readings

   f. Start-up performance reports

   g. Change-over information related to the County's occupancy, use, operation and maintenance

   h. Final Cleaning

   i. Application for reduction of retainage and consent of surety

j. Advice on shifting insurance coverage

k. List of incomplete Work, recognized as exceptions to County's Certificate of Substantial Completion

10. Final Completion Application for Payment: Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:

a. Prior to submitting a request for final payment or the County issuing a Certificate of Completion for the Work, the Contractor shall submit the final Record Documents to the County for approval. Retainage funds will be withheld at the County's discretion based on the quality and accuracy of the final Record Documents.

b. Completion of project close-out requirements

c. Completion of items specified for completion after Substantial Completion

d. Assurance that unsettled claims are settled

e. Assurance that work not complete and accepted is now completed

f. Transmittal of required project construction records to the County

g. Proof those taxes, fees and similar obligations have been paid

h. Removal of temporary facilities and services has been completed.

i. Removal of surplus materials, rubbish and similar elements

j. Change of door locks to County's access

k. Execute certification by signature of authorized officer.

l. Prepare Application for Final Payment as required in General Conditions.

D. Submittal Procedures

1. Submit four (4) copies of each Application for Payment at time stipulated in Agreement.

2. Submit under transmittal letter.

E. Substantiating Data

1. When the County requires substantiating information, submit data justifying line item amounts in question.

2. Provide one (1) copy of data with cover letter for each copy of submittal. Show Application number and date, and line item by number and description.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01040 CONSTRUCTION COORDINATION

A. Coordination

1. Other phases of construction may begin before this contract is completed which will interface with this work. Additionally, other projects will be constructed adjacent to the Work during the life of this contract. Coordinate your activities with the other contractors to allow orderly and timely completion of all the work.

2. When access through interfacing and/or overlapping construction areas must be disrupted, provide alternate acceptable access for other contractors.

3. Coordinate your activities in the interface or common areas with these other contractors. Submit to the Owner and Engineer a description and schedule as to how the common areas will be utilized, recognizing the required coordination with other contractors.

4. The existing wastewater treatment facilities must remain in service at all times during construction with the *exception of the following;*

Unit Process	Outage Duration	Work to be Performed
Phase I/II BNRs 1 & 2, Clarifiers 1 & 2 w. RAS/WAS/SCUM PS	270 days	Processes 211, 216, 217, 221, 222, 231, 241, 242 & 251
Phase I/II BNRs 3 & 4, Clarifiers 3 & 4 w. RAS/WAS/SCUM PS	270 days	Processes 212, 218, 219, 220, 223, 224, 232, 243, 244, 252 & 253
Phase III BNR 5	180 days	Processes 311, 312, 316, 317, 325 and 335
Phase III BNR 6	180 days	Processes 313, 314, 318, 319, 326 and 336
Phase I/II Clarifiers 7 & 8	24 Hours	Tie In Process 253 WAS Pumps and Process 562
Phase III Clarifier 9	24 Hours	Tie in Process 352 WAS and RAS Piping.
Phase III Clarifiers 5 & 6	24 hours	Tie-In Process 563
Phase IV BNR 7, Clarifier 9 & 10	24 hours	Tie-In Processes 564 540
Reject Storage Pond	270 days	Grade and install liner
42″ Effluent Piping	7 days	Reroute existing 42″ PCCP RW for Clarifier 11

5. All contact, request, coordination with all County Personnel including but not limited to the EWRF Operation staff for any reason shall be initiated through Owner's Resident Project Representative (R.P.R.)in writing by the Contractor processing a Construction Assistance Request (C.A.R.). Contractor will not have contact with any County personnel without processing of a C.A.R. through the County's R.P.R.

6. The Phase III BNRs cannot be taken offline at the same time as the Phase I/II BNRs. Unless otherwise noted within the Contract Documents, for all activities affecting treatment process operation, a CAR shall be submitted a minimum of thirty (30) days in advance of the scheduled activity. Unless otherwise noted within the Contract Documents, the schedule for performing work which will require shutting down a unit process must be coordinated with the Owner by CAR submittal a minimum of sixty (60) days in advance of the scheduled activity. Connections to existing piping and structures must be coordinated with the Owner as described herein or other pertinent Sections. The Owner will provide the Contractor with the day and start/stop points for the aforementioned allotted time period.

B. Utilities

Coordinate the activities of all utility companies with equipment in the construction area with the Contractor's and subcontractors' work.

C. Cutting and Patching

No cutting and patching of new work will be accepted. All work must be new and continuous in its final form.

D. Scheduling

Certain items cannot be removed, replaced, abandoned, or demolished until certain other work has been accomplished. The following describes the other work to be accomplished before such work may be performed. The contractor shall take the following items into account when creating the construction schedule required by Section 01310:

1. General Sequence of Construction

   a. Install storm water Best Management Practices prior to any work on the sites.

b. Perform demolition and abandonment of existing utilities. Reference the Drawings and other Sections for areas of demolition and abandonment that require coordination with replacement utilities or other process improvements.

c. Clear and grub site. Install on-site yard piping and electrical/instrumentation & control improvements. Test yard piping and electrical/instrumentation & control facilities.

d. Construct preliminary treatment structure, clarifier 11 & RAS pump station modification, flocculation basin modification, chlorine contact tanks, effluent pump station modifications, reject pump station, reject storage pond structures, secondary effluent diversion structures, modification to existing processes (Phase I/II, III, and IV modifications, clarifier rehabilitations, in-plant lift station), external carbon source feed and storage system, and stormwater conveyance & treatment improvements.

e. Perform hydraulic testing of new structures in accordance with Section 03800.

f. Install mechanical equipment and other respective mechanical and equipment elements.

g. Construct electric ductbanks, external electrical, mechanical and HVAC components.

h. Perform field testing of individual process equipment, as described in the equipment specifications. Perform start-up testing and system testing of treatment process, as described in Section 01664.

i. As described in Section 01664, Part 1.A.4, the Contractor is to perform system start-up and system testing procedure for the following major facilities;

(1) Biological Nutrient Removal Reactors (BNR):

(a) BNR Part A1 – Process 520: Supplemental Carbon Feed and Storage

(b) BNR Part A2 - Phase I/II BNR Process Train (South), North Control Building, Clarifier 3 and 4 RAS/WAS/SCUM pumping station, and Clarifier 7 and 8 WAS pumping station; including but not

limited to Processes 155, 212, 218-219, 223-224, 232, 243-244, 252, 253.

(c) BNR Part B - Phase I/II BNR Process Train (North) and Clarifier 1 and 2 RAS/WAS/SCUM pumping station; including but not limited to Processes 211, 216-217, 221-2242, 231, 241-242, and 251.

(d) BNR Part C - Phase III BNR Process Train (North), Main/Electrical Blower Building, and Clarifier 9 WAS Pumping Station; including but not limited to Processes 185, 311-312, 316-317, 325, 335 and 352

(e) BNR Part D - Phase III BNR Process Train (South) including but not limited to Processes 313-314, 318-319, 336 and 352.

(f) BNR Part E - Phase IV BNR Process Train, Clarifier 10 and 11 RAS/WAS/SCUM pumping station, Clarifier 11 including but not limited to Processes 420, 450, 540

(2) Preliminary Treatment Structure (PTS)

(a) Part A - Preliminary Treatment Structure (Processes 500)

(3) Tertiary Treatment

(a) Part A - West Electrical Building (Process 575)

(b) Part B1 – New Filter Splitter Box (Process 360) – Part 1 Improvements (South), i.e. improvements in portion of tank to feed secondary effluent to the Phase IV Disk Filter (Process 470) and Chlorine Contact Tank (Process 580))

(c) Part B2 - Relocated Disk Filter (Process 470)

(d) Part B3 – Phase V Chlorine Contact Chamber (Process 580)

(e) Part B4 - Effluent Pump Station (Process 390); start-up and System Testing required for each pump prior to proceeding with work for subsequent

pumps. Process 395 In-Plant Reuse Pump Station may be taken down for replacement after interconnection service installed from the EWRF Public Access Reuse Pumping Facilities.

(f) Part C - Secondary Effluent Reject Pump Station, Diversion Boxes, Outfall Structure, Reject Storage Pond and Rapid Infiltration Basin Improvements (Process 560, 561, 562, 563, 564, and 565)

(g) Part D – New Filter Splitter Box (Process 360) - Phase 2 Improvements (North), i.e. improvements in portion of tank to feed secondary effluent to Phase III traveling bridge filters (Process 370)

(4) As described in Section 01664, the Contractor is to perform system start-up and system testing procedure for the remaining facilities

(5) Existing roadway & storm drain repairs, sidewalks and perform fine grading over the site.

2. Specific Construction Sequencing

a. Preliminary Treatment Structure (PTS) – Raw Sewage piping cannot be connected to the inlet piping into Preliminary Treatment Structure until system start-up, as defined in Section 01664, has been completed for PTS (Process 500), and accepted by the Owner. Once Raw Sewage can be diverted to the PTS the process of system testing, as defined in Section 01664, may be initiated. Once the PTS has passed system testing and substantially complete by the Owner, only then may any demolition and abandonment of existing pipelines and the existing PTS (Process 300) may be performed.

b. Prior to beginning any work interior to the Phase I/II BNRs (Processes 220 and 230), coordinate downtime and duration with the Owner. Only one pair of the two pairs of Phase I/II BNRs 1-4 (Process 221 and 222 or 223 and 224) may be taken from service at any given time. Only one of the two Fermentation and 2nd Anoxic processes may be taken from service at any given time. Only one pair of the two pairs of Phase I/II Clarifiers 1-4 (Process 241 and 242 or 243 and 244) may be taken from service at any given time.

Unless otherwise noted, Clarifiers 7 & 8 are to remain operational throughout construction. The corresponding RAS/WAS pump station to each pair of clarifiers may only be taken from service when the clarifiers are taken offline. The Contractor may only take those corresponding Fermentation and 2nd Anoxic processes offline in conjunction with the respective BNRs. The Contractor may only take those corresponding clarifiers offline in conjunction with the respective upstream processes.

c. The Phase III BNR cannot be taken offline at the same time as the Phase I/II BNRs. Prior to beginning any work interior to the Phase III BNRs (Processes 320 and 330), coordinate downtime and duration with the Owner. Only one BNR, either 5 or 6 (Process 325 or 326) may be taken from service at any given time. The Contractor may only take those corresponding Fermentation, 1st Anoxic and 2nd Anoxic processes offline in conjunction with the respective BNR. Only one of the three Phase III Clarifiers 5, 6 and 9 (Process 345, 346 and 349) may be taken offline at any given time.

d. The effluent pipeline from Clarifier 11 cannot be connected to the existing 42″ secondary effluent pipeline at Clarifier 10 until Clarifier 11 has been hydrostatically tested and accepted by the Owner. The outage for connecting Clarifier 11 to the existing 42″ secondary effluent pipeline is to be performed concurrently with the modifications associated with Process 564.

e. Conversion of the Existing Phase III Effluent Flocculation Basin into a New Filter Splitter Box (Process 360) must be conducted in multiple stages to not interrupt the operation of the filtration process. There will be two main areas that can be isolated by closing the corresponding slide gates. Area 1 will ultimately deliver flow to the future disk filters (Process 570) and chlorine contact tank (Process 580). Area 2 conveys flow to the Phase III traveling bridge filters (Process 370). Flow shall continue flowing through Area 2 to deliver secondary effluent the Phase III traveling bridge filters until modifications are completed in Area 1 and secondary effluent is connected to the inlet piping into the chlorine contact tank, the flow to the Phase III traveling bridge filters can be diverted to the new chlorine contact tank and remaining work in Area 2 can be completed.

f. The Process 390 effluent pump station modification must be conducted in multiple stages to not interrupt its operation. The EPS must maintain at least its existing pumps aggregate nameplate capacity of 42.5 mgd (four pumps rated @ 4,000 gpm and three pumps rated @ 4,500 gpm) during Phase V construction.

g. The Process 395 In-Plant Reuse Pump Station may be taken down for replacement after interconnection service installed from the EWRF Public Access Reuse Pumping Facilities, by the installation of the 12″ backflow preventer assembly illustrated on Drawing C-124 and the hydro pneumatic tank bypass piping on Drawing C-121.

h. Clarifier 11 cannot be constructed until the existing 42″ Precast Concrete Cylinder Pipe (PCCP) is rerouted as shown on Drawings C-126 and C-127. The pipeline can be shut down for a duration of 7 days.

END OF SECTION

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STRUCTURE AND PROCESS LABELS		
NUMBER	DESC	TAG
01	PH I/II CLARIFIER NO. 7	PROCESS 247
02	PH I/II CHLORINE CONTACT TANKS	PROCESS 280
03	PH I/II CLARIFIER NO. 1	PROCESS 241
04	PH I/II CLARIFIER NO. 2	PROCESS 242
05	PH I/II CLARIFIER NO. 3	PROCESS 243
06	PH I/II CLARIFIER NO. 4	PROCESS 244
07	PH I/II RAS / WAS PUMP STATION 2	PROCESS 252
08	PH I/II 2nd ANOXIC	PROCESS 230
09	PH I/II AERATION BASINS 1–4	PROCESS 220
10	PH I/II 1st ANOXIC BASINS	PROCESS 215
11	PH I/II BLOWER ENCLOSURE	PROCESS 220
12	PH III AERATION BASINS 5&6	PROCESS 320
13	PH III FERMENTATION	PROCESS 310
14	PH III 1st ANOXIC BASINS	PROCESS 315
15	PH III 2nd ANOXIC BASINS	PROCESS 330
16	PH III CLARIFIER NO. 5	PROCESS 345
17	PH III ABW FILTERS	PROCESS 370
18	PH III CHLORINE CONTACT TANKS	PROCESS 380
19	PH III EFFLUENT PUMP STATION	PROCESS 390
20	FILTER SPLITTER BOX	PROCESS 360
21	PH III CLARIFIER NO. 6	PROCESS 346
22	PH III CLARIFIER NO. 9	PROCESS 349
23	PH III RAS/WAS PUMP STATION 2	PROCESS 352

STRUCTURE AND PROCESS LABELS		
NUMBER	DESC	TAG
24	PH III BLOWER BUILDING	PROCESS 180
25	PH IV BNR BASIN NO. 7	PROCESS 420
26	PH IV IN–PLANT LIFT STATION	PROCESS 495
27	PH IV CLARIFIER NO. 10	PROCESS 440
28	BELT FILTER PRESS DEWATERING BLDG	PROCESS 640
29	BIOSOLIDS HANDLING BLDG	PROCESS 630
30	CHEMICAL STORAGE BLDG	PROCESS 135
31	NORTH ELECTRICAL BUILDING	PROCESS 155
32	MAINTENANCE BLDG	PROCESS 175
33	OPERATIONS & CONTROL BLDG	PROCESS 170
34	MAIN ELECTRICAL / BLOWER BLDG	PROCESS 185
35	SOUTH ELECTRICAL BLDG	PROCESS 160
36	WAS HOLDING TANKS	PROCESS 620
37	FUEL DEPOT	–
38	NORTH CONTROL BLDG	PROCESS 155
39	CLARIFIER NO. 10 ELECTRICAL BLDG	PROCESS 190
40	PH I/II FERMENTATION	PROCESS 210
41	PH I/II PRETREATMENT	(ABANDONED)
42	PH III PRETREATMENT	PROCESS 300
43	PH I/II ABW FILTERS	PROCESS 280
44	PH I/II CLARIFIER NO. 8	PROCESS 248
45	PH III STORMWATER POND	
46	PH IV DISK FILTER	PROCESS 470
60	SECONDARY EFFLUENT REJECT PUMP STATION	PROCESS 560

STRUCTURE AND PROCESS LABELS		
NUMBER	DESC	TAG
61	SODIUM HYPOCHLORITE STORAGE AND METERING	(BY OTHERS)
62	CHLORINE CONTACT	PROCESS 580
63	WEST ELECTRICAL BLDG	PROCESS 575
64	STORM DRAIN POND	–
65	SECONDARY CLARIFIER NO. 11	PROCESS 540
66	SUPPLEMENTAL CARBON BLDG	PROCESS 520
67	PRETREATMENT STRUCTURE	PROCESS 500
68	FUTURE DISK FILTERS	–
69	INFLUENT FLOW METER STATION	PROCESS 500
70	PH III RS FLOW METER STATION	PROCESS 500
71	FUTURE EFFLUENT PUMP STATION	–
72	FUTURE DISK FILTERS	–
73	FUTURE CHLORINE CONTACT CHAMBER	–
74	FUTURE MEMBRANE PROCESS	–
75	FUTURE BNR BASIN NO. 8	–
76	FUTURE CLARIFIER NO. 12	–
77	FUTURE CLARIFIER NO. 13	–
78	FUTURE ELECTRICAL BLDG	–
79	VACTOR DUMPING STATION	
80	CENTRIFUGE DEWATERING BLDG (BID PACKAGE B)	PROCESS 650
81	PH I/II SE EFFLUENT REJECT DIVERSION NO. 1	PROCESS 561
82	PH I/II SE EFFLUENT REJECT DIVERSION NO. 2	PROCESS 562
83	PH III SE EFFLUENT REJECT DIVERSION NO. 1	PROCESS 563
84	PH III/IV SE EFFLUENT REJECT DIVERSION NO. 1	PROCESS 564

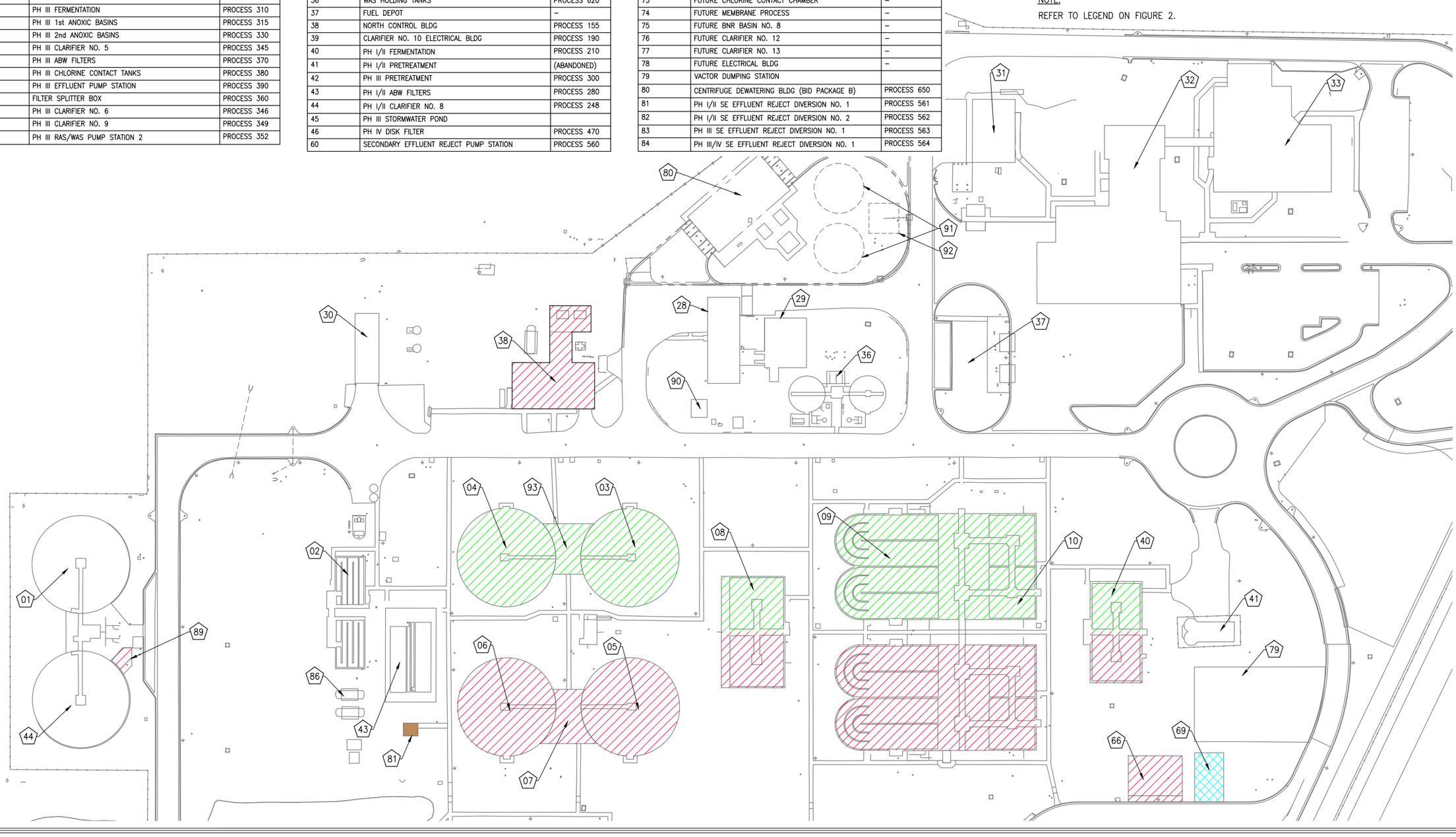
STRUCTURE AND PROCESS LABELS		
NUMBER	DESC	TAG
85	SE EFFLUENT REJECT METER STATION	PROCESS 560
86	NPW HYDROPNEUMATIC TANKS	PROCESS 390
87	RELOCATED PH IV DISK FILTER	PROCESS 470
88	PH IV RAS/WAS PUMP STATION	PROCESS 450
89	PH I/II RAS/WAS PUMP STATION 3	PROCESS 253
90	PH I/II WAS BOOSTER PUMP STATION (BID PACKAGE B)	PROCESS 610
91	FUTURE WAS HOLDING TANKS	PROCESS 660
92	FUTURE WAS SCREENING	PROCESS 670
93	PH I/II RAS/WAS PUMP STATION 1	PROCESS 251
94	PH III RAS/WAS PUMP STATION 1	PROCESS 351

50 0 50

SCALE: 1" = 50'

NOTE:

REFER TO LEGEND ON FIGURE 2.



AECOM
AECOM TECHNICAL SERVICES, INC.
100 NORTH ORANGE AVENUE, SUITE 200
ORLANDO, FLORIDA 32801
PHONE 407.843.6552

CERTIFICATE OF AUTHORIZATION NO. EB-8115

SPECIFICATION SECTION 01040
CONSTRUCTION COORDINATION

NORTH SITE PLAN

FIGURE
1

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SOUTH SITE PLAN

SPECIFICATION SECTION 01040
CONSTRUCTION COORDINATION

FIGURE 2

AECOM
AECOM TECHNICAL SERVICES, INC.
150 NORTH ORANGE AVENUE, SUITE 200
ORLANDO, FLORIDA 32801
PHONE 407.843.6552

CERTIFICATE OF AUTHORIZATION NO. EB-8115

50 0 50
SCALE: 1" = 50'

LEGEND:

BNR:

- SUBSTANTIAL COMPLETION A
- SUBSTANTIAL COMPLETION B
- SUBSTANTIAL COMPLETION C
- SUBSTANTIAL COMPLETION D
- SUBSTANTIAL COMPLETION E

PTS:

- SUBSTANTIAL COMPLETION A

TERTIARY TREAMENT:

- SUBSTANTIAL COMPLETION A
- SUBSTANTIAL COMPLETION B
- SUBSTANTIAL COMPLETION C
- SUBSTANTIAL COMPLETION D

TAG LEGEND:

XX REFER TO EXISTING/PROPOSED PROCESS LABELS ON FIGURE 1

WETLANDS BOUNDARY
AS SURVEYED 11/2004

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SECTION 01050 SURVEYING AND FIELD ENGINEERING

PART 1 - GENERAL

A. Description

1. Professional Surveyor: Provide professional surveying and mapping work required for the execution of the contract, including verification of existing survey data, construction layout, and production of the As-Built Drawings. This Work shall be performed by a Surveyor that is licensed by the State of Florida as a Professional Surveyor and Mapper pursuant to Chapter 472, F.S.

2. Professional Engineer: The Contractor shall provide the services of a Registered Professional Engineer currently licensed in the State of Florida for the following specific services as applicable to the Work.

B. REQUIREMENTS

1. Survey Services

a. The Contractor shall retain the services of a registered Surveyor and Mapper licensed in the State of Florida to provide professional surveying and mapping services, and maintain both a control survey and an as-built survey during construction. The Surveyor will identify control points (monuments and benchmarks noted on the Drawings). The construction layout survey shall be established from the control points shown on the Construction Drawings and confirmed. The method of field staking for the construction of the Work shall be at the option of Contractor. The accuracy of any method of staking shall be the responsibility of Surveyor. All staking shall be done to provide for easy verification of the Work by the County. The Contractor shall provide all surveys necessary for the construction of the Work.

2. Engineering Services

a. The Engineer shall be responsible for duties during

Construction to include, but not limited to:

1) Inspections, testing, witnessing requiring a licensed Professional Engineer.

2) Design of temporary shoring, bridging, scaffolding or other temporary construction, formwork and protection of existing structures.

3) Other requirements as specified herein.

b. Engineering related designs, tests and inspections shall be signed by the licensed Professional Engineer as required by the County.

C. Qualifications of the Surveyor

The Surveyor, who is proposed by the Contractor to provide services for the Project, is subject to the approval of the County. Prior to any services being performed, the Contractor shall submit the name and address of any proposed Surveyor and a written acknowledgement from the Surveyor stating that he has the hardware, software and adequate scope of services in his agreement with the Contractor to fully comply with the requirements of this specification. These submittals shall be provided to the County prior to Notice to Proceed. It is recommended that the Surveyor attend the Pre-Construction meeting. Any Surveyor, who has not previously performed work for the County shall attend the Pre-Construction meeting.

D. Submittals

1. Provide qualifications of the Surveyor or Engineer.

a. A Florida Registered Professional Engineer or Registered Surveyor and Mapper, who is proposed by the Contractor to provide services for the Work, shall be acceptable to the County prior to field services being performed.

b. A Professional Engineer shall be of the discipline required for the specific service for the Work.

c. Submit name, address and telephone number of the Surveyor and/or Engineer, as appropriate to the

County for acceptance before starting survey or engineering work.

2. On request, submit documentation verifying accuracy of survey work.

3. Surveyor shall certify all elevations and locations included in Table 01050- 2, 3, and 4.

PART 2 - PRODUCTS

A. Survey Documents

1. Survey documents shall comply with the Minimum Technical Standards of Chapter 5J-17 of the Florida Administrative Code (FAC) and Table 01050-1 Minimum Survey Accuracies, whichever are more stringent. All coordinates shall be geographically registered in the Florida State Plan Coordinate System using the contract Drawings control points for horizontal and vertical controls.

2. The Surveyor shall not copyright any of their Work related to this project.

Table 01050-1
Minimum Survey Accuracies

Asset	Horizontal Accuracy (feet)	Elevation Accuracy (feet)	Location: Horizontal Center and Vertical Top, unless otherwise specified
Bench Marks	0.01	0.01	Point
Baseline Control Locational Accuracy	0.01	N/A	Point
Tract and Easement Corners	*	N/A	Survey Monuments
Mains at 100-feet maximum intervals	0.1	0.1	Pipe, Pipe at Valves, Pipe at Bore & Jack Casing
PVC pipe >16-inch at every pipe joint	0.1	0.1	Pipe, Pipe at Valves, Pipe at Bore & Jack Casing
Fittings, Sleeve, Tapping Saddle, and end of the pipe if Plugged or Capped.	0.1	0.1	Fitting

Table 01050-1
Minimum Survey Accuracies

Asset	Horizontal Accuracy (feet)	Elevation Accuracy (feet)	Location: Horizontal Center and Vertical Top, unless otherwise specified
Restrained Pipe	0.1	N/A	Restrained Joint Limits
Connections	0.1	0.1	Pipe
Bore & Jack Casing	0.1	0.1	Top of Casing at the Casing Limits
Directional Drill	0.1	0.1	10-foot intervals during the directional drill operation
Hydrants	0.1	N/A	Operating Nut of Hydrant
Valves	0.1	0.1	Operating Nut
Air Release, Blow off, and Backflow Valves	0.1	N/A	Valve Enclosure
Master Meters, Deduct Meters & Wastewater Meters	0.1	N/A	Register
Meter Box	0.1	N/A	Meter Box
Clean out	0.1	N/A	Clean out
Manhole Rim	0.1	0.1	Manhole
Manhole Inverts	N/A	0.01	Pipe Inverts
Pump Station (Public & Private)	0.1	0.01	Wetwell and Pipe Inverts
Production Well or Monitoring Well	0.1	0.1	Well
Grease Interceptor	0.1	0.1	
Oil / Water Separators	0.1	0.1	
Demolished Pipe (abandoned in place or removed)	0.1	0.1	Limits of Abandoned or Removed Pipe
Existing Utilities water, wastewater, reclaimed water, and appurtenant structures **	0.1	0.1	Pipe or Structure
* Shall conform to the requirements of the "Chapter 5J-17, 'Minimum Technical Standards', FAC", certified by a SURVEYOR.			

Table 01050-1
Minimum Survey Accuracies

Asset	Horizontal Accuracy (feet)	Elevation Accuracy (feet)	Location: Horizontal Center and Vertical Top, unless otherwise specified
** Existing utilities including but not limited to water, wastewater, reclaimed water, stormwater, fiber optic cable, electric, gas and structures within the limits of construction.			

TABLE 01050-2

Asset Attribute Data Form Examples

Hydrants Worksheet

Microsoft Excel - Example ContractorUploadSheet 2010-0326.xls

	A	C	D	E	F	G	H	I
1	ID Number	Plan Sheet #	Easting	Northing	Elevation	Manufacturer	Model #	Comments
2	FH-1	C-7	518456.40	1483743.63	49.53	Brand B	XJ7-B	
3	FH-2	C-9	518477.68	1483758.95	54.23	Brand B	XJ7-B	

General Info | Hydrant | Valve | Manhole | Meter | Fitting | Cleanout | Pipe

Valves Worksheet

Microsoft Excel - Example ContractorUploadSheet 2010-0326.xls

	A	C	D	E	F	G	H	I	J
1	ID Number	Plan Sheet #	Easting	Northing	Elevation	Valve Type	Main Type	Valve Size	Valve Manufacture
2	ARV-1	C301	518060.09	1483231.33	81.72	ARV - Combination	Water Main	2	Brand H
3	ARV-1	C303	518083.55	1483280.50	81.15	ARV - Vacuum	Force Main	4	Brand G
4	BFP-1	C303	518086.00	1483282.88	78.21	Backflow Preventer	Reclaimed Water Main	8	Brand F
5	BO-9	C405	518088.83	1483289.43	78.20	Blowoff	Water Main	2	Brand E
6	BFV-1	C405	518088.11	1483295.00	81.95	Butterfly	Water Main	30	Brand D
7	GV-3	C405	518132.54	1483372.75	81.23	Gate	Water Main	16	Brand C
8	LS-W1	C405	576779.36	1539706.97	64.30	Line Stop	Water Main	16	Brand B
9	PV-22	C405	576880.60	1539718.32	64.52	Plug	Force Main	12	Brand A

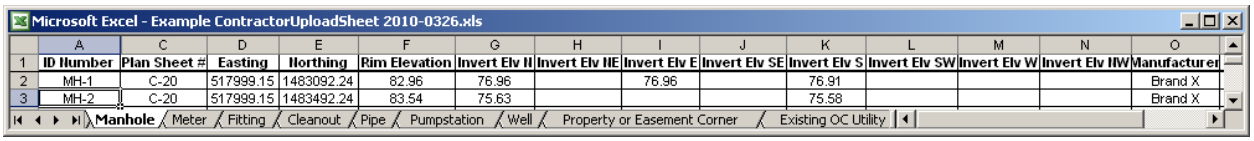
General Info | Hydrant | Valve | Manhole | Meter | Fitting | Cleanout | Pipe | Pumpstation | Well

Microsoft Excel - Example ContractorUploadSheet 2010-0326.xls

	J	K	L	M	N	O	P	Q
1	Valve Manufacturer	Valve Model #	# of Turns to Close	Gear Actuator	Gear Ratio	Side Actuator	uator Manufact	Comments
2	Brand H	100XT						
3	Brand G	1000						
4	Brand F	2000 fgs						
5	Brand E	14 turbo						
6	Brand D	230 xls	200	Yes	3 to 1	Yes	Brand C	
7	Brand C	2225846	300	Yes	3 to 1	NO		
8	Brand B	7n6r44						
9	Brand A	Z100	200	Yes	3 to 1	Yes	Brand A	

General Info | Hydrant | Valve | Manhole | Meter | Fitting | Cleanout | Pipe | Pumpstation | Well

Manhole Worksheet

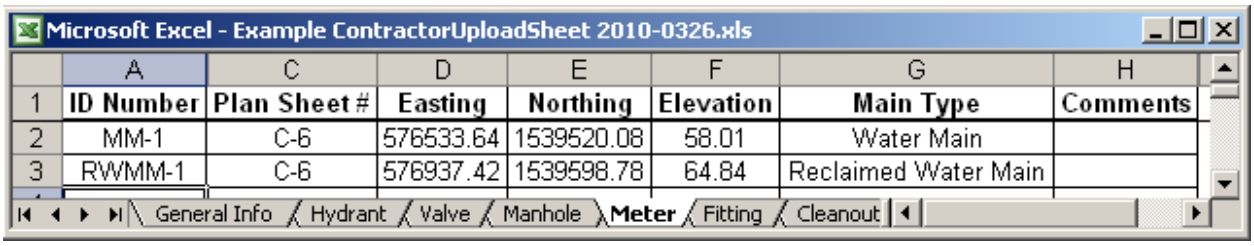


Microsoft Excel - Example ContractorUploadSheet 2010-0326.xls

	A	C	D	E	F	G	H	I	J	K	L	M	N	O
1	ID Number	Plan Sheet #	Easting	Northing	Rim Elevation	Invert Elv N	Invert Elv NE	Invert Elv E	Invert Elv SE	Invert Elv S	Invert Elv SW	Invert Elv W	Invert Elv NW	Manufacturer
2	MH-1	C-20	517999.15	1483092.24	82.96	76.96		76.96		76.91				Brand X
3	MH-2	C-20	517999.15	1483492.24	83.54	75.63				75.58				Brand X

Manhole | Meter | Fitting | Cleanout | Pipe | Pumpstation | Well | Property or Easement Corner | Existing OC Utility

Meter Worksheet

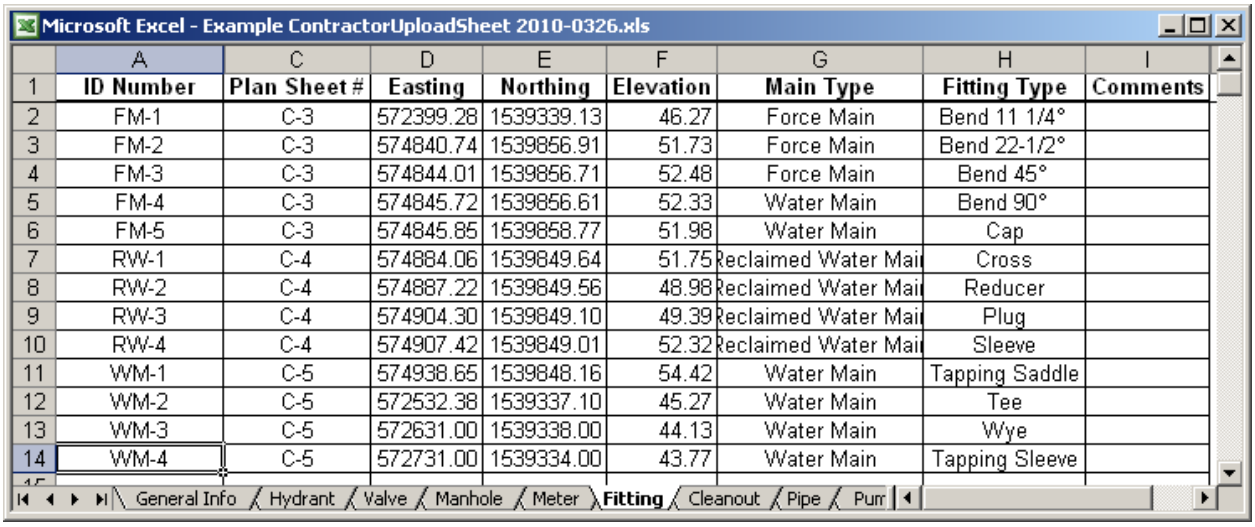


Microsoft Excel - Example ContractorUploadSheet 2010-0326.xls

	A	C	D	E	F	G	H
1	ID Number	Plan Sheet #	Easting	Northing	Elevation	Main Type	Comments
2	MM-1	C-6	576533.64	1539520.08	58.01	Water Main	
3	RWMM-1	C-6	576937.42	1539598.78	64.84	Reclaimed Water Main	

General Info | Hydrant | Valve | Manhole | Meter | Fitting | Cleanout

Fitting Worksheet

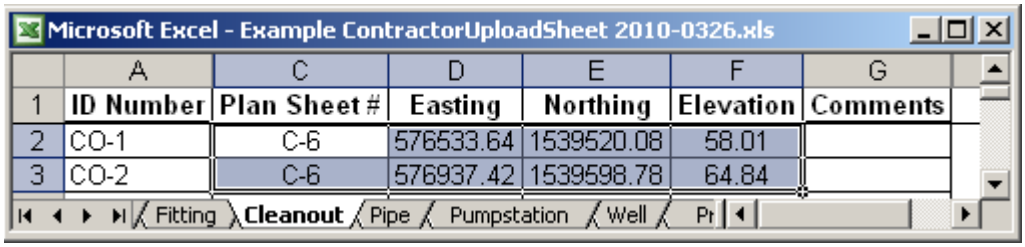


Microsoft Excel - Example ContractorUploadSheet 2010-0326.xls

	A	C	D	E	F	G	H	I
1	ID Number	Plan Sheet #	Easting	Northing	Elevation	Main Type	Fitting Type	Comments
2	FM-1	C-3	572399.28	1539339.13	46.27	Force Main	Bend 11 1/4°	
3	FM-2	C-3	574840.74	1539856.91	51.73	Force Main	Bend 22-1/2°	
4	FM-3	C-3	574844.01	1539856.71	52.48	Force Main	Bend 45°	
5	FM-4	C-3	574845.72	1539856.61	52.33	Water Main	Bend 90°	
6	FM-5	C-3	574845.85	1539858.77	51.98	Water Main	Cap	
7	RW-1	C-4	574884.06	1539849.64	51.75	Reclaimed Water Mai	Cross	
8	RW-2	C-4	574887.22	1539849.56	48.98	Reclaimed Water Mai	Reducer	
9	RW-3	C-4	574904.30	1539849.10	49.39	Reclaimed Water Mai	Plug	
10	RW-4	C-4	574907.42	1539849.01	52.32	Reclaimed Water Mai	Sleeve	
11	WM-1	C-5	574938.65	1539848.16	54.42	Water Main	Tapping Saddle	
12	WM-2	C-5	572532.38	1539337.10	45.27	Water Main	Tee	
13	WM-3	C-5	572631.00	1539338.00	44.13	Water Main	Wye	
14	WM-4	C-5	572731.00	1539334.00	43.77	Water Main	Tapping Sleeve	

General Info | Hydrant | Valve | Manhole | Meter | Fitting | Cleanout | Pipe | Pum

Cleanout Worksheet

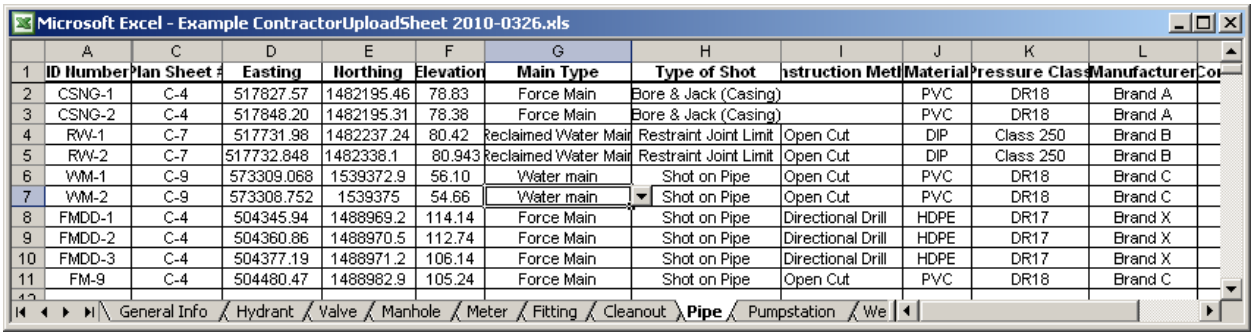


Microsoft Excel - Example ContractorUploadSheet 2010-0326.xls

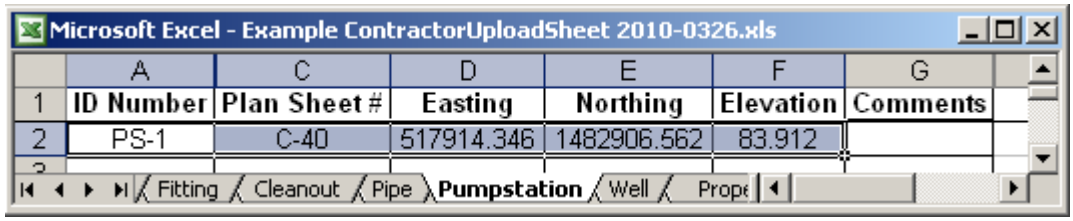
	A	C	D	E	F	G
1	ID Number	Plan Sheet #	Easting	Northing	Elevation	Comments
2	CO-1	C-6	576533.64	1539520.08	58.01	
3	CO-2	C-6	576937.42	1539598.78	64.84	

Fitting | Cleanout | Pipe | Pumpstation | Well | Pr

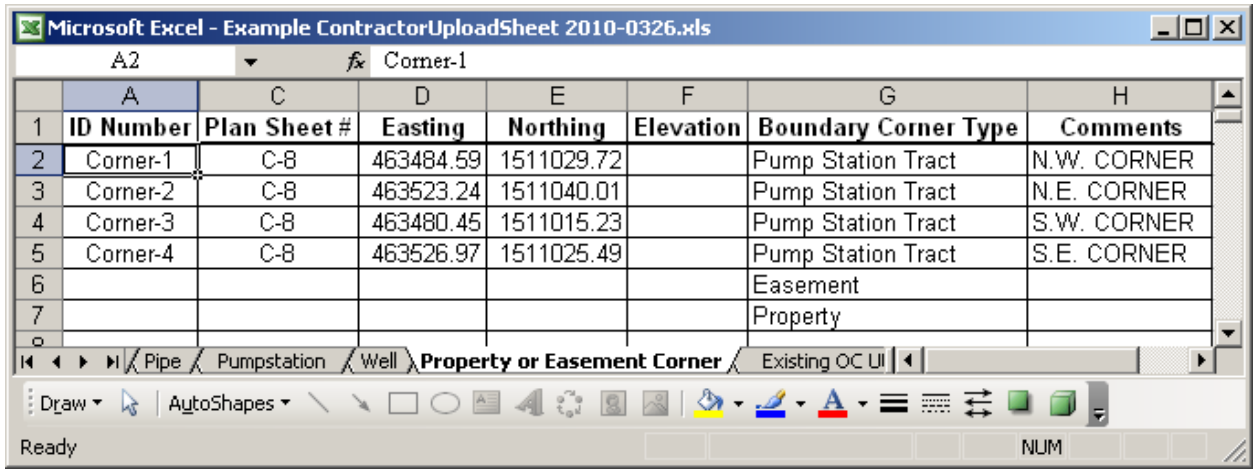
Pipes Worksheet



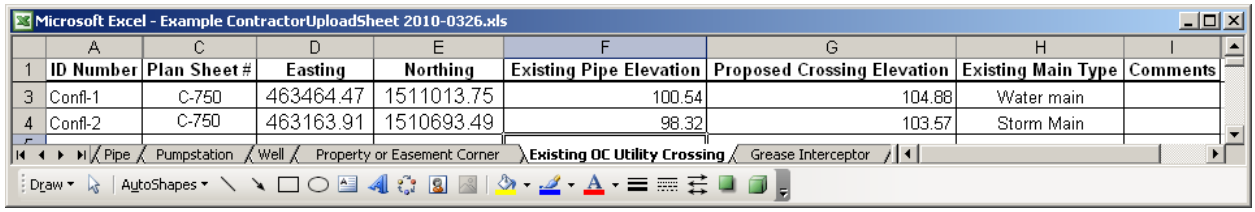
Well Worksheet



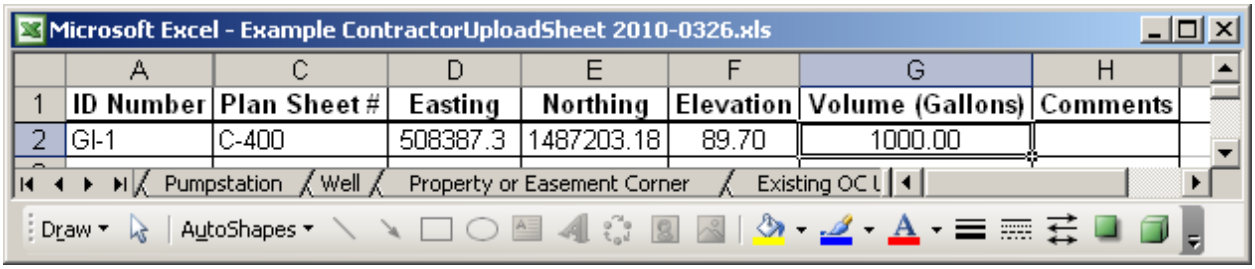
Easements Worksheet



Existing OC Utility Crossing



Grease Interceptor

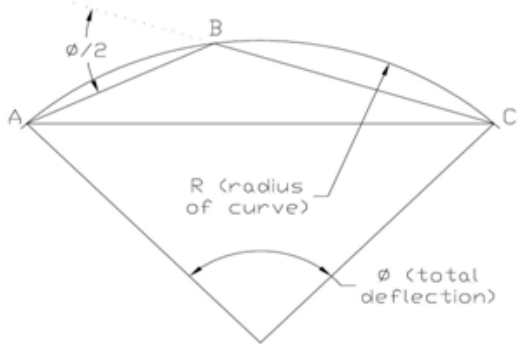


For ease of calculating pipe deflections in Table 01050-3, begin by providing a unique asset ID (top of pipe shots and fittings) for each utility and type, numbered sequentially along the pipe run (including changes in direction) from start to finish of the pipe in the Table 01050-2. Then branches and services of the same utility type can be numbered. It is recommended that each utility (water, wastewater or reclaimed water) numbering format be distinguishable from the other. This will allow organization and convenient sorting after the individual asset table worksheet tabs are combined in the spreadsheet program prior to copying and pasting to the deflection table spreadsheet.

TABLE 01050-3

PIPE DEFLECTION TABLE EXAMPLE

Project:			
Contractor:			
Progress Mtg Date:			
Contract #			
Dwg Sheet #			
Utility Type		FM	
Pipe Manufacturer		National Pipe	
Pipe size & material		16" PVC C905	
PVC Manufacturer Deflection		6	**inches**
County Allowable Deflection	75%	4.5	**inches**
Allowable Angle of Offset		1.5	**degrees**
Allowable Radius of Curvature		764	**feet**
Laying Length of Pipe		20	**feet**



ID	Size and Type	Northing	Easting	Elev.	Calculations Including Elevation (XYZ)						
					Distance between points AB	Distance between points BC	Distance between points AC	Total Deflection Ø'	Radius of Curve**	Average Offset Angle***	Average Offset****
					Length AB	Length BC	Length AC	XYZ (w/ elevation)	XYZ (w/ elevation)	per laying length	per laying length
					ft	ft	ft	degrees	ft	degrees	inches
14041	16" FM	1505131.50	468948.53	107.68	-	-	-	-	-	-	-
7000	16" FM	1505059.60	468932.08	108.15	73.76	38.93	112.66	5.48	1,178.35	0.97	4.07
2128	16" FM	1505022.11	468921.60	108.55	38.93	39.61	78.54	2.29	1,961.65	0.58	2.45
2127	16" FM	1504983.85	468911.35	108.29	39.61	38.35	77.96	1.78	2,505.50	0.46	1.92
2126	16" FM	1504946.67	468901.96	107.81	38.35	39.13	77.42	8.79	505.16	2.27	9.51
2125	16" FM	1504908.11	468895.31	107.48							

Data that has be inputted

Values in yelloware over spec

*Uses lawof cosines to determine angle ABC and Ø.
angle ABC = arccos((AB²+BC²-AC²)/(2*AB*BC))
180-Ø/2 = angle ABC
Calculate the total deflection Ø.
to the outer point (A or C) is equal in angle to
the approach from the next point along the

** Uses lawof sines, using the chord length AC and radius R.
Since sin((Ø/2)*(PI/180))=(Chord/2)/R and length AC=Chord
R=AC/(2*sin(Ø*PI/360)
This calculation assumes an average radius over the bend between three points.

*** Adds the lengths of AB + BC / 20ft to get an approximate number of bends over the span.
This value is divided by the total deflection
angle to calculate the average bend angle of
This assumes that the bend angle consistent across the entire length.

**** Uses average offset angle and laying length of pipe.

PART 3 - EXECUTION

A. Survey Field Work

1. Locate, reference, and preserve existing horizontal and vertical control points and property corners shown on the Drawings prior to starting any construction work. If the Surveyor performing the Work discovers any discrepancies that will affect the Project, the Contractor must immediately report these findings to the County. All survey work shall meet the requirements as defined in Florida Administrative Code 5J-17. Reference and preserve all survey points during Construction. If survey points are disturbed, it is the responsibility of the Contractor's Surveyor to reset the points at the Contractor's expense. Copies of the Surveyor's field notes and/or electronic files for point replacement shall be provided to the County.

   a. The Surveyor shall locate all improvements for the project As-Built Asset Attribute Data using State Plane Coordinates as the horizontal datum and the benchmark referenced on the Drawings as the vertical datum. The County will provide electronic files of the Drawings to be used by the Surveyor in complying with these specifications.

   b. The construction layout shall be established from the reference points shown or listed on the Drawings. The accuracy of any method of staking shall be the responsibility of the Contractor. All construction layout staking shall be done such as to provide for easy verification of the Work by the County.

2. Only a Surveyor licensed in the State of Florida shall be employed for this Work. All control points shall be protected by the Contractor from disturbance. If the monuments are disturbed, any Work that is governed by these monuments shall be held in abeyance until the monuments are reestablished by the Contractor and approved by the County. The accuracy of all the Contractor's stakes, alignments and grades is the responsibility of the Contractor. However, the County has the discretionary right to check the Contractor's stakes, alignments, and grades at any time.

3. Use survey control points to layout such work tasks

including but not limited to:

a. Clearing, grubbing, work limits, right-of-way lines and easements

b. Locations for pipelines and all associated structures and appurtenances

4. The Surveyor shall reference and replace any project control points, boundary corners, benchmarks, section corners, and right-of-way monuments that may be lost or destroyed, at no additional cost to the County. Establish replacement points based on the original survey control. Copies of all reference field notes and/or electronic files for point replacement shall be submitted to the County.

B. Surveying

1. Locate and protect existing horizontal and vertical control points shown on the construction Drawings prior to starting any work. If the Surveyor performing the Work finds differences that will effect the Work, the Contractor must immediately report the findings to the County. Establish control points, lines and levels by instrumentation and similar appropriate means. The location of these points should minimize the number of sightings necessary to control the Work and the likelihood of the points being disturbed. Preserve and reference all permanent reference points during Construction. If permanent reference points are disturbed, it is the responsibility of the Contractor’s Surveyor to reset the points at the Contractor’s expense. Copies of the Surveyor’s field notes shall be provided to the County.

a. Record locations, with horizontal and vertical data, on project As-Built survey.

b. Make no changes or relocations without prior written notice to the County or without receipt of written approval from the County.

c. Report to the County when any control point is lost or destroyed or requires relocation because of necessary changes in grades or locations.

2. Cover for water, reclaimed water and force mains shall vary to provide long uniform gradient or slope to pipe to minimize air pockets and air release valves. The locations shown on the Drawings for air and vacuum release valve assemblies are approximate and the Contractor shall field adjust these locations to locate these valves at the highest point in the pipeline installed.

3. To insure a uniform gradient for gravity pipe and pressure pipe, all lines shall be installed using the following control techniques as a minimum:

   a. Gravity lines: Continuous control, using laser beam technology,

   b. Pressure lines: Control stakes set at 50 ft. intervals using Surveyor’s level instrument.

C. Survey Documents

The Tables 01050-2 Asset Attribute Data, 01050-3 Pipe Deflection Table, and 01050-4 Gravity Main Table shall be signed, sealed and dated by the Surveyor with each pay request as specified in Section 01027 "Application for Payment" and the requirements of Section 01720 "Project Record Documents."

END OF SECTION

SECTION 01065 PERMITS AND FEES

A. General

The Contractor shall:

1. Obtain and pay for all permits and licenses as provided for in the General Conditions, except as otherwise provided herein.

2. Schedule all inspections and obtain all written approvals of the agencies required by the permits and licenses.

3. Comply with all conditions specified in each of the permits and licenses.

4. The Contractor shall, within 14 days of the date of the Notice-to-Proceed, prepare for and attend a meeting with representatives from the Owner and the Engineer to review requirements for preparation of a Florida Department of Environmental Protection (FDEP) Notice-of-Intent (NOI) application and Storm Water Pollution Prevention Plan (SWPPP) for compliance with the USEPA's NPDES General Permit for construction activities.

B. Permits by Contractor

Contractor shall apply and pay for at least the following permits and pay costs to keep permits active:

1. FDEP Notice of Intent to use the Generic Construction NPDES permit (See Section 02270).

2. St. John's River Water Management District Dewatering Permit. Refer to Section D below.

3. Orange County Division of Building Safety - Commercial Building Permit(s).

   a. General Commercial Building Permit – The County will pay all fees associated with the General Commercial Building Permit from the Orange County Division of Building Safety. Orange County Utilities Engineering will provide Resident Project Representatives for inspection services associated with the Utilities Engineering Division.

   b. Subtrade Commercial Building Permit(s) - The Contractor shall pay for and obtain all the Sub-trade Commercial Building Permits associated with the General Building Permit. The Contractor shall be

responsible for scheduling and paying for all inspection services associated with the Building Permit in order to obtain final approval.

c. Fire Alarm System – The Contractor is responsible for paying for and submitting fire alarm drawings signed and sealed by an electrical engineer registered in the State of Florida. These drawings shall be submitted to the Orange County Division of Building Safety within six (6) weeks of issuance of the Notice to Proceed for this project. The Contractor will be responsible for providing timely responses to any comments received from the Building Department to avoid delaying issuance of the Building Permit. The Contractor shall be responsible for scheduling and paying for all inspection services associated with the Fire Alarm System in order to obtain final approval.

d. Fence Permit - The Contractor shall pay for and obtain a permit for the chain link fence surrounding the proposed improvements

4. The Contractor shall pay for and obtain all other permits as required to perform the Work.

C. Permits by County

1. The County will apply and pay for the following permits:

a. Florida Department of Environmental Protection (FDEP) Domestic Wastewater Facility Permit.

b. Florida Department of Environmental Protection (FDEP) Environmental Resource Permit.

2. A copy of the FDEP permits obtained by the County will be furnished to the Contractor at the time when the Notice to Proceed is issued.

3. The County will pay all fees associated with the General Commercial Building Permit from the Orange County Division of Building Safety. Orange County Utilities Engineering will provide Resident Project Representatives for inspection services associated with Utilities Engineering Division. The Contractor shall pay for and obtain all the Sub-trade Commercial Building Permits associated with the General Building Permit. The Contractor shall be responsible for scheduling and paying for all inspection services associated with the Building Permit in order to obtain final approval.

D. Dewatering Activities

If dewatering is required, the Contractor shall coordinate with the St. John’s River Water Management District regarding the applicable rules and regulations. If a dewatering permit is required, the Contractor shall prepare an application to the District and pay any fee.

END OF SECTION

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SECTION 01200 PROJECT MEETINGS

A. Preconstruction Conference

Pursuant to Article 5 of the General Conditions, a pre-construction conference will be held to discuss submittals as indicated in Section 01300 of this division and the Contractor’s responsibilities described in the General Conditions.

B. Monthly Progress Meetings

On days as mutually agreed upon in the pre-construction conference, monthly progress meetings shall be held at the County's office or Contractor's project office to review the progress of the work and required submittals.

C. Field Meetings

At strategic times during the construction process, as specified in the standard specifications and other locations in the Contract Documents, field inspection meetings shall be requested by the Contractor. Contractor shall coordinate such field inspection meetings as to fulfill requirements of these documents prior to the approval of progress pay requests for such items. The Contractor shall document the decisions and directives administered during Field Meetings within the Contractor’s Daily logs.

D. Project Close-Out Meeting

A project close-out meeting shall be held to finalize and secure the requirements as specified in Section 01700 of this division.

E. Attendance

The Contractor's relations with his subcontractors and material suppliers and discussions relative thereto are the Contractor's responsibility as described in the General Conditions and are not part of the project meetings content. Persons designated by the Contractor to attend and participate in project meetings shall have all required authority to commit the Contractor to solutions as agreed upon in the project meetings.

F. Minutes of Progress Meetings

The Engineer will compile a report of each progress meeting and will distribute copies to the Owner and the Contractor. The Contractor shall make and distribute other copies as necessary to subcontractors.

END OF SECTION

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SECTION 01300 SUBMITTALS

A. General

1. This section includes the submissions of shop drawings, samples, operation and maintenance manuals and record drawings. There are other requirements in the Contract documents for submittals that are not addressed herein.

2. The submittal shall contain a copy of the pertinent specification Section(s) respective to that submittal, 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, 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.

3. Accompanying a copy of the pertinent specification Section(s) as noted in Part A.2, the submittal shall contain a copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

4. Submittals shall be identified per the respective specification Sections which the elements are specified

within, e.g. 15100-001A for Manual, Check and Process Valves.

5. The Contractor shall group all elements specified within a respective specification Section into a singular submittal per that specification Section. For certain specification Sections with a large volume of content, the Contractor may provide no more than three (3) submittals for inclusive content within a singular specification Section.

6. Shop drawings and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will be performed at times convenient to the Engineer and at the Contractor's expense, based on the Engineer's then prevailing rates. The Contractor shall reimburse the Owner for all such fees invoiced to the Owner by the Engineer. Submittals are required until accepted. Any need for more than one (1) resubmission, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the Contract Time.

7. Partial submittals will not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor and will be considered "Not Accepted" until resubmitted. The Engineer may at his option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.

8. Identify submittals with the name of the project, date, and accompany each lot submitted with a letter of transmittal referring to the name of the project, the specification page number, and/or drawing number, and tag number for identification for each item. Submittals for each type of work shall be numbered per specification consecutively, and the numbering system shall be retained throughout all revisions.

9. In all submittals and schedules, allow 30 days for the Engineer's review of each shop drawing submittal or resubmittal.

10. Resubmittals will be handled in the same manner as first submittals. On resubmittals, the Contractor shall identify all revisions made to the submittals, either in writing on the letter of transmittal or on the shop drawing by use of revision triangles or other similar methods. The resubmittal shall clearly respond to each comment made by the Engineer on the previous submission. Additionally, the Contractor shall direct specific

attention to any revisions made other than the corrections requested by the Engineer on previous submissions.

B. Shop Drawings

1. Prepare shop drawings in accordance with Article 9 of the General Conditions and send to the Project Manager carriage prepaid. Submit shop drawings and product data for all materials and equipment to be incorporated into the Work.

2. The term "shop drawing" as used herein includes fabrication, erection and installation, layout, and setting drawings, manufacturer's drawings, descriptive literature, catalogs and brochures, performance and test data, mix design, wiring and control diagrams, all other drawings and descriptive data pertaining to materials, equipment, piping, duct and conduit systems, and methods of construction as may be required to show that the materials, equipment or systems, and the positions thereof conform to the Contract requirements. As used herein, the term "manufactured" applies to standard units usually mass-produced; and "fabricated" means items specifically assembled or made out of selected materials to meet individual design requirements.

3. Shop Drawings shall be prepared and submitted with identification per specification section wherein the elements are specified, e.g. 15100-001A for Manual, Check, and Process Valves.

4. Multiple shop drawings shall not be submitted for individual respective elements within a single specification section. One shop drawing shall be prepared per specification section in order to encompass all elements within that specification. For large specification sections, a group of no greater than three shop drawings shall be prepared for those sections.

5. Shop drawings shall establish the actual detail of all manufactured or fabricated items, indicate proper relation of adjoining work, amplify design details of mechanical and electrical equipment in proper relation to physical spaces in the structure, and incorporate minor changes of design or construction to suit actual conditions. Shop drawings shall be drawn to scale and shall be completely dimensioned.

6. If shop drawings cover more than one piece of equipment or components, the shop drawing shall show the entire

assembly and the relationship and connections between all components.

7. Supply short and long term storage procedures on all equipment submitted.

8. Coordinate the shop drawings from different manufacturers and supplies so that all equipment and material will fit and work together.

9. The contract drawings are diagrammatic and are intended to indicate general arrangement of equipment, ducts, conduits, piping, and fixtures. The Contractor shall be fully responsible for observing the need for and making any changes in the arrangement of piping, connections, wiring, manner of installation, etc., which may be required by the materials/equipment he proposes to supply both as pertains to his own work and any work affected under other parts, headings, or divisions of drawings and specifications. Changes shall be reviewed in advance by the Engineer.

10. Shop drawings, including manufacturer's literature, catalog cuts, or other printed material shall be entitled with the name of the project on each sheet and shall otherwise be identified by listing the particular Division, Section, Article, or reference of the work pertaining thereto. Differing items shall not be submitted on the same sheet. For acceptance of differing items, any deviations shall be highlighted and annotated.

C. Samples

Submit physical examples to illustrate materials, equipment, or workmanship and to establish standards by which work is to be evaluated.

D. Equipment Operation and Maintenance Manuals

1. Provide installation, operation, and maintenance manuals from manufacturers and suppliers. Submit three (3) hard copies and one (1) electronic copy of manuals to the Project Manager within 30 days after review of shop drawings, product data, and samples and not later than the date of shipment of each item of equipment to the project site. Electronic copies shall be submitted in "PDF" format.

2. Provide manuals for each piece of equipment including individual components and subsystems of complete assemblies. Line out all non-applicable text and

illustrations. The section of the manual on operation shall describe the functions and limitations of each component and its relationship to the system of which it is a part. Where several models, options, or styles are described, the manual shall identify the items actually provided.

3. The manual shall contain the following:

   a. Manufacturer's identification, including order number, model, and serial number.

   b. Blue line prints or reviewed shop drawings and diagrams of all systems, including temperature control system.

   c. Certified equipment drawings or reviewed shop drawing data clearly marked for equipment furnished.

   d. Complete operating and maintenance instructions for each and every items of equipment, setting forth in detail and step-by-step the procedure for starting, stopping, operating and maintaining the entire system as installed. A schedule of recommended maintenance intervals shall also be included.

   e. Complete parts list of all replaceable parts, their part numbers, and the name and address of their nearest vendor.

   f. A complete valve tag list including the name and function of the pipe in which the valve is mounted.

   g. Any special emergency operating instruction and a list of service organizations (including addresses and telephone numbers) capable of rendering emergency service to the various parts of the system.

   h. All manufacturer's equipment guarantees and warranties.

4. Brochures shall be loose leaf with durable plastic or fiberboard covers. Each sheet shall be reinforced to prevent tearing from continued use, and each brochure shall have the following information clearly printed on its cover:

   a. Project name, name of County and address.

   b. Name and address of Engineers.

c. Name and addresses of Contractors and subcontractors and department to contact.

d. Telephone number of contractors, including night and emergency numbers.

e. Major equipment vendors' names and telephone numbers.

5. In addition to these written instructions, fully and carefully instruct the County or his selected representatives as to the proper care and maintenance of each system and its equipment, and provide signed statements from personnel receiving such instructions to the Engineer.

6. Submit complete manuals at least two weeks before the date of the instruction.

7. Operation and maintenance manuals specified herein are in addition to any operation, maintenance, or installation instructions required by the Contractor to install, test, and start up equipment.

E. Phase V Operation and Maintenance Manual

1. The Contractor is required to retain an Engineer that is licensed in the State of Florida in order to prepare an Operations and Maintenance Manual for the new Phase V Improvements. The Operations and Maintenance Manual shall meet the requirements and criteria noted within Rule 62-620 FAC and for preparation of Form 62-620.910(13) for the Notice of Availability of Record Drawings and Final Operations and Maintenance Manuals. The Engineer shall prepare a draft O&M Manual that will be submitted to Orange County Utilities for final review and acceptance.

F. Compilation of Manufacturer’s Warranties & Certification Letters

1. The Contractor shall provide and compile all documentation and pertinent information regarding all warranties on the Phase V Improvements into compilation notebook(s). The warranties shall be collated in a series of notebooks that shall be indexed by equipment tag number, unit processes and/or other pertinent organizational method as directed by Orange County Utilities. The notebooks shall include a singular table which shall document the commencement and expiration dates of all warranties on the project. The table shall be electronically transmitted to Orange County Utilities

in MS Excel format. The information shall be formatted in a manner, as directed by the Orange County Utilities EWRF Operations staff, for input and incorporation into the County's Maximo Asset Management software. The warranties shall be accompanied by the manufacturer's certification letters that are supplied to the County for each respective piece of equipment furnished. The letters provide certification from the manufacturer that the equipment was properly installed in accordance with the contract documents, manufacturer's requirements and is operating properly at commencement of service. The letters shall be provided in the same divider as the warranty information.

G. Maximo Asset Management Software – Equipment Data

1. The Contractor shall prepare an MS Excel based spreadsheet in a format as provided or directed by the Orange County Utilities EWRF Operations staff, for pertinent specification data from all equipment furnished within the Project for input into the County's Maximo Asset Management software.

END OF SECTION

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SECTION 01310 PROGRESS SCHEDULES

PART 1 GENERAL

A. Requirement

1. The Contractor will submit precedence method cost-loaded Critical Path Method (CPM) Progress Schedules to the Project Manager depicting the approach to prosecution and completion of the Work. This requirement includes, but is not limited to the Contractor's approach to Activity cost-loading, recovering schedule and managing the effect of changes, substitutions and Delays on Work sequencing.

2. The Progress Schedule shall show how the Contractor's priorities and sequencing for the Work (or Work remaining) conform to the Contract requirements and the sequences of Work indicated in or required by the Contract Documents; reflect how the Contractor anticipates foreseeable events, site conditions and all other general, local and prevailing conditions that may affect cost, progress, schedule, furnishing and performance of the Work; and show how the Contractor's Means and Methods translate into Activities and logic.

3. The Progress Schedule will consist of the Initial Submittal, Payment Submittals and Revision Submittals. Upon acceptance by the Project Manager, the Initial submittal will become the As-Planned Schedule for the Work. Revision submittals upon acceptance will become the As-Planned Schedule for the Work remaining to be completed as of the submittal date for that Revision.

4. References to the Critical Path Method (CPM) are to CPM construction industry standards that are consistent with the requirements of this Section.

B. Glossary Of Terms

1. The following terms, whether or not already defined elsewhere in the Contract Documents, have the following intent and meanings within this Section:

   a. Activity Value (Value) – That portion of the Contract Price representing an appropriate level of payment for the part of the Work designated by the Activity.

   b. As-Planned Schedule – The first, complete Initial Progress Schedule submitted by the Contractor with the intent to depict the entire Work as awarded and

accepted by the Project Manager or returned as no resubmittal required.

c. Contract Float – Days between the Contractors anticipated date for completion of the Work, or of a specified portion of the Work, if any, and the corresponding Contract Time.

d. CPM Schedule – The Progress Schedule based on the Critical Path Method (CPM) of scheduling. The term Critical Path means any continuous sequence of Activities in the Progress Schedule controlling, because of their sum duration, the Early Date of a pertinent, specified Contract Time.

e. Early/Late Dates – Early/late times of performance, based on CPM calculations, for an Activity in the Progress Schedule. Early Dates will be based on proceeding with all or part of the Work on the date when the corresponding Contract Time commences to run. Late Dates will be based on completing all or part of the Work on the corresponding Contract Time, even if the Contractor plans early completion.

f. Milestones – Key, pre-determined points of progress in the completion of a facility, denoting interim targets in support of the Contract Times. Milestones may pinpoint targets for key excavation and substructure events, significant deliveries, critical path transition from superstructure to piping and electrical rough–in and building enclosure. Also, hook–up of mechanical and electrical equipment, availability of power for testing, equipment shakedown, training of County personnel, start–up, Substantial Completion and other events of like import.

g. Official Schedule – The Initial or most recent Revision Submittal accepted by the Project Manager or returned as no resubmittal required and the basis for Payment Submittals until another Revision Submittal is submitted and accepted. The accepted Initial Submittal is also the As-Planned Schedule.

h. Payment Submittal – A monthly Progress Schedule update reflecting progress and minor adjustments on the Activities, sequencing and restraints for Work remaining.

i. Total Float – Days by which an activity may slip from its Early Dates without necessarily extending a pertinent Contract Time. Total Float at least equals Contract Float. Total Float may also be calculated and reported in working Days. When an activity is delayed beyond Early Dates by its Total Float it becomes a Critical Path activity and if delayed further will impact a Contract Time.

C. Quality Assurance

1. The Contractor may self-perform the Work covered by this Section or employ a Subcontractor, subject to the Project Manager's consent. Employment of a scheduling Subcontractor shall not in any way alter or reduce the Contractor's obligations under the Contract Documents.

2. The Contractor will obtain a written interpretation from the Project Manager, if the Contractor believes that the selection of activities, logic ties and/or restraints requires a written interpretation of the Contract Documents. With each submission, the Contractor will point out by specific, written notation, any Progress Schedule feature that may reflect variations from any requirements of the Contract Documents.

3. It is the Contractor's responsibility to obtain information directly from each Subcontractor and Supplier when scoping their respective Activities, Values, logic ties and restraints.

4. Neither Acceptance nor Review of any Progress Schedule will relieve the Contractor from the obligation to comply with the Contract Times and any sequence of Work indicated in or required by the Contract Documents and to complete, within the Contract Times, any Work omitted from that Progress Schedule.

5. Neither Acceptance nor Review of any Progress Schedule will imply approval of any interpretation of or variation from the Contract Documents, unless expressly approved by the Project Manager through a written interpretation or by a separate, written notation on the returned Progress Schedule Submittal.

D. Allowances

1. Work covered by contractual allowances will be completed within the Contract Times. The Progress Schedule will incorporate the Contractor's best estimate of the activities, logic and restraints required, using the

information in the Contract Documents or as indicated by the Project Manager in writing.

E. "Or Equals" And Substitutions

1. Activities in the Initial Submittal will be based strictly on the products named or specified in the Contract Documents and will not reflect any "or equal" or substitute materials or equipment, even if the Contractor intends to pursue "or equal" and substitution proposals. This limitation also applies to Means and Methods indicated in or required by the Contract Documents.

F. Milestones And Schedule Recovery

1. The Project Manager will select Milestones and Milestone Dates on the basis of the As-Planned Schedule. As the Official Schedule is revised, Milestone Dates will be revised accordingly. Milestone Dates will serve as target dates.

2. Whenever any Activity slips by fourteen (14) or more Days from the Late Date for an activity in the Official Schedule, Milestone Dates selected by the Project Manger, or a pertinent Contract Time, the Contractor will deliver a Revision Submittal documenting the Contractor's schedule recovery plan and/or a properly supported request for an extension in the Contract Time. The narrative will identify the Delay and actions taken by the Contractor to recover schedule, whether by adding labor, Subcontractors or construction equipment, activity re-sequencing, expediting of submittals and/or deliveries, overtime or shift Work, and so forth. Activity shortening and overlapping shall be explained as to their basis (and be supported by increases in resources).

3. Upon evaluation of that Revision Submittal, if the Project Manager determines there is sufficient cause, the County may withhold liquidated damages or provide a notice of intent to do so, if schedule is indeed not recovered, and/or may give a notice of default.

G. Progress Schedule Software

1. The scheduling software employed by the Contractor to process the Progress Schedule will be the current version of Primavera P6® or Primavera® Contractor CPM scheduling software, no other software shall be allowed.

2. If the Contractor intends to use companion schedule reporting, analysis or graphics software tools, the Contractor will furnish to the Project Manager descriptive materials and samples describing such software tools.

H. Non-Performance

1. The Project Manager may refuse to recommend all or any part of any payment, if the Contractor fails, refuses or neglects to provide the required Progress Schedule information on a timely basis. Partial payments without a properly updated Progress Schedule shall be returned to the Contractor as non-conforming.

2. If justified under the circumstances, the Owner also may prepare alternate Progress Schedules, as appropriate, and deduct from the Contract Amount all related costs by Change Order and/or take other action commensurate with the breach

I. Reports, Schedules And Plots

1. Schedule Reports will include Activity (ID) code and description, duration, calendar, Early Dates, Late Dates and Total Float. Separate Schedule Reports will tabulate, for each Activity, all preceding and succeeding logic types and lead times, whether CPM Plots displaying logic ties are appended or not.

2. CPM Schedule Plots will be plotted on a suitable time scale and identify the Contract Times, Critical Paths, phases and work areas on 24"x 36" or smaller sheets. Activities will be shown on the Early Dates with Total Floats noted by Late Date flags. For Payment and Revision Submittals plot a target comparison based on the current Official Schedule.

3. The Activity Value report will tabulate Activity code and description and Activity Value, percent complete and earned value as calculated by the scheduling software. Cash flow plots shall be provided showing the monthly and cumulative actual and planned earned values with curves shown for Early and Late Dates in the schedules. For Payment and Revision Schedule submittals, the cash flow curves shall also plot the most current Official Schedule planned earnings curves.

4. Each submittal shall include listings of all added and deleted activities, logic, constraints, Activity Value changes and update information vs. the previous Progress Schedule submittal. This list may be manually prepared or generated by accessory software that will generate such listings.

J. Narrative Requirements

1. The Initial Submittal narrative will describe the Contractor’s approach to prosecution of the Work and the

basis for determination of activity durations, sequence and logic, including the Contractor's management of the site, e.g., lay down, staging, parking, etc.; Contractor's phasing of the Work; use of crewing and construction equipment; identification of non-work Project Managers, shifts, weekend Work and multiple calendars applied to activities and an explanation of the basis for restraint dates

2. Revision and Payment Submittal narratives will explain any changes to the approach or planning referred to in Paragraph A above on account of any change, delay, schedule recovery, substitution and/or Contractor-initiated revision occurring since the previous submittal.

3. Each narrative will list the Critical Path Activities and compare Early and Late Dates against Contract Times and Milestone Dates. Narratives shall also recap progress and Days gained or lost vs. the current Official Schedule, and identify delays, their extent and causes.

4. The Initial Submittal narrative will describe all delays occurring since Contract Award and all pending and anticipated "or equal" and substitution proposals. Payment and Revision Submittals narratives will describe any new delays and shall certify that the Contractor has not been delayed, as of the cut-off date, by any acts or omissions of the County or Project Manager, except as otherwise specifically stated.

K. Activity Requirements

1. Separate activities will identify permits, design when included in the Work, construction, Submittal preparation and review (and resubmission and re-review), deliveries (site or storage), testing, start-up, commissioning and Punch List. Separate Activities will be used for County-furnished equipment, interfaces with other work and other responsibilities of the County, Project Manager and Professional.

2. Activities will be detailed to the extent required to show the transition of trade Work. Activities will delineate the progression of the Work through mass excavation, substructure, superstructure, equipment installation, start of piping and conduit rough-in, building enclosure, mechanical and electrical equipment hook–up phase, building mechanical, electrical and plumbing (MEP), interior finishes, training of County personnel, equipment checkout & testing and start–up.

3. Submittal Activities will segregate long-lead items, any item requiring structural access and other procurements that, in the Contractor's judgment, may bear on the rate of progress. If the Contract Documents require MEP coordination drawings, separate MEP coordination drawing Activities will be used for each floor. Allow time for reviews per Section 01300 and the General Conditions, and revisions and re-submittals. Also include activities for or provide a separate tabular schedule of submittal dates for all shop drawings, product data, and samples including County furnished products and the dates reviewed submittals will be required from the Project Manager. Indicate decision dates for selection of finishes.

4. Activities will not combine separate or non-concurrent items of Unit Price or lump sum Work, Work in separate structures and Work in distinct areas, locations or floors within an area or structure; or rough-in and finish Work.

5. Activity durations will equal the work Days required to sufficiently complete the Work designated by the Activity, (i.e., when finish-to-start successors could start, even if the Activity is not quite 100% complete). Installation Activities will last from ten (10) to forty (40) workdays. Submittal review activity durations shall conform to specified timeframes.

6. Activities will be assigned consistent descriptions and identification codes. Sort codes will group Activities by building or structure, floor or area, Change Order and other meaningful schemes.

7. Activities will be assigned Activity Values as appropriate and needed to reasonably allocate the Contract Amount to the time periods that they will be earned and eligible for payment based on the Progress Schedule and Schedule of Values. Separate pay activities may be used to simplify cost-loading of the Progress Schedule. When used, pay activities shall be loaded with the cost of Work that is included, at no cost, in related (generally, concurrent) CPM activities. Pay activities shall not control the rate of progress; however, their start and finish dates shall be consistent with those of their related CPM activities to ensure accurate Early Date and Late Date cash-flow plots.

L. Float Tolerances And Float Ownership

1. Any Progress Schedule with Early Dates after a Contract Time will yield negative Total and Contract Floats, whether shown/calculated or not. Any Revision Submittal with less than negative twenty (20) Days of Float will be

returned as “Revise and Resubmit,” unless a time extension is requested or the County assesses liquidated damages or gives notice of intent to do so, in the event schedule is not recovered.

2. Float calculated from the definitions given in this Section supersede any conflicting Float values in any early completion Progress Schedule.

3. Neither the County nor the Contractor own the Float time, the Project owns the Float time. Neither the County nor the Contractor use of positive Total Float will impact a Contract Completion Date or justify an extension of Contract Time.

M. Submittals

1. Each Progress Schedule Submittal will consist of a narrative, five (5) copies of the required reports and plots and an optical ROM data disk with the Contractor's corresponding schedule and schedule layout files in Primavera “.XER” format.

2. The Project Manager will review Progress Schedule Submittals and return a review copy within 14 Days after receipt and the Contractor shall, if required, resubmit within 7 Days after return of the review copy.

3. Requirements for a Preliminary Submittal:

   a. Within twenty (20) Days after receipt of Notice to Proceed and prior to commencing Work on the Project, prepare and submit to the Project Manager a Preliminary Submittal of the Progress Schedule for the Work. The Preliminary Submittal will show the Work as awarded, without delays, Change Orders or substitutions. The Preliminary Submittal shall be in CPM format and show general work planning and sequencing for the entire Contract Time and detailed planning for the first 90 days after Notice to Proceed.

   b. No cost or resource loading of activities is required for the Preliminary Submittal. The Project Manager may issue comments on the Preliminary Submittal. A narrative should be included if needed to clarify planning and sequencing represented in the Preliminary Submittal. Any comments issued should be considered and incorporated as appropriate in the development of the full Progress Schedule Initial Submittal.

4. Requirements for the Initial Submittal:

a. Within forty-five (45) Days after receipt of Notice to Proceed and prior to commencing Work on the Project, prepare and submit to the Project Manager the Initial Submittal of the Progress Schedule for the Work. The Initial Submittal will show the Work as awarded, without delays, Change Orders or substitutions.

(1) Activity Values will prorate Schedule of Values costs and/or pay items through to Activities. Provide a cross-reference listing with two parts; a part that will list each activity with the respective amounts allocated from each Schedule of Values and Unit Price Item making up the total value of each activity and a second part that will list the Schedule of Values and Unit Price Items with the respective amounts allocated from each activity that make up the total value of each item.

b. After the As-Planned Schedule is established, the Project Manager will select Milestones and record the Milestone Early and Late Dates. As the Official Schedule evolves, Milestone Dates will be revised accordingly.

c. If the Project Manager refuses to endorse the Initial Submittal (or a resubmission) as "Resubmittal Not Required," the As-Planned Schedule will not be established. In that event, the Contractor will continue to submit Payment and Revision Submittals reflecting progress and the Contractor's approach to remaining Work. The Project Manager will rely on the available Payment and Revision Submittals, subject to whatever adjustments it determines appropriate.

5. Requirements for Payment Submittals:

a. Payment Submittals with progress up to the closing date and updated Early Dates and Late Dates for progress and remaining Activities will be due with each Progress Payment. As-built data will consist of actual dates, percent complete, earned payment, changes, Delays and other significant events occurring before the closing date.

b. Activity percent complete and earned value should indicate a level of completion that corresponds to the Application for Progress Payment for the same period. The earned value should be calculated by the scheduling software as Activity Value time’s percent complete. Explanation should be provided whenever the cumulative earned value of activities in a Payment

Submittal is not within 10% of the value of work completed as represented in the corresponding Application for Progress for Payment.

c. At the Contractor’s option, a Payment Submittal may overlay minor adjustments on activities and sequencing for Work remaining. This excludes Activity re-scoping to reflect Delays, changes, schedule recovery or substitutions.

6. Requirements for Revision Submittals:

a. Revision Submittals will be submitted when necessary because of major changes or delays affecting activities, sequencing or restraints for Work remaining and/or to put forth a schedule recovery plan. Revision Submittals may also be required because of Contractor-initiated re-planning, or when Contractor plans to perform Work ahead or out-of-sequence that will require additional testing or inspection personnel, or when requested by the Project Manger when Work is performed out-of-sequence from the current Official Schedule such that the number of Days gained or lost can not be determined or the scheduled dates of completion of the Work in a Payment Submittal are not viewed as reliable.

b. If requesting a time extension, the Revision Submittal should show the impact of the delay after incorporating reasonable mitigation to minimize the impact and illustrate how the number of Days requested time extension was determined. The delay should be determined as the change in the forecast Contract Completion Date(s) resulting solely from delays that entitle the Contractor to a time extension as provided in the General Conditions. Any and all Contractor slippage and delay occurring prior to and concurrent with the delay potentially entitling the Contractor to a time extension shall be incorporated in the Revision and explained such that the concurrent and non-concurrent periods of delay are indicated. If the Contractor does not follow the procedures contained in this Section or, if the Contractor's analysis is not verifiable by an independent, objective evaluation by the Project Manager using the electronic files and data furnished by the Contractor, any such extension in Contract Time will not be granted.

7. Retrospective Delay Analysis.

a. If the Project Manager refuses to endorse any Revision Submittal as “Resubmittal Not Required,” the

Contractor and County will use the latest Official Schedule when evaluating the effect of Delays on Contract Time and/or Contract Price. The procedure to be used will consist of progressively updating the latest Official Schedule at key closing dates corresponding to starting and finishing dates of the delays and/or dates the delays became critical or dates the Critical Path may have changed for other reasons. For each Progress Schedule iteration, slippage between actual Milestone Dates and Initial Milestone Dates will be correlated to Delays occurring solely in that iteration.

b. For each iteration, revisions in Activities, logic ties and restraints affecting Work after the closing date will be included in that Progress Schedule only if they meet any of the following conditions. First, they are Progress Schedule revisions that the Project Manager consented to contemporaneously (i.e., before the closing date) in writing. Second, they reflect comments or objections raised by or on behalf of the Project Manager and that were actually confirmed by the as-built progress. Lastly, they represent Contractor’s schedule recovery plans or other Progress Schedule revisions that were actually confirmed by the as-built progress.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

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SECTION 01323 SCHEDULE OF VALUES

A. Preliminary Schedule of Values

The preliminary schedule of values listing shall include, at a minimum, the proposed value for the following major work components:

1. General Requirements/Mobilization/Demobilization. General Requirement Mobilization/Demobilization costs on the Schedule of Values shall not exceed 5% of the total Contract Amount. All Work included in the Schedule of Value that falls under this heading as described in this paragraph (including such Work by Subcontractors) will be added and checked for compliance with the 5% limitation. Any actual cost in excess of this amount shall be distributed proportionately to Schedule of Values items for direct Work items not covered by this heading. Work under this heading may be detailed on Schedule of Value line items identifying each as to whether it is mobilization or initial costs, maintenance or overhead cost or finalization or demobilization cost. The subdivision of this Work into Schedule of Values line items shall be done to support the payment process that shall be distributed as follows: 50% for the first progress payment, 10% for the final payment following demobilization and restoration, and 40% spread evenly over payments made in between.

2. The total value of miscellaneous site improvements inclusive of clearing and grubbing, stripping, excavation, fill construction, paving, road removal, site restoration, and all incidental work associated with miscellaneous site improvements. This total value shall be itemized into separate values for each item.

3. The total value of yard piping construction work inclusive of fabrication, excavation, pipe installation, pipe structures (air-release valves, blowoff valves, and vents), backfilling, testing, site restoration, and all incidental work associated with yard piping construction. The total value shall be broken down into separate values for each pipe section.

4. The total value of reinforced concrete work by structure and building inclusive of all excavation, dewatering, subgrade preparation, backfill, and incidental work for all new structures. Additionally, this total value shall be broken down into separate values for each new

structure constructed as a part of the work. Miscellaneous and minor concrete work may be listed as one item in this breakdown.

5. The total value of all mechanical work (HVAC and plumbing), including piping, valves, and equipment.

6. The total value of process piping, valves, and mechanical equipment (such as pumps).

7. The total value of electrical work.

8. The total value of instrumentation and control work including fiber-optic cable system.

9. Record Drawings/Operations and Maintenance (O&M) Manuals/Warranty and Certification Documentation. A minimum of 0.5% of the total Contract Amount shall be included within the Schedule of Values for the Contractor's preparation of Record Drawings, Operations and Maintenance Manuals and the Warranty and Certification Documentation.

10. The total value of all other work not specifically included in the above items.

11. The Contractor and Engineer shall meet and jointly review the preliminary schedule of values and make any adjustments in value allocations if, in the opinion of the Engineer, these are necessary to establish fair and reasonable allocation of values for the major work components. Front-end loading will not be permitted. The Engineer may require reallocation of major work components from items in the above listing if, in the opinion of the Engineer, such reallocation is necessary. This review and any necessary revisions shall be completed within 15 days from the date of the notification of the required reallocation.

B. Detailed Schedule of Values

1. Base the detailed schedule of values on the accepted preliminary schedule of values for major work components. Because the ultimate requirement is to develop a detailed schedule of values sufficient to determine appropriate monthly progress payment amounts through cost loading of the CPM schedule activities, provide sufficient detailed breakdown to meet this requirement. Provide breakdown of line item quantities when applicable: cubic yards, linear feet, pounds, etc.

The Engineer shall be the sole judge of acceptable numbers, details, and description of values established. If, in the opinion of the Engineer, a greater number of schedule of values items than proposed by the Contractor is necessary, the Contractor shall add the additional items so identified by the Engineer as a condition to processing the payment requests.

2. At a minimum the schedule of values shall be separated by unit process area and/or by building and the following general work elements. The minimum detail of breakdown of the major work components is indicated below.

   a. General Requirements/Mobilization/Demobilization. General Requirement Mobilization/Demobilization costs on the Schedule of Values shall not exceed 5% of the total Contract Amount. All Work included in the Schedule of Value that falls under this heading as described in this paragraph (including such Work by Subcontractors) will be added and checked for compliance with the 5% limitation. Any actual cost in excess of this amount shall be distributed proportionately to Schedule of Values items for direct Work items not covered by this heading. Work under this heading may be detailed on Schedule of Value line items identifying each as to whether it is mobilization or initial costs, maintenance or overhead cost or finalization or demobilization cost. The subdivision of this Work into Schedule of Values line items shall be done to support the payment process that shall be distributed as follows: 50% for the first progress payment, 10% for the final payment following demobilization and restoration, and 40% spread evenly over payments made in between.

   b. Miscellaneous site construction shall be broken down by clearing and grubbing, stripping, excavation, full construction, erosion control, paving, paving removal, site restoration, and any other items determined to be necessary for the establishment of pay and schedule activity items.

   c. Yard piping construction work shall be broken down separately by pipeline segment, which shall not exceed 500-foot-long sections of the pipeline. Each pipeline segment shall be broken down into excavation, pipe fabrication (by wall thickness),

pipe installation, pipe structures (air-release valves, blowoff valves, and vents), backfilling, testing, site restoration, and any other items determined to be necessary for the establishment of pay and schedule activity items.

d. Concrete structures and buildings shall be broken down by structure into excavation, subgrade preparation, and appurtenant prefoundation work; concrete foundation construction; slabs on grade; walls/columns; miscellaneous metalwork; and backfill.

e. Mechanical (HVAC and plumbing) work shall be broken down to identify individual piping and ductwork and equipment installation and equipment testing.

f. Piping, valve, and equipment work shall be broken down to identify individual piping systems, equipment installation by equipment (including valves, actuators, etc.), name and number, and equipment testing and checkout.

g. Electrical work shall be broken down by structure into conduit and raceway installation, cable and wire installation, electrical equipment installation, terminations, and lighting. Yard facilities shall be broken down by duct bank designation and substations.

h. Instrumentation and control work shall be broken down by pull boxes, duct, fiber-optic cable, and installation and testing.

i. Equipment testing and start-up broken down for completion milestones and substantial completions for each.

3. Other work not specifically included in the above items shall be broken down as necessary for establishment of pay and schedule activity items.

4. The Contractor, Engineer, and Resident Project Representative shall meet and jointly review the detailed schedule of values within 40 days from the date of Notice to Proceed. The value allocations and extent of detail shall be reviewed to determine any necessary adjustments to the values and to determine if sufficient detail has been proposed to provide cost loading of the CPM schedule activities. Make any adjustments deemed

necessary to the value allocation or level of detail, and submit a revised detailed schedule of values within 10 days from the date of the review meeting.

5. Following acceptance of the detailed schedule of values, incorporate the values into the cost loading portion of the CPM schedule. The CPM activities and logic shall have been developed concurrent with development of the detailed schedule of values; however, it shall be necessary to adjust the detailed schedule of values to correlate to individual schedule activities. It is anticipated that instances will occur, due to the independent but simultaneous development of the schedule of values and the CPM schedule activities, where interfacing these two documents will require changes to each document. Schedule activities may need to be added to accommodate the detail of the schedule of values. Schedule of value items may need to be added to accommodate the detail of the CPM schedule activities. Where such instances arise, the Contractor shall propose changes to the schedule of values and to the CPM schedule activities to satisfy the CPM schedule cost loading requirements.

C. Incorporation of Schedule of Values into CPM Schedule

1. In conjunction with each submittal of the construction schedule, submit a cash flow projection indicating estimated earnings by month during the entire contract period and a schedule of values of the work using the "Schedule of Values" described above, including quantities and prices. The aggregate of these extended prices shall equal the contract price. Costs shall include all materials, labor, equipment, and appurtenant items necessary to accomplish the work in accordance with the contract documents. This schedule shall be satisfactory in form and substance to the Engineer and shall subdivide the work into the specified component parts. Upon review by the Engineer, incorporate the schedule into the form for Application for Payment. The Owner reserves the right to delete (or add) items of work from the contract and the total contract amount shall be reduced (or increased) by the total amount shown in the schedule of values.

2. Develop the schedule of values (lump-sum price breakdown) and incorporate into the cost loading function of the CPM schedule. Determine monthly progress payment amounts from the monthly progress updates of the

CPM schedule activities. Develop the schedule of values independent but simultaneous with the development of the CPM schedule activities and logic.

D. Cross-Reference Listing

1. To assist in the correlation of the schedule of values and the CPM schedule, provide a cross-reference listing, furnished in two parts. The first part shall list each scheduled activity with the breakdown of the respective valued items making up the total cost of the activity. The second part shall list the valued item with the respective scheduled activity or activities that make up the total cost indicated. In the case where a number of schedule items make up the total cost for a valued item (shown in the schedule of values), the total cost for each scheduled item should be indicated.

2. Update and submit these listings in conjunction with each CPM monthly submittal.

3. Incorporate executed change orders reflected in the CPM schedule into the schedule of values as a single unit identified by the change order number.

E. Changes to Schedule of Values

1. Changes to the CPM schedule which add activities not included in the original schedule but are included in the original work (schedule omissions) shall have values assigned as reviewed by the Engineer. Other activity values shall be reduced to provide equal value adjustment increases for added activities as approved by the Engineer.

2. In the event that the Contractor and Engineer agree to make adjustments to the original schedule of values because of inequities discovered in the original accepted detailed schedule of values, increases and equal decreases to values for activities may be made.

END OF SECTION

SECTION 01333 PRODUCT CODE COMPLIANCE CERTIFICATION

A. Description

This section describes the product code certification that the Florida Building Code (FBC) requires for certain items within the building envelope.

B. Code Compliance

1. Provide FBC product approval documentation for the following items in the project:

   a. Styrene-Butadiene-Styrene (SBS) Modified Bituminous Membrane Roofing: 07552.

   b. Manufactured Roof Specialties: 07710.

   c. Steel Doors and Frames: 08110.

   d. Overhead Coiling Doors: 08331.

   e. Door Hardware (Exterior Doors Only): 08710.

   f. FRP Sandwich Panels: 08952

   g. Grit Removal, Washing, and Dewatering Systems: 11320

   h. Mechanically Cleaned Fine Screens and Appurtenances (Band Type): 11328

   i. Biotrickling Filter: 11530

   j. Prefabricated Metal Building: 13121.

   k. Louvers and Ventilation Equipment as specified within the Drawings

2. If the products being proposed are changed between the submittal for the building permit and the shop drawing, document these changes with the building code authority having jurisdiction and document the reason for the change with the Owner’s Representative.

END OF SECTION

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SECTION 01380 CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

A. Quality Assurance

1. Aerial Photographer: Qualified as a commercial photographer, engaged as a professional in business for a period of not less than three years. Electronic ground level photos do not require a professional photographer.

2. Site photos may be submitted digitally as photographed by the Contractor.

B. Submittals

1. Submit sample photographs, aerial vantage points, monthly vantage points, file structure, etc…

2. Submit a proof of the final completion aerial.

PART 2 - PRODUCTS

A. Monthly Progress Photos – Digital

1. The Contractor may furnish monthly progress photos in digital format from typical monthly vantage points and site locations as mutually agreed upon with the County R.P.R.

2. Format and resolution shall be as mutually agreed upon with the County R.P.R.

3. Provide monthly photos within a CD or DVD. Furnish a file index that lists photo number or file name and description of view per respective date, unit process and/or vantage point within a file structure as mutually agreed upon with the County R.P.R.

B. Aerial Prints

1. Full color.

2. Finish: Matte finish.

3. Minimum Size: 15 inches x 21 inches.

4. Paper Weight: Single.

5. Mounting: In plastic sheets in loose leaf, three ring binders.

6. Provide a CD with electronic photo files. Furnish a file index that lists photo number or file name and description of view.

C. Aerials

1. Provide monthly aerials containing at least four (4) views of project site.

   a. At final completion, provide three (3) 24″ X 36″ framed aerials showing the progression sequencing of monthly aerials with the centered final aerial of one of the selected views. Include the respective logos of the Owner, Contractor and Engineer.

   b. The proof of the final completion aerial shall be submitted to the Owner and Engineer for review.

D. Identification:

1. Digital photographs shall be categorized and saved based upon the date which they were photographed.

2. Under the main folder in which the photographs were taken, photos are to be organized into categorized subfolders based upon unit process number, specific construction activity, recurring vantage point(s), or other means necessary to properly index them in coordination with respective areas of the Work.

PART 3 - EXECUTION

A. Technique

1. Factual presentation.

2. Correct exposure and focus.

   a. High resolution and sharpness

   b. Maximum depth-of-field

   c. Minimum distortion

B. Pre-Construction Photographs

See Section 01500.

C. Views Required

1. Consult with Engineer for instructions concerning views required at each specified visit to site. At a minimum provide four (4) views of each Process area included within the Work.

2. Photograph from locations to adequately illustrate state of project, or condition of construction.

3. Take photographs from as close to the same position for each period as practical.

4. Take a series of ground level photographs for each area under construction during the photographic visit, areas of construction completion from previous months “under construction views” and undisturbed areas where Contractor anticipates construction during the one month period prior to the next scheduled photographic visit.

5. Schedule and conduct photographic visits during the first work day of each month.

6. In addition, provide and conduct up to seven (7) additional photographic visits prior to, at critical stages of, and at the end of construction, when they do not coincide with scheduled photographic visit days. The timing of these additional photographic visits shall be subject to the prior approval of the Owner or Engineer.

D. Delivery of Prints

1. Deliver three (3) DVDs or CDs containing the copies of the monthly progress photos to accompany each request for progress payment.

2. If the submitted photographs do not meet the requirements of this section, submit another series within one week.

END OF SECTION

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SECTION 01390 COLOR AUDIO-VIDEO CONSTRUCTION RECORDS

PART 1 - GENERAL

A. Scope

1. Prior to commencing work on the Project and after Final Completion of the Project, the CONTRACTOR shall provide a continuous color audio-video DVD recording of the entire construction area of the Project to serve as a record of the site's pre- and post-construction conditions. The entire length shall be defined as the entrances to the EWRF plant that are to be traveled by vehicles of the Contractor, subcontractors, suppliers, work areas, staging areas, etc. The CONTRACTOR shall submit one (1) copy of the pre-construction DVD to the ENGINEER prior to construction for approval. A copy of the pre-construction DVD shall be kept at the site by the CONTRACTOR until completion of the Project. As a condition of Final Completion, the CONTRACTOR shall have a continuous color-video DVD recording taken of the entire site to serve as a record of post-construction conditions and shall submit one (1) copy to the ENGINEER and two (2) copies to the COUNTY prior to the submittal of the Final Payment Application.

B. Approval

1. The DVD recording shall be made less than six (6) weeks prior to commencement of construction. The COUNTY and ENGINEER shall have the County to reject all or any portion of a DVD not conforming to this specification and require that it be redone at no additional cost to the COUNTY. The CONTRACTOR shall reschedule unacceptable coverage within five (5) days after being notified. All tapes and written records shall be well-maintained without any damage and shall become property of COUNTY. All videotaping shall be done in the presence of a COUNTY representative of the ENGINEER and who will designate areas to be covered by the DVD. The CONTRACTOR shall provide the COUNTY with a minimum of 48-hrs notice prior to filming. The COUNTY shall have the authority all or any portion of a DVD not conforming to specifications and order that it be redone at no additional charge to the COUNTY.

C. Professional Electrographers(Videographers)

1. The CONTRACTOR shall engage the services of a professional electrographer. The color audio-video tape recordings shall be prepared by a responsible commercial firm known to be skilled and regularly engaged in the business of preconstruction color audio-video DVD documentation. The electrographer through the CONTRACTOR shall furnish to the ENGINEER a list of all equipment to be used for the audio-video taping, i.e., supplier's (manufacturer's) name, model number, specifications and other pertinent information. Additional information to be furnished to the ENGINEER by the electrographer through the CONTRACTOR shall include the names and addresses of two (2) references for which the electrographer has performed color audio-video taping on projects of a similar nature within the last twelve (12) months.

PART 2 - PRODUCTS

A. General

1. The total audio-video recording system and the procedures employed in its use shall be such as to produce a finished product that will fulfill the technical requirements of the Project. The video portion of the recording shall produce bright, sharp, and clear pictures with accurate colors and shall be free from distortion, tearing, rolls, and any other form of picture imperfection. All video recordings shall, by electronic means, display on the screen the time of day, the month, day, and year of the recording. This date and time information shall be continuously and simultaneously generated with the actual recording. The audio portion of the recording shall produce the commentary of the camera operator with proper volume, clarity, and be free from distortion.

2. The recording system shall utilize AIA Standard Video and NTSC compatible color (American TV Standard).

PART 3 - EXECUTION

A. Equipment

1. Camera: the color video camera used in the recording system shall be of Industrial Grade and shall have EIA

standard NTSC type color – 1.0v 75 ohms. Video output from the camera(s) shall be capable of a horizontal resolution of 350 lines at center and utilize a minimum of 8:1 zoom with 2/3" Newvicon tube or CCD pick-up element for optimum color imagery plus minimum lag through one foot candle (10 LUX).

2. Recorder: the recording shall be made with an industrial grade DVD recorder. The recorder shall record the signal with a minimum horizontal resolution of 525 lines, 60 fields; NTSC color signal; RF modulated 72db. The construction documentation shall be recorded in SP mode.

3. Digital Video Disc: the DVDs used for the recordings shall be the 4.7GB industry standard dics.

4. DVD playback compatibility: the recorded DVD's shall be compatible for playback with any American TV standard DVD player.

B. Recorded Information – Video

1. All video recordings shall contain coverage of all surface features located within the construction zone of influence and shall include but not be limited to: all designated easements staking, all roadways, pavements, detention ponds, ditches, walls, railroad tracks, curbs, driveways, sidewalks, culverts, headwalls, retaining walls, treatment structures, pipe systems, pump stations, buildings, landscaping, trees, shrubbery, fences and CONTRACTOR staging areas. Of particular concern shall be pre-existing faults, fractures, or defects with existing infrastructure noted. Taped coverage shall be limited to one side of the site, street, easement or right of way at any one time. Tape coverage shall include all surface conditions located within the zone of influence of construction supported by appropriate audio description including the location relative to construction stations. Panning, zoom-in and zoom-out rates shall be sufficiently controlled to maintain a clear view of the object.

2. All video recordings shall, by electronic means, display continuously and simultaneously generated with the actual taping transparent digital information to include the date and time of recording and coordinate locations as shown on the Drawings. The date information shall contain the month, day and year. The time information shall contain the hour, minutes, and seconds. Additional

information shall be displayed periodically. Such information shall include, but not be limited to. Project Name, direction of travel and location. This transparent information shall appear on the extreme upper left hand third of the screen.

C. Recorded Information – Audio

1. Accompanying the video recording shall be a corresponding and simultaneously recorded audio recording. Each tape shall begin with the recording date and project name and COUNTY'S Project Number and be followed by the general location, i.e., structure or process. The audio track shall consist of an original live recording. The recording shall contain exclusively the narrative commentary of the electrographer, recorded simultaneously with the video record of the zone of influence of construction. The recording shall assist in viewer orientation and in any needed identification, differentiation, clarification, or objective description of the features being shown in the video portion of the recording, including location relative to construction stations. The audio recording shall be free from any conversations between the camera operator and any other production technicians.

2. The COUNTY and ENGINEER reserve the right to supplement the audio portion of the taping as deemed necessary.

D. DVD Indexing

1. DVD identification: All DVDs shall be permanently labeled and shall be properly identified by DVD number and Project Name.

2. DVD logs: Each DVD shall have a log of that DVD's contents. The log shall describe the various segments of coverage contained on that DVD in terms of the names of the streets or easements, coverage beginning and end, directions of coverage, video unit counter numbers, engineering station numbers, and date.

3. DVD index: The CONTRACTOR shall provide an index listing, in order by DVD number, each DVD, including DVD number and a brief description of coverage contained on that DVD, including engineering station numbers.

E. Time of Execution

1. All recording shall be performed during times of good visibility. No recording shall be done during period of significant precipitation, mist, or fog. The recording shall only be done when sufficient sunlight is present to properly illuminate the subject, and to produce bright, sharp video recordings of those subjects. No taping shall be performed when more than 10% of the area to be taped contains debris or obstructions unless otherwise authorized by the ENGINEER.

F. Continuity of Coverage

1. In order to increase the continuity of the coverage, the coverage shall consist of a single, continuous, unedited recording which begins at one end of a particular construction area and proceeds uninterrupted to the other end of the construction area. Such coverage shall consist of an organized, interrelated sequence of recordings at various positions within that proposed construction area (e.g., high service pump station). Such coverage shall be obtained by walking or special approval by the Engineer.

G. Camera Operation

1. Camera Height and Stability: If conventional wheeled vehicles are used as conveyances for the recording system, the vertical distance between the camera lens and the ground shall not exceed ten (10) feet. The camera shall be firmly mounted such that transport of the camera during the recording process will not cause an unsteady picture.

2. Camera Control: Camera pan, tilt, zoom-in, and zoom-out rates shall be sufficiently controlled such that recorded objects will be clearly viewed during DVD playback. In addition, all other camera and recording system controls such as lens focus and aperture, video level, pedestal, chroma, white balance, and electrical focus shall be properly controlled or adjusted to maximize picture quality.

3. Viewer Orientation Techniques: The audio and video portions of the recording shall maintain viewer orientation. In easements where the proposed construction location will not be readily apparent to the DVD viewer, highly visible yellow flags shall be

placed by the CONTRACTOR in such a fashion as to clearly indicate the proposed centerline of construction.

4. Electrographer Experience: The electrographer in charge shall have had previous experience with audio-video documenting preconstruction work.

H. DVD Viewer

The CONTRACTOR shall make available for use by the COUNTY and ENGINEER, at the site, one (1) DVD viewer system. The system shall be provided as requested by the ENGINEER, for the duration of the Project and be made available for on-site viewing until Final Completion. The system shall consist of the following components:

1. DVD Player: The DVD player shall be capable of playback standard DVD(s) as hereinafter specified and shall be powered by a standard 120 volt, 60 HZ service. Player features shall include resettable digital counter, and 10-foot uhf coaxial output connecting cable for connection to any conventional TV set. The player shall consist of a videocassette player/recorder or similar type as used for recording with corresponding digital counter number sequence so as to be compatible with the documentation. It shall be capable of speed search, clear still frame and frame-by-frame advance.

2. TV receiver: TV receiver shall be a color American TV Standard VHP 2-13 channel coverage. It shall have a viewing area, diagonally measured, of no less than fourteen (14) inches and shall have direct video and audio input. The cables for the video and audio connections shall also be supplied.

END OF SECTION

SECTION 01400 WEB BASED PROJECT CONTROLS SYSTEM

PART 1 GENERAL

A. Project Controls

The Project Controls on this project shall be performed through the use of web-based project controls software. In fulfilling this requirement the Contractor shall provide the following:

1. Utilization of Version 12.1 or the latest version of Primavera Contract Manager web-based software hosted and managed on the Orange County Utilities server. No other software shall be acceptable. The intended users on the individual license shall include the Owner (three (3) users), Construction Consultant (one user), Engineer (two (2) users), and Contractor (two (2) users). The software, owner's manuals, concurrent licensing and database shall be owned and retained by the County. If the Contractor requires additional users, additional user licenses shall be provided to the County by the Contractor at no cost to the County and those additional licenses may be retained by the Contractor at project final completion.

2. The Contractor shall access the Orange County Utilities server through the use of computer(s) provided by the contractor. The computer(s) shall be located at the EWRF Contractor's Temporary Field Offices and shall be dedicated to the sole use of Contract Manager. These computers will be put in service by the Orange County IT Department and shall be loaded with the appropriate Orange County parameters, software, Firewalls, etc. as needed, Computers shall be accessible at anytime throughout the entire duration of the project by the Orange County IT Department.

   The Contractor shall be responsible to install a single Mode Fiber Optic cable exterior and Multi-Mode interior, from the existing North Electrical Building to the Temporary Contractor's Field Offices. The Temporary Contractor's office is expected to be

located in general vicinity of Clarifier #11 and the Owner’s Field Office west of the Reclaimed Water Pumping Facility located approximately 3000-feet west of Clarifier #10, if a different location is desired and/or available, the contractor shall remain responsible for all that is necessary to provide the connections of the Temporary Contractor’s Field Offices.

3. All project correspondence and documentation including but not limited to Requests for information, Notices, Change Orders / Change Management, noncompliance notices, Notice of claims, requests for clarification, updates, meeting minutes, shop drawing transmittals, shop drawings in PDF format, shop drawing comments, letters, memo’s, etc. shall be created and managed in Primavera Contract Manager. **The use of emails as project correspondence and documentation is unacceptable and shall be considered to be noncompliance with this specification**.

4. Contractor shall attend a minimum one day joint training session for the Owner, owner construction consultant, Engineer and Contractor, for all components of the software in the manner detailed in Part 3.A of this specification.

5. Statement of capability and cooperation - The Contractor shall have the capability of preparing and utilizing the specified document control software, critical path scheduling techniques and specified software packages. A statement of capability shall be submitted in writing to the Engineer with the return of the executed Agreement to the Owner and will verify that either the Contractor’s organization has in-house capability qualified to use the technique or that the Contractor employs a consultant who is so qualified. The statement shall include the name of the individual on the Contractor's staff or qualified Consultant who will be responsible for the use of Primavera Contract Manager and associated reports and for providing the required updating information of same. The Contractor shall also submit a statement of cooperation with the specifications, including the elimination of emails as a form of communication on the specified project as well as acknowledgment that all documentation shall be created and maintained in Contract Manager.

B. Submittals

1. Provide a statement of Capability and Cooperation per Part 1.A.

2. Provide a digital list of all Contract Manager requested user's, contact information (first name, last name, middle initial, address, company name, email address, phone, title, etc.) and provide a list all companies or persons (Company, contact name, email address) that may be receiving direct correspondence out of Contract Manager.

PART 2 PRODUCTS

A. Web-based Project Controls Software

Primavera Contract Manager 12.1 or latest edition. Software. Collaboration by all parties on a single project database storing all project documentation during construction and through project final completion.

PART 3 EXECUTION

A. Requirements for Operation of Contract Manager

The Contractor, Owner and Engineer shall use the following functions of the Contract Manager Software:

1. Project Information Modules

a. Companies – All contact information for parties involved in this project will be entered by the County. Contractor shall provide a digital list of all contact information (Full Name with middle initial, Company Name, address, phone number, cell phone, email address, title, etc).

b. Issues – Issues shall be created as necessary to monitor potential problems on the project. Issues shall be assigned from items in requests for information, meeting minutes, or independently generated items. The project team shall be responsible for entering data and maintaining this list.

2. Communication Modules

a. Transmittal – All transmittals between the Contractor, Owner and Engineer shall be generated in the Contract Management software including but not limited to shop drawing transmittal cover letters, submittals and other project related packages or documentation.

b. Requests for Information - All requests for information shall be generated and performed through Contract Manager. Requests for Information shall be performed completely electronically. All requests shall be complete. If necessary, the Contractor shall attach electronic attachments of all sketches, photographs or other documentation as necessary to provide full details of the issue or concern. References to all pertinent details, drawings, schedule activities, and issues shall be noted in each request for information. All project participants shall be responsible for electronic updates for their action items. Contractor shall submit all RFI's with a ball in court (BIC) to the Engineer. The Engineer shall provide a response and submit the RFI with a ball in court to the County. RFI's shall not be considered answered and shall not be acted upon by the Contractor until the County has officially CLOSED the RFI.

c. Notices – All notices be performed in this module. Notices shall be comprised of all documentation previously written in the form of letters, memo's, emails, test requests, Notice of claim, general correspondence, clarification, schedule update, bulletin, etc. and shall be created in Contract Manager with the appropriate attachments as required.

d. Notices of Non-compliance – All notices of non-compliance shall be generated and performed through Contract Manager. Both the original notice from the Owner/Engineer and the proposed corrective action by the Contractor shall be completed in web-based software. Owner/Engineer shall submit all notices of non compliance with a ball in court (BIC) to the Contractor. The Contractor shall provide a response and submit the NCN with a ball in court to the Engineer. NCN's

shall not be considered answered and shall not be acted upon by the Contractor until the County has officially CLOSED the NCN.

e. Meeting Minutes – All meetings shall be documented in Contract Manager.

Business Items and Attendees will be documented, and attachments will be attached as appropriate. Recurring meetings shall be generated using delivered functionality within Contract Manager, and will be updated by the meeting organizer. Logs presented at the meetings including but not limited to Shop drawing logs, RFI logs, Change Order Logs, Test Request & Results logs, and correspondence logs shall be generated from Contract Manager, dispersed and attached to the meeting minutes module. Logs shall be downloaded as of the date of the meeting to provide the most current status of all logs.

3. Contract Information Modules

a. Change Management – Change Management shall be used to organize all related documents for each change to scope of work, schedule, or budget.

Related documents shall be linked via Issues and included in the CPM schedule. Estimates, proposals, and final change orders shall be linked as Attachments. The contractor shall input data and maintain this module.

The Change Management process shall only be initiated from a request for information in the RFI module.

b. Payment Requisition – The Contractor shall utilize the Payment Requisition module for the purpose of inputting the monthly pay applications into Contract Manager for the project record as well as for the required approval of the “pencil copy” or preliminary submittal for approval by the County inspector prior to submitting each month’s printed copy through normal means.

4. Logs Modules

   a. Submittal Packages – Submittals will be combined into Submittal Packages as appropriate, when workflow is similar and using Packages increase efficiency.

   b. Submittals – Contract Manager shall be used to create all transmittals between the Engineer, Owner and Contractor for all submittals. The printed copy of the submittals will be transmitted through normal means.

      Contractor shall enter a complete list of all known submittals for the project at the start of the project. Submittals shall include required by dates so that all parties are aware of upcoming submittals, and will use industry standard specification codes to categorize the submittals and shall be included in the Primavera CPM schedule. Contractor shall provide and attach a digital copy of the shop drawing submittal including all revisions, in PDF format for a complete project record and access for all users. However, only hard copy shop drawings submittals shall be reviewed and approved by the Engineer.

   c. Contractor Daily Reports – Daily Reports shall be inputted daily through Contract Manager by the Contractor. Daily Reports shall be complete and include electronic attachments, photographs, or other documentation as appropriate. Daily Reports shall be documented in accordance with the Standard Specifications for the project.

5. Other

   a. Correspondence Sent – All correspondence sent shall be logged within Contract Manager by the originating party in the appropriate module.

      Documents generated within Contract Manager shall be recorded via delivered functionality within Contract Manager. Documents generated external to Contract Manager shall be kept to an absolute minimum and shall be manually added to appropriate contract manager module. Digitally Attach

applicable documents as appropriate to Contract Manager.

b. Correspondence Received – All correspondence received from outside parties pertinent to the project shall be logged within Contract Manager by the receiving party. Receipt of submittals or other documents that originated out of Contract Manager shall be recorded by the contractor via delivered functionality within Contract Manager in the appropriate module. Digitally Attach applicable documents as appropriate to Contract Manager.

END OF SECTION

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SECTION 01420 GENERAL ABBREVIATIONS

PART 1 - GENERAL

A. General

Interpret abbreviations used on the drawings and in the specifications as tabulated below. If an abbreviation on a drawing is not explained below, it shall be as explained in ANSI Y1.1. The interpretation of abbreviations shall consider the context or discipline in which they are used, for example:

1. FF usually means "finish floor" when referring to a floor slab.

2. FF usually means "flat face" when referring to a pipe flange.

B. List of General Abbreviations

Abbreviation	**Term**
A	
A	Ampere/Area
AA	Aluminum Association
AABC	Associated Air Balance Council
AADF	Annual Average Daily Flow
AAMA	Architectural Aluminum Manufacturer's Association
AAS	Airport Advisory Service
AASHTO	American Association of State Highway and Transportation Officials
AB	Anchor Bolt/Aggregate Base
ABAN	Abandoned
ABC	Asphalt Base Course
ABT	About
AC	Acre/Asphaltic Concrete/Alternating Current/Air Conditioning
ACCU	Air Cooled Condensing Unit
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute

Abbreviation	Term
ACP	Asbestos-Cement Pipe
ACU	Air Conditioning Unit
AD	Access Door
ADDL	Additional
AE	Architect-Engineer
AF	Air Filter/Ampere Frame
AFB	Air Force Base
AFBMA	Anti-Friction Bearing Manufacturer's Association
AGA	American Gas Association
AGMA	American Gear Manufacturer's Association
AHD	Ahead
AHU	Air Handling Unit
AI	The Asphalt Institute
AIA	American Institute of Architects
AICS	Amperes Interrupting Capacity, Symmetrical
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AL	Aluminum
ALIGN	Alignment
ALM	Alarm
ALTN	Alternate
AMB	Ambient
AMCA	Air Movement and Control Association
AMP	Ampere
ANCH	Anchor
ANG	Angle
ANSI	American National Standards Institute
API	American Petroleum Institute
APPROX	Approximate
APWA	American Public Works Association
ARCH	Architecture/Architectural
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ARV	Air-Release Valve

Abbreviation	Term
ARVV	Air-Release/Vacuum Valve
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPH	Asphalt
ASSY	Assembly
ASTM	American Society of Testing and Materials
ATS	Automatic Transfer Switch
AVE	Avenue
AVG	Average
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWPB	American Wood Preservers Bureau
AWS	American Welding Society
AWWA	American Water Works Association
B	
BB	Back-to-Back
BC	Beginning of Curve/Back of Curve/Bolt Circle
BCR	Begin Curb Return
BEG	Begin
BETW	Between
BF	Blind Flange
BFV	Butter Fly Valve
BHP	Brake Horsepower
BK	Back/Brake
BKR	Breaker
BL	Base Line
BLDG	Building
BLK	Block
BM	Bench Mark/Beam
BO	Blowoff
BOCA	Building Officials Code Administration International, Inc.
BOD	Biochemical Oxygen Demand
BOT	Bottom

Abbreviation	Term
BP	Baseplate
BR	Bronze/Branch
BRG	Bearing
BTN	Button
BTU	British Thermal Unit
BUR CBL	Buried Cable
BVC	Begin Vertical Curve
BW	Block Wall
C	
C	Conduit/Celsius
CAB	Crushed Aggregate Base
CANTIL	Cantilevered
CAP	Capacity
C.A.R.	Construction Assistance Request
CATV	Cable Television
CB	Catch Basin/Circuit Breaker
CC	Cooling Coil
C-C	Center-to-Center
CCB	Concrete Block
CCP	Concrete Cylinder Pipe
CCS	Central Control Station
CCT	Chlorine Contact Tank
CD	Cross Drain/Condensate Drain/Ceiling Diffuser
CEM	Cement
CF	Cubic Feet/Curb Face
CFH	Cubic Feet Per Hour
CFM	Cubic Feet Per Minute
CFS	Cubic Feet Per Second
CG	Ceiling Grill
C & G	Curb and Gutter
CH	Chiller
CHG	Change
CHKD PL	Checkered Plate
CI	Cast Iron
CIP	Cast in Place/Cast-Iron Pipe

Abbreviation	Term
CISP	Cast Iron Soil Pipe
CISPI	Cast-Iron Soil Pipe Institute
CJ	Construction Joint
CL	Centerline/Class/Clearance
CLR	Clear
CMAA	Crane Manufacturer's Association of America
CMC	Cement-Mortar Coated or Coating
CML	Cement-Mortar Lined or Lining
CMLCSP	Cement-Mortar Lined and Coated Steel Pipe
CMP	Corrugated Metal Pipe
CMPA	Corrugated Metal Pipe Arch
CMU	Concrete Masonry Unit
CO	Cleanout/Conduit Only
COL	Column
COMM	Communication
COMP	Composite
COMPL	Complete
CONC	Concrete
CONN	Connection
CONST	Construct or Construction
CONT	Continuous
CONTR	Contractor
COORD	Coordinate/Coordinated
COP	Copper
COR	Corner
CPLG	Coupling
CPU	Central Processing Unit
CRES	Corrosion Resistant Steel
CRSI	Concrete Reinforcing Steel Institute
CS	Carbon Steel/Commercial Standard
CSP	Corrugated Steel Pipe
CT	Center Top/Current Transformer
CTG	Coating
CTR	Center
CTV	Cable Television

Abbreviation	Term
CULV	Culvert
CU YD, CY	Cubic Yard
CYL	Cylinder
D	
D	Degree of Curvature
DB	Direct Buried/Decibel
DBL	Double
DC	Direct Current
DEPT	Department
DET	Detail/Detour
DG	Decomposed Granite
DI	Drop Inlet/Ductile Iron
DIA	Diameter
DIAG	Diagonal
DIM	Dimension
DIMJ	Ductile-Iron Mechanical Joint
DIP	Ductile-Iron Pipe
DIPRA	Ductile-Iron Pipe Research Association
DISCH	Discharge
DIST	Distance
DIV	Divide/Division
DO	Dissolved Oxygen
DMH	Drop Manhole
DN	Down
DP	Differential Pressure
DPI	Differential Pressure Indicator
DPNL	Distribution Panel
DR	Drain/Door
DSL	Diesel
DWG	Drawing
DWY	Driveway
E	
E	East
EA	Each
EC	End of Curve

Abbreviation	Term
ECC	Eccentric
ECR	End of Curb Return
ED	External Distance
EDUC	Eductor
EE	Each End
EF	Each Face/Exhaust Fan
EFF	Efficiency
EFL	Effluent
EG	Exhaust Grill
EGL	Energy Grade Line
EL	Elevation/Each Layer
E/L	Easement Line
ELEC	Electric
ELEV	Elevation
ELP	Elliptical
EMB	Embankment
ENC	Encasement
ENCL	Enclosure
ENG	Engine
ENGR	Engineer
EOP	Edge of Pavement
EOS	Equivalent Opening Size
EOTW	Edge of Traveled Way
EP	Explosion Proof/Edge of Pavement
EPA	Environmental Protection Agency (Federal)
EPS	Effluent Pump Station
EQ	Equation
EQL	Equal
ESMT	Easement
EST	Estimate or Estimated
ETC	And so Forth
ETM	Elapsed Time Meter
EVAP	Evaporator
EVC	End Vertical Curve
EW	Each Way

Abbreviation	Term
EWC	Electric Water Cooler
EWRF	Eastern Water Reclamation Facility
EXC	Excavate or Excavation
EXP	Expansion
EXST	Existing
EXT	Exterior/Extension
F	
F	Fahrenheit/Floor
FAA	Federal Aviation Administration
FAB	Fabricate
FBC	Florida Building Code
FBRBD	Fiberboard
FC	Foot-Candle
FCC	Filter Control Console
FCO	Floor Cleanout
FCV	Flow Control Valve
FD	Floor Drain
FDEP	Florida Department of Environmental Protection
FDN	Foundation
FDOT	Florida Department of Transportation
FE	Flanged End
FF	Finished Floor/Flat Face
FG	Finished Grade
FHY	Fire Hydrant
F&I	Furnish and Install
FIG	Figure
FIN	Final
FIT	Fitting
FL	Floor/Flow Line
FLEX	Flexible/Flexure
FLG	Flange
FLT	Float
FLUOR	Fluorescent
FM	Force Main/Factory Mutual
FMH	Flexible Metal Hose

Abbreviation	Term
FNSH	Finish
FOC	Face of Concrete
FOS	Face of Stud
FPC	Flexible Pipe Coupling
FPM	Feet Per Minute
FPS	Feet Per Second
FPT	Female Pipe Thread
FS	Finished Surface/Floor Sink/Federal Specifications
FSTNR	Fastener
FT	Feet or Foot
FTG	Footing
FUT	Future
FWY	Freeway
G	
G	Gas
GA	Gauge
GAL	Gallon
GALV	Galvanized
GAS	Gasoline
GB	Grade Break
GDR	Guard Rail
GE	Grooved End
GEN	Generator
GENL	General
GFI	Ground Fault Interrupter
GM	Gas Main
GMT	Greenwich Mean Time
GND	Ground
GPD	Gallons Per Day
GPM	Gallons Per Minute
GR	Grade
GRTG	Grating
GSKT	Gasket
GUT	Gutter
GV	Gate Valve

Abbreviation	Term
GWB	Gypsum Wallboard
GWBX	Gypsum Wallboard, Fire Rated
GYP	Gypsum
H	
H	Humidistat
HARN	Harness
HB	Hose Bibb
HC	Heating Coil
HD	Heavy Duty
HDPE	High Density Polyethylene
HEPA	High Efficiency Particulate Air
HGL	Hydraulic Grade Line
HGT	Height
HID	High Intensity Discharge
HOA	Hand-Off-Automatic
HOR	Hand-Off-Remote
HORIZ	Horizontal
HP	Horsepower/High Pressure
HPS	High Pressure Sodium
HPT	High Point
HR	Hour/Handrail
HS	High Strength
HTG	Heating
HTR	Heater
HV	Hose Valve
HVAC	Heating, Ventilating, and Air Conditioning
HVY	Heavy
HW	Headwall/Hot Water
HWL	High Water Level
HWY	Highway
HYDR	Hydraulic
HZ	Hertz (cycles per second)
I	
I	Intersection Angle
ICBO	International Conference of Building Officials

Abbreviation	Term
ID	Inside Diameter
IE	Invert Elevation
IEEE	Institute of Electrical and Electronics Engineers
IN	Inches
INCAND	Incandescent
INCL	Include
INL	Inlet
INS	Insulating
INSTL	Install or Installation
INTR	Interior/Intersection
INV	Invert
IP	Iron Pipe
IPS	Iron Pipe Size
IPT	Iron Pipe Thread
IRR	Irrigation
ISA	Instrument Society of America
J	
J	Joist
JB	Junction Box
JCT	Junction
JN	Join
JT	Joint
K	
KG	Kilogram
KM	Kilometer
KIPS	Thousands of Pounds
KV	Kilovolt
KVA	Kilovolt-Ampere
KW	Kilowatt
KWH	Kilowatt-Hour
KWHM	Kilowatt-Hour Meter
L	
L	Length of Curve/Long/Left
LATL	Lateral
LAV	Lavatory

Abbreviation	Term
LB	Pound
LBR	Lumber
LCL	Local
LF	Linear Foot
LG	Long
LI	Level Indicator
LLO	Long Leg Outstanding
LOC	Location/Locate
LOS	Lockout Stop
LP	Light Pole
LPT	Low Point
LR	Long Radius
LS	Lift Station
LT	Left/Light
LTG	Lighting
LWC	Lightweight Concrete
LWIC	Lightweight Insulating Concrete
LWL	Low Water Level
M	
MA	Milliampere
MAG	Magnet/Magnetic
MATL	Material
MAX	Maximum
MB	Machine Bolt/Megabyte/Millibars
MBH	Thousand BTU Per Hour
MECH	Mechanical
MC	Metal Channel
MCC	Motor Control Center
MCM	Thousand Circular Mils
MCP	Motor Circuit Protector
MD	Motorized Damper
MFR	Manufacturer
MG	Million Gallons/Milligram
MGD	Million Gallons Per Day
MH	Manhole

Abbreviation	Term
MHZ	Megahertz
MI	Malleable Iron/Mile
MIL	Military Specifications
MIN	Minimum
MISC	Miscellaneous
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MJ	Mechanical Joint
MMA	Monorail Manufacturer's Association
MO	Motor Operator/Motor Operated/Masonry Opening
MOD	Modification
MON	Monument
MOT	Motor
MPT	Male Pipe Thread
MSL	Mean Sea Level
MSS	Manufacturer's Standardization Society
MTD	Mounted
N	
N	North/Neutral/Nitrogen
NA	Not Applicable
NBFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
N & C	Nail and Cap
NC	Normally Closed
NE	Northeast
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFC	National Fire Code
NIC	Not in Contract
NIP	Nipple
NO	Number/Normally Open
NOM	Nominal
NPT	National Pipe Taper
NRS	Nonrising Stem
NTS	Not to Scale

Abbreviation	Term
NW	Northwest
NWL	Normal Water Level
O	
OA	Overall/Outside Air
OC	On Center/Overcurrent
OD	Outside Diameter
ODP	Open Dripproof
OE	Or Equal
OF	Outside Face
OPER	Operator
OPNG	Opening
OPP	Opposite
ORIG	Original
OSA	Outside Air
OSHA	Occupational Safety and Health Administration
O TO O	Out to Out
OVFL	Overflow
OVHD	Overhead
P	
P	Pole
PARA	Paragraph
PB	Push Button/Pull Box
PC	Point of Curvature/Programmable Controller
PCA	Portland Cement Association
PCC	Point of Compound Curvature/Portland Cement Concrete
PDI	Plumbing and Drainage Institute
PE	Plain End/Polyethylene/Professional Engineer
PEN	Penetration
PERF	Perforated
PF	Power Factor
PG	Pressure Gauge
PI	Point of Intersection
PJTN	Projection
PKWY	Parkway
PL	Plate/Property Line

Abbreviation	Term
PLATF	Platform
PLF	Pounds Per Lineal Foot
PNL	Panel
POB	Point of Beginning
POC	Point of Connection
POJ	Push-On Joint
PP	Power Pole/Polypropylene
PPB	Parts Per Billion
PPM	Parts Per Million
PR	Pair
PRC	Point of Reverse Curve
PRESS	Pressure
PRL	Parallel
PROV	Provisions
PRPSD	Proposed
PRVC	Point of Reverse Vertical Curve
PSI	Pounds Per Square Inch
PSIG	Pounds Per Square Inch Gauge
PSF	Pounds Per Square Foot
PT	Point of Tangency
PTS	Preliminary Treatment Structure
PV	Plug Valve
PVC	Polyvinyl Chloride
PVMT	Pavement
PWR	Power
Q	
Q	Flow Rate
QTY	Quantity
R	
R	Right/Radius
RAD	Radius/Radial
RAF	Return Air Fan
RAG	Return Air Grille
RC	Reinforced Concrete
RCB	Reinforced Concrete Box

Abbreviation	Term
RCP	Reinforced Concrete Pipe
RCPA	Reinforced Concrete Pipe Arch
RD	Road
RDC	Reduce
RDCR	Reducer
RDWY	Roadway
REF	Reference
REINF	Reinforce or Reinforced
RELOC	Relocated
REQ	Required/Requirement
REQD	Required
REV	Revise/Revision
RF	Raised Face
RH	Relative Humidity
RJ	Restrained Joint
RLG	Railing
RND	Round
RPM	Revolutions Per Minute
RR	Railroad
RST	Reinforcing Steel
RT	Right
RTD	Resistance Temperature Detector
R/W	Right-of-Way
S	
S	South/Slope in Feet Per Foot/Sewer
SAE	Society of Automotive Engineers
SAN	Sanitary
SAR	Supply Air Register
SBCCI	Southern Building Codes Congress International
SC	Seal Coat
SCFM	Standard Cubic Feet Per Minute
SCHED	Schedule
SCR	Silicon-Controlled Rectifier
SCRN	Screen
SD	Storm Drain

Abbreviation	Term
SDG	Siding
SDI	Steel Deck Institute
SDWK	Sidewalk
SE	Southeast
SECT	Section
SF	Square Feet
SGL	Single
SH	Sheet/Sheeting/Shielded
SIM	Similar
SLP	Slope
SLV	Sleeve
SM	Sheet Metal
SOL	Solenoid
SOV	Solenoid-Operated Valve
SP	Space/Steel Pipe/Static Pressure/Spare
SPCG	Spacing
SPEC	Specification
SPLC	Splice
SPRT	Support
SQ	Square
SQ FT	Square Feet
SR	Short Radius
SS	Sanitary Sewer
SSPC	Steel Structures Painting Council
SST	Stainless Steel
ST	Street
STA	Station
STBY	Standby
STD	Standard
STK	Stake
STL	Steel
STR	Straight
STRL	Structural
STRUCT	Structure
STS	Storm Sewer

Abbreviation	Term
STGR	Stringer
STWY	Stairway
SURF	Surface
SW	Southwest
SWG	Swing
SYMM	Symmetrical
SYS	System
T	
T	Ton/Tangent Length of Curve/Telephone
TAN	Tangent
T/B	Top of Beam
TB	Top of Bank/Terminal Board
T & B	Top and Bottom
TBG	Tubing
TBM	Temporary Bench Mark
TC	Top of Curb
TD	Time Delay
TDH	Total Dynamic Head
TDS	Total Dissolved Solids
TEFC	Totally Enclosed Fan Cooled
TEL	Telephone
TEMP	Temperature/Temporary
TENV	Totally Enclosed Nonventilated
THB	Thrust Block
THD	Thread or Threaded
THH	Thrust Harness
THK	Thick
TIR	Total Indicator Reading
TO	Turnout
T/O	Top of
TOC	Top of Concrete
TOS	Top of Slab
TOT	Total
TP	Telephone Pole
TRD	Tread

Abbreviation	Term
TRA	Tie Rod Assembly
TS	Tube Steel
TV	Television
TYP	Typical
U	
UBC	Uniform Building Code
UD	Underdrain
UG	Underground
UH	Unit Heater
UL	Underwriters' Laboratories, Inc.
ULT	Ultimate
UNO	Unless Noted Otherwise
UPS	Uninterruptible Power Supply
UR	Urinal
USGS	United States Geological Survey
UTC	Underground Telephone Cable
UTR	Up Through Roof
V	
V	Vent/Valve/Volt
VAC	Vacuum/Volts, Alternating Current
VC	Vertical Curve
VCP	Vitrified Clay Pipe
VEL	Velocity
VERT	Vertical
VFD	Variable Frequency Drive
VOL	Volume
VPC	Vertical Point of Curve
VPI	Vertical Point of Intersection
VPT	Vertical Point of Tangency
VSS	Volatile Suspended Solids
VTR	Vent Through Roof
W	
W	West/Watt/Wide/Water
W/	With
WC	Water Closet

Abbreviation	Term
WCO	Wall Cleanout
WG	Water Gauge
WH	Wall Hydrant
WL	Waterline
WLD	Welded
WM	Water Meter/Water Main
W/O	Without
WP	Waterproof/Working Point
WRF	Water Reclamation Facility
WRGWB	Water-Resistant Gypsum Wallboard
WSE	Water Surface Elevation
WSP	Water Stop
WT	Weight
WTR	Water
WWF	Welded Wire Fabric
WWM	Woven Wire Mesh
X	
XFMR	Transformer
XFR	Transfer
Y	
YCO	Yard Cleanout
YD	Yard
YP	Yield Point
YR	Year
YS	Yield Strength
Z	

PART 2 - MATERIALS

Not used.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 01500 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

A. Temporary Electric Power

Purchase electric power or provide portable electric power for the construction of the project. Provide for the extension of utility lines to the point of usage. The Contractor is responsible for the permitting and the provisions required in order to provide temporary power for construction facilities. There is no excess electrical power available at plant site.

B. Temporary Water

1. Make arrangements for developing water sources and supply all labor and equipment to collect, load, transport, and apply water as necessary for compaction of materials, concrete construction operations, testing, dust control, and other construction use.

2. Furnish potable drinking water in suitable dispensers and with cups for use of all employees at the job site during the entire construction period.

C. Temporary Sanitary Facilities

1. Provide temporary toilet facilities separate from the job office. Maintain these during the entire period of construction under this Contract for the use of all construction personnel on the job. Provide enough chemical toilets to conveniently serve the needs of all personnel.

2. Chemical toilets and their maintenance shall meet the requirements of the State and local health regulations and ordinances. Any facilities or maintenance methods failing to meet these requirements shall be corrected immediately.

D. Construction Staking

The Contractor shall provide all construction staking for the work.

E. Silt Barriers, Turbidity Curtains, and Screens

Install silt barriers, turbidity curtains and screens for capturing sediments-solids from erosion.

F. Site Administration and Security

1. Site Administration: The Contractor shall be responsible for all areas of the Site used by it and by all

Subcontractors in the performance of the Work. The Contractor shall exert full control over the actions of all employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to the County or others. The Contractor shall have the right to exclude from the Site all persons who have no purpose related to the Work or its inspection, and may require all persons on the Site (except County's employees) to observe the same regulations as the Contractor requires of its employees.

Access to the Site during construction will be limited to Contractor's and/or Subcontractor's employees, agents, and vendors (hereinafter "Representatives") for the sole purpose of performing the Work. All Representatives shall have photo identification issued by the Contractor. Contractor/Subcontractor Representative's identity and business purpose will be subject to verification by County's security representative. Access to the Site will be limited to the main gate off Alafaya Trail unless specific alternate arrangements are made with the County. Contractor will supply, and update, a list with the names, driver's license and license plate numbers of all personnel.

The County reserves the right to direct the Contractor to permanently remove any Contractor or subcontracted employee from the site for breach of security, policy, unsafe working practice, unprofessional behavior, or failure to comply with access restrictions.

2. Security: The Contractor shall be responsible for protection of the Site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

   The County is implementing special security measures to protect the public wastewater system and the Contractor shall provide the same level of security. The Contractor shall provide the following security measures:

   a. All personnel, employees, and/or subcontractors and suppliers that pass through the security perimeter shall wear Contractor issued photo identification badges.

   b. Contractor will supply, and update, a list with the names, driver's license and license plate numbers of all personnel.

c. All personnel passing through the security perimeter shall be subject to background checks to identify any historical crimes dealing with terrorism, sabotage, or other government related illegal activities.

d. All project deliveries shall be inspected prior to entering the security perimeter of the Facility in order to verify contents. All delivery personnel and delivery vehicles shall be under supervision while within the security perimeter of the Facility in lieu of issuance of photo identification badges.

e. If access other than the main gate off Alafaya Trail is utilized, a full time guard shall be provided at the construction gate during contractor working hours. All arrangements for alternative access shall be pre-arranged with the County. All alternative access must be secured and locked when not in use.

No Claim shall be made against the County by reason of any act of an employee or trespasser, and the Contractor shall make good all damage to the County's property resulting from the Contractor’s failure to provide security measures as specified.

G. Access Road and Parking Areas

1. Obtain access to project site through the existing gates from Alafaya Trail. Keep the existing gate accessible at all times so that the County’s vehicles have access to the site.

2. The Contractor and his employees will be permitted to park their vehicles on the County’s property. The County will designate a location for the Contractor and employee parking.

H. Drainage, Erosion, Dust, and Mud Control

1. Provide for the drainage of stormwater as may rain or flow onto or be discharged from the site in performance of the work. Drainage facilities shall be adequate to prevent damage to the work, the site, and adjacent property.

2. Existing drainage channels and conduits shall be cleaned, enlarged or supplemented as permitted by drainage control agencies to carry all runoff attributable to Contractor's operations. Dikes shall be constructed to divert runoff from entering adjacent property (except in natural channels), to protect

County's facilities and the Work, and to direct water to drainage channels or conduits. Ponding shall be provided to prevent downstream flooding and waterway contamination.

3. Prevent erosion of soil on the site and adjacent property resulting from the construction activities. Effective measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operation that will disturb the natural protection. Install silt barriers or screens for capturing sediments/solids from erosion.

4. Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and natural vegetation preserved to the greatest extent practicable. Temporary storage and construction buildings shall be located, and construction traffic routed, to minimize erosion. Temporary fast growing vegetation or other suitable ground cover shall be provided as necessary to control runoff.

5. Perform dust and mud control operations to prevent construction operations from producing dust and mud in amounts harmful to persons or causing a nuisance to persons living nearby or occupying buildings in the vicinity of the work. Use water or dust preventative to control dust during dry weather. Take necessary steps to prevent the tracking of mud onto adjacent streets and highways.

I. Project Sign(s)

Provide and erect one sign near the project site in accordance with the drawings. Construct the sign of 3/4-inch exterior grade plywood with 4-inch by 4-inch posts. Brace each sign with at least 2-inch x 4-inch lumber. Paint the sign as indicated in the drawing.

J. Contractor's Field Office and Storage Sheds

Provide field office with parking spaces, a telephone and storage sheds for the performance of the work, and protection of materials and equipment. Provide personnel to answer the telephone during working hours. If the facilities are located off the project site, the Contractor shall indemnify and insure the owner of the land against claims for accident, theft, and other items in accordance with the General Conditions.

K. Owner’s Field Office

Furnish, equip, and maintain an office trailer for the sole use of the Owner, with secure entrance doors and one key per occupant. Provide entrance/exit steps at all exterior doors. Provide parking areas for County vehicles. No Contractor employees or equipment parking will be permitted on Owner parking areas. Contractor shall have Owner’s field office fully functional prior to any construction activities.

1. Area: 1,200 square feet minimum, with minimum dimensions 24 feet x 50 feet.

    a. Divide trailer into three (3) offices, one on each end, reception area, restroom, and conference hall.

    b. Obtain prior approval of Engineer of floor plan. Each room shall have doors with integral locks, keyed alike.

2. Windows:

    a. Minimum: 3, with a minimum total area of 10 percent of floor area.

    b. Operable sash and insect screens.

    c. Locate to provide view of construction areas.

    d. Provide operable Venetian blinds for all windows.

3. Flooring:

    a. Provide VTC flooring throughout interior of trailer.

4. Furniture:

    a. Two (2) conference tables 30 inches x 96 inches with conference chairs.

    b. Three (3) standard size desks, 3-foot x 5-foot with four drawers.

    c. Three (3) office chairs with armrest, high back, swivel and reclining.

    d. Two (2) plan tables: 36 inches x 60 inches.

    e. Two (2) plan table stools with cushion and high backs.

    f. One (1) plan rack to hold a minimum of six sets of project drawings.

g. One (1) standard four-drawer legal size metal filing cabinet with lock and keys (one key per occupant).

h. Two (2) wooden bookshelves with four shelves each.

i. Four (4) office chairs with armrest (2 per office).

j. Four (4) wastebaskets.

k. One (1) tack board, 30 inches x 48 inches.

l. One (1) dry erase board, 30 inches x 42 inches.

m. One (1) coat rack.

n. One (1) 5 cubic-foot refrigerator.

o. One (1) 1.5 cubic-foot microwave oven.

p. One (1) table for printer, copier, fax.

q. One (1) personal computer with minimum 19-inch flat screen monitor. It shall be equipped at a minimum with a Windows 7 operating system, 3rd Gen Intel® Core™ i5 Processor, 6 GB memory and 500 GB Hard Drive.

(1) Full size keyboard and mouse

(2) Network connectivity: 10/100BaseT Ethernet

(3) Wireless router

(4) Productivity Software:

(a) Microsoft Office Professional 2010 or higher

(b) Adobe Acrobat 9 Pro or higher

(c) Internet Security: Integrated software, providing software firewall, virus, spyware, phishing and spam protection in a combined application.

(d) Backup: External hard drive, minimum 2 TB with automated backup software providing daily backups.

5. Office Equipment and Supplies:

a. Two (2) fire extinguishers (per code).

b. One (1) plain paper facsimile (fax) machine with independent phone line.

c. One (1) water cooler dispenser with hot and cold-water valves, including water service for the duration of the Project.

d. One (1) copier machine (sorter, double side copying, letter, legal and 11 x 17) with software for O.C. computer to operate.

e. One (1) color printer EPSON WorkForce Pro WP-4020 or equal.

f. Provide paper for copies in all sizes for the duration of the Project.

g. Provide standard office supplies for the duration of the Project.

h. One (1) first-aid kit.

6. Office Communications:

a. One (1) telephone system with minimum 3 rotary lines and 3 receivers, caller ID.

b. One (1) telephone digital answering machine for 3 lines.

c. Three (3) fastest speed available internet connections, at a minimum DSL, Roadrunner, etc., including e-mail service with connections in each office for the duration of the Project.

d. Four (4) surge protector power strips.

e. The field office telephone numbers will **not** be published publicly.

7. Services (AOD):

a. Lighting: 50-foot-candles at desktop height.

b. Exterior lighting at entrance door.

c. Automatic heating and mechanical cooling equipment sufficient to maintain comfort conditions.

d. Minimum of four-110 volt duplex electrical convenience outlets, at least one on each wall.

e. Electric distribution panel: two circuits minimum, 110-volt, 60-hertz service.

f. Equip washroom with flush toilet, washbasin with two faucets, medicine cabinet with supplies, toilet tissue holder, 10-gallon capacity automatic electric water heater, and paper towel holder.

g. Provide potable water service to all trailer fixtures.

h. Provide a single waste discharge to sanitary disposal system.

i. Cleaning service for the duration of the Project (min. once per week).

j. Furnish, replace, and replenish light bulbs, fluorescent tubes, toilet paper, paper towels, soap, etc.

L. Removal of Temporary Construction When No Longer Needed

When temporary facilities, services, and controls are no longer needed and before the Work is completed, remove the various temporary facilities, services, and controls and legally dispose of them. Portions of the site used for temporary facilities shall be reconditioned and restored to their previous condition.

M. Construction Solid Waste Disposal

Provide a roll-off container for construction debris for the duration of the construction contract.

N. County’s Construction Inspector Work Hours

See Section 01015.

O. Overtime and Weekend Work Pay Rate

See Section 01015.

P. Method of Payment

See Section 01015.

Q. Emergency Wastewater Spill and Water Main Break Procedures

1. Excavate Cautiously: The Contractor shall exercise extreme caution when excavating in proximity of wastewater force mains and gravity sewers. Force main and sewer locations shown on the plans are not exact or

guaranteed. The Contractor is responsible for field verifying existing utility locations.

2. Telephone Notification: The Orange County dispatch operator and County R.P.R shall be notified immediately in the event of a force main, gravity sewer, or water main break or damage at 407-836-2777.

3. Repair Immediately: All damage to Orange County's mains shall be repaired immediately by the Contractor at the Contractor's expense, in accordance with the current edition of the Orange County Utilities Standards and Construction Specifications Manual. If the repair is not made in a timely manner, as determined by the Orange County Utilities Inspector, Orange County may perform repairs and the Contractor will be charged for the repairs.

4. Orange County Utilities Department General Telephone Numbers:

   a. Orange County Utilities Construction Inspection Section…407-836-5550

   b. Orange County Utilities Water Reclamation Division…407-254-9680

   c. Orange County Utilities Water Division…407-254-9850

   d. Orange County Utilities Engineering Division…407-254-9900

5. Advance Notification of Construction: The Orange County Utilities Construction Section (407-836-5550) shall be notified at least seven (7) days prior to any construction activity.

6. Operation of Orange County Valves: Water, wastewater, and reuse valves are to be operated only by Orange County Utilities Inspector (407-836-5550). All valves being installed are to remain closed during construction.

R. Construction Sequence Plan

In addition to the Progress Schedule required by Section 01323, the Contractor shall submit a detailed construction sequence plan to the Project Manager for review and coordination with the plant's operations staff. The construction sequence plan must be accepted by the County before the work is started. The construction sequence plan shall comply with the time limits in Section 01040.

S. Construction Photographs

Prior to starting construction, the Contractor shall photograph the existing facilities from locations to adequately illustrate the condition of the facilities. Deliver three (3) mounted sets of prints to the County. Prints shall be 5″ x 7″ minimum, mounted in plastic sheets in loose leaf, three ring binders. Identify each print on back with the name of the project, description of view, and the time and date of exposure.

END OF SECTION

SECTION 01600 MATERIAL AND EQUIPMENT

A. Transportation and Handling

Deliver manufactured materials and products to the project site as needed for installation, undamaged, in original packages, containers, or bundles, as packaged by the manufacturer with manufacturer's name, brand, seals, and labels intact. Materials other than those designated within the Specifications shall not be delivered to the project site. No deliveries will be accepted by OCU personnel, Contractor shall be on site for all deliveries.

B. Storage and Protection

1. Protect and preserve all materials until final acceptance of the Project. Store all materials in a manner to facilitate inspection and to prevent damage, contamination, or intermixing.

2. Miscellaneous metal, reinforcement bars, welded wire fabric, and masonry reinforcement materials shall be stored to prevent contact with the ground and from being damaged by its own weight or by other loads. Reinforcement that has become muddy shall be cleaned before use.

3. Store cementitious materials in weathertight sheds on elevated floors away from damp surfaces. Prevent freezing.

4. Do not use and dispose of materials that have been stored for longer than their maximum recommended shelf life or beyond their recommended shelf date.

5. Store and protect all material and equipment in accordance with manufacturer's recommendations.

6. Store mechanical equipment with moving parts (pumps, valves, operators, etc.) in weathertight sheds on elevated floors.

7. Store electrical and electronic control equipment (motor control centers, panelboards, switch gear, wiring devices, etc.) in weathertight sheds on elevated floors and in an environment similar to the one in their final location (ventilated, air conditioned, etc.). Store all other electrical material in a manner to prevent contact with the ground and from being damaged by its own weight or by other loads.

C. Protection of Equipment

1. During construction, protect all equipment from moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps, coverings, or other suitable means. Apply protection immediately on receiving the products and maintain continually.

2. Keep products clean by elevating above ground or floor and by using suitable coverings. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

3. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore any finishes that become stained or damaged.

D. Equipment Selection and Serviceability

1. Locate and install all equipment so that it may be serviced. Demonstrate that there is room to remove all fan shafts, bearings, filters, pumps and motors, and similar equipment.

2. Equipment that is too large or poorly located to permit servicing shall be replaced or repositioned at no additional cost to the County.

3. Where piping, control diagrams or sequencing differ from the recommended piping arrangements of the equipment manufacturer, and will directly affect the equipment performance, the manufacturer's recommendations shall be submitted in writing to the Engineer for review prior to purchasing the equipment involved. Obtain such recommendations from the manufacturers in order to effect correct and perfect operation of the equipment at the capacities and temperatures indicated.

E. Spare Parts

1. Spare parts shall be packaged in sealed, rotationally moulded LLDPE military grade storage containers that can be stacked. Storage containers shall have exterior metallic hinges, clasps and handles. The Contractor shall produce a construction submittal for type of containers intended to be supplied for review and acceptance by the Owner and Engineer.

2. Pertaining to general inventory of all containers, the Contractor shall provide a general ascending alpha-

numerical numbering convention to label all individual containers supplied. Labeling shall be provided in consistent location on all bins such that inventory can be reviewed when stacked.

3. Pertaining to contents, the containers shall include exterior labeling that shall include the following at a minimum; Process description and Process number, equipment description, equipment tag, Manufacturer's information. Labeling shall be provided in consistent location on all bins such that inventory can be reviewed when stacked.

4. The Contractor shall provide an electronic log in MS Excel of all containers which include the following at a minimum; container alpha-numerical designation, content description, site storage location, O&M Manual volume subsection reference.

5. A copy of all inventory and manufactures product information data sheets shall be provided within a file pocket attached within the container.

6. Containers shall be positioned on site as designated by the Owner's Representative

END OF SECTION

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SECTION 01664 SYSTEM START-UP AND TESTING

PART 1 - GENERAL

A. Description

1. This section includes system start-up and System Testing. Substantial completion for various portions of the work will be required prior to starting work on other portions of the project. Refer to Section 01040 for specific construction sequencing requirements.

2. Prior to requesting issuance of the Certificate of Substantial Completion for any portion of work, complete system start-up and System Testing as specified herein, must be completed to the satisfaction of the Owner.

3. At least 90 days prior to initiation of the start-up for each process as described below, submit a detailed start-up plan and schedule of operational circumstances described below. It is the intent of this section that the entire system as described below be operated and tested under actual operating conditions prior to acceptance. The start-up plan must be accepted by Owner and Engineer prior to initiation of start-up.

4. For issuance of substantial completion for each major respective process, the Contractor is to perform system start-up and System Testing procedure for the following major facilities. Some of the major facilities are necessary to be tested prior to performing start-up and System Testing of other facilities. At a minimum the Contractor is required to perform an individual system start-up and System Testing procedure for the following major facilities.

5. Reference Figure 1 and Figure 2 in Specification Section 01040 for an illustrative representation of the minimum amount of substantial completions identified for the Project

   a. Biological Nutrient Removal Reactors (BNR):

      (1) Part A1 – Process 520: Supplemental Carbon Feed and Storage including but not limited to the following:
          (a) Prefabricated Metal Building
          (b) Chemical Feed Skids
          (c) Chemical Storage Tanks
          (d) All electrical transformers, switchgear and starters.

(e) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(2) Part A2 - Phase I/II BNR Process Train (South), North Control Building, Clarifier 3 and 4 RAS/WAS/SCUM pumping station, and Clarifier 7 and 8 WAS pumping station; including but not limited to Processes 155, 212, 218-219, 223-224, 232, 243-244, 252, 253 and the following improvements;
(a) Fine Bubble Diffusers
(b) Air piping
(c) Blowers
(d) Gates
(e) Supplemental Carbon Feed & Storage System – Process 520
(f) RAS, WAS, and SCUM Pumps
(g) North Control Building Structural and Architectural Systems
(h) North Control Building HVAC System
(i) All electrical transformers, switchgear and starters.
(j) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(3) Part B - Phase I/II BNR Process Train (North) and Clarifier 1 and 2 RAS/WAS/SCUM pumping station; including but not limited to Processes 211, 216-217, 221-2242, 231, 241-242, and 251 and the following improvements;
(a) Fine Bubble Diffusers
(b) Air piping
(c) Blowers
(d) Gates
(e) RAS, WAS, and SCUM Pumps
(f) All electrical transformers, switchgear and starters.
(g) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(4) Part C - Phase III BNR Process Train (North), Main/Electrical Blower Building, and Clarifier 9 WAS Pumping Station; including but not limited to Processes 185, 311-312, 316-317, 325, 335 and 352 and the following improvements:

(a) Fine Bubble Diffusers
(b) Air piping
(c) Blowers
(d) Gates
(e) WAS Pumps
(f) Main Electrical Blower Building Improvements
(g) All electrical transformers, switchgear and starters.
(h) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(5) Part D - Phase III BNR Process Train (South) including but not limited to Processes 313-314, 318-319, 336 and 352 and the following improvements:
(a) Fine Bubble Diffusers
(b) Air piping
(c) Gates
(d) All electrical transformers, switchgear and starters.
(e) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(6) Part E - Phase IV BNR Process Train, Clarifier 10 and 11 RAS/WAS/SCUM pumping station, Clarifier 11 including but not limited to Processes 420, 450, 540 and the following improvements:
(a) Fine Bubble Diffusers
(b) Air piping
(c) Blowers
(d) Gates
(e) RAS, WAS, and SCUM Pumps
(f) All electrical transformers, switchgear and starters.
(g) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

b. Preliminary Treatment Structures (PTS)

(1) Part A - Preliminary Treatment Structure (Processes 500) including but not limited to the following;
(a) Process Equipment
(b) Screening System

(c) Grit Removal System
(d) Odor Control System
(e) Weir and Slide Gates
(f) Scum Spray System
(g) Electrically Actuated Gates/Valves
(h) Gates
(i) Structural and Architectural Systems
(j) HVAC Systems
(k) All electrical transformers, switchgear and starters.
(l) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

c. Tertiary Treatment

(1) Part A - West Electrical Building (Process 575)
(a) Structural and Architectural Systems
(b) HVAC Systems
(c) All electrical transformers, switchgear and starters.
(d) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(2) Part B1 – New Filter Splitter Box (Process 360) – Part 1 Improvements (South), i.e. improvements in portion of tank to feed secondary effluent to the Phase IV Disk Filter (Process 470) and new Chlorine Contact Tank (Process 580)) including but not limited to the following:
(a) Main Process equipment
(b) Gates
(c) Electrically Actuated Gates/Valves
(d) All electrical transformers, switchgear and starters.
(e) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(3) Part B2 - Relocated Phase IV Disk Filter (Process 470)
(a) Main Process equipment
(b) Filter Feed Pumps
(c) Relocated Disk Filter
(d) Backwash Pumping System

(e) All electrical transformers, switchgear and starters.
(f) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(4) Part B3 – Phase V Chlorine Contact Chamber (Process 580)
(a) Gates
(b) Mixer
(c) All electrical transformers, switchgear and starters.
(d) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(5) Part B4 – Phase III Effluent Pump Station (Process 390) and In-Plant Reuse Pump Station (Process 395); start-up and System Testing required for each pump prior to proceeding with work for subsequent pumps, including but not limited to the following:
(a) Main Process equipment-
(a) Pumps
(b) Electrically Actuated Valves in yard piping system to West of Process 390
(c) Reject Storage Pond
(b) All electrical transformers, switchgear and starters.
(c) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

(6) Part C - Secondary Effluent Reject Pump Station, Diversion Boxes, Outfall Structure, Reject Storage Pond and Rapid Infiltration Basin Improvements (Process 560, 561, 562, 563, 564, and 565) including but not limited to the following:
(a) Process equipment
(b) Pumps
(c) Gates
(d) Electrically Actuated Valves/gates
(e) Reject Storage Pond Improvements
(f) Rapid Infiltration Basin Improvements
(g) All electrical transformers, switchgear and starters.
(h) Instrumentation system & field instruments required to operate in its

intended automatic and/or manual mode as a complete system.

(7) Part D – New Filter Splitter Box (Process 360) - Phase 2 Improvements (North), i.e. improvements in portion of tank to feed secondary effluent to Phase III traveling bridge filters (Process 370) including but not limited to the following:
(a) Main Process equipment
(b) Gates
(c) Electrically Actuated Gates/Valves
(d) All electrical transformers, switchgear and starters.
(e) Instrumentation system & field instruments required to operate in its intended automatic and/or manual mode as a complete system.

6. For those major facilities identified within Part 1.A.5 as designated for an independent facility System Start-up and System Testing procedure as required for issuance of substantial completion, it is intended that each major facility be placed in operation by accomplishing the following three general procedures:

a. Preliminary Matters - field testing of individual components and equipment during the Contract Time, which may be accomplished one at a time and is to be performed as specified per the individual respective components' specification.

b. System Start-up - starting the facility under operational conditions and showing it will work for a specified length of time, which shall be accomplished before System Testing. Unless otherwise noted, System Start-Up shall be conducted utilizing plant effluent, have a minimum duration of 48 consecutive hours, at that processes rated capacity and operate successfully to the acceptance of the Owner without instances including but not limited to overflows, problems or stoppages required to make corrective measures.

c. System Testing - proving that the entire Work will function properly as a system, each individual component will operate within the system and that the system will function to meet the specified standards over a stated period of time. Unless otherwise noted, shall be conducted utilizing the intended media to be processed, have a minimum duration of 7 consecutive days, at that processes

rated capacity and operate successfully to the acceptance of the Owner without instances including but not limited to overflows, problems or stoppages required to make corrective measures.

7. For those facilities not identified within Part 1.A.4 as designated for an independent facility System Start-up and System Testing procedure, the Contractor is perform System Start-Up and System Testing following the procedure outlined herein.

B. Submittals

1. At least 90 days prior to each facility's system start-up, submit a system start-up and System Testing program to the Engineer for review.

   a. The plan shall be a comprehensive report that includes detailed activities and coordination required to implement the requirements of this specification. The report shall include at a minimum preliminary matters, system start-up and System Testing for both the wastewater process equipment and the electrical equipment.

   b. The report shall include a detailed schedule for the sequence of all operations that the Contractor will perform for the System Testing specified herein.

   c. Identify the Owner's activities required for the system start-up and System Testing. Schedule a meeting with Owner and Engineer to review draft start-up plan at least 60 days prior to initiating start-up activities. Revise draft plan to incorporate comments from Owner and Engineer and re-issue start-up plan at least 30 days prior to initiating start-up activities.

2. At least 45 days prior to initiating the System Testing period, the Contractor shall provide a seeding plan for the Engineer to review regarding draining the structures of reclaimed water and filling with mixed liquor prior in preparation for System Testing.

PART 2 - PRODUCTS

A. Water, Fuel, Chemicals and Electricity

The Contractor is responsible to supply all potable water, fuel, chemicals and electricity as necessary to perform all the system start-up and System Testing. At no cost to the

Contractor, the Owner will provide the supply for all reclaimed water, or effluent or non-potable water. The Contractor is responsible to meter the volume of reclaimed water to be utilized. The Contractor is responsible to provide the temporary pumping and conveyance facilities for the reclaimed water.

B. Supplemental Carbon – MicroC2000™

The Contractor is responsible to supply all MicroC2000™ product manufactured by Environmental Operating Solutions, Inc. as required for start-up, System Testing and as necessary for issuance of substantial completion for Process 520 and all BNRs; Phase I/II BNR (Process 210 – 250), Phase III BNR (Process 310 – 352), Phase IV BNR (Process 420, 450 and 540). Following issuance of substantial completion Process 520 and all BNRs (noted herein), the Contractor is required to fill all storage tanks within Process 520 to capacity, 520-TK-1 and 520-TK-2.

C. Laboratory System Testing Services

The Contractor is responsible to supply all services related to sample collection and laboratory System Testing services. The Contractor shall utilize a laboratory certified in the State of Florida. The certified laboratory is responsible to perform all the laboratory System Testing and produce the laboratory System Testing reports as required herein.

D. Electrical Test Recorders

Install 24-hour test recorders to each motor starter for the purpose of the tests only and remove them after completion of System Testing.

E. Temporary Pumping and Piping Facilities

1. The Contractor is responsible to supply a complete pumping and piping system to convey all fluids to the various facilities being tested.

2. The Contractor will be responsible for pumping down the Reject Storage Pond and Repaid Infiltration Basins in order to perform the Work within the Contract Documents.

3. The Contractor is responsible for temporary pumping systems as required to empty and refill the structures to be improved. The Contractor is responsible for temporary pumping systems as required to simulate the process performance criteria noted within the Contract Documents.

4. Additional temporary pumping may be required for other processes. The Contractor will be responsible for all temporary pumping and piping systems for completion of the work described within the Contract Documents.

F. Temporary Pumping and Piping Facilities for BNR and Secondary Clarifier Treatment

1. The Contractor will be responsible for pumping down all structures to be taken out of service over 72 hour duration of continuous pumping. At the designation of the Owner's Representative, the Contractor may divert the flow to be discharged to either Process 395 or 495 in-plant lift stations.

2. Temporary pumping will be required to perform the System Start-Up Test. The Contractor shall fill the tanks with reclaimed water and recirculate it within the processes at the prescribed flow rates in order to comply with the System Start-Up Testing criteria noted within the Contract Documents.

3. Following acceptance of the System Start-Up Test, and at the designation of the Owner's Representative, the reclaimed water will be pumped out of the structures by the Contractor to the either Process 395 or 495 in-plant lift stations.

4. Following the removal of the reclaimed water from the structures, mixed liquor will be pumped from another structure in order to fill the tanks over a seeding period. The seeding period will last approximately five (5) to seven (7) days. During the seeding period, the Contractor will pump mixed liquor from another structure in close vicinity. The structure will be filled over a period of three (3) to four (4) days. During the filling and seeding period, the Contractor shall be responsible to provide temporary piping and pumps in order to circulate mixed liquor from the 2nd anoxic tanks to the fermentation tanks at varying rates over the respective duration. The Contractor shall prepare and submit a seeding plan to the Owner and Engineer for review.

5. Once seeding is completed the system will be brought into service for the 21-day System Testing duration.

PART 3 - EXECUTION

C. Preliminary Matters

1. Conduct all field inspections as defined in the individual specification sections, installation checks, hydrostatic tests, performance tests, and necessary corrections required, to demonstrate that individual components of the Work have been properly erected and found to operate in accordance with the Contract Documents, so that they can be utilized for their intended purposes.

2. Remove all electrical jumpers, bypasses or other items connected to the equipment, which are not intended to remain in the facility and are not required by the specifications. Demonstrate that each component is operating under its own control as designated.

3. Confirm that all electrical circuits are energized in the automatic position, that valves and gates are set to their normal position and that the flow path through the Work is unobstructed.

4. Assure that the water supply to the seal water system is on. Until the plant service water becomes available, provide temporary seal water with backflow preventer.

5. Fill each hydrostatic structure in the process flow stream with effluent in accordance with Section 03800.

D. Start-Up System Testing

1. Provide personnel and equipment except as stated in paragraph entitled "Interface Between Contractor and Owner" during the start-up System Testing period to perform the start-up System Testing tasks.

2. Prior to commencing system start-up and by utilizing the CAR procedure a minimum of fourteen (14) days in advance of the work, coordinate system start-up activities with the Owner's operating personnel and the Engineer.

3. Initiate component start-up in accordance with the manufacturer's operation and maintenance manual.

4. Coordinate with Owner for any adjustments desired or operational problems requiring debugging.

5. Make adjustments as necessary.

6. During this start-up System Testing period, a representative of the manufacturer of each major piece

of equipment shall visit the site for at least one day to inspect the equipment and certify to the Engineer and Owner in writing that the equipment has been installed properly and is operating properly.

7. During the start-up System Testing period, operate the facilities in a manner to test alarms, controls, and interlocks. Repair or replace equipment that does not respond to the interlocks, alarms and controls designed. The work must operate successfully during this System Testing period in the manner intended. If the work does not operate successfully, correct the problem and start the test over.

8. Test all motors for vibration by measuring the vibration on the shaft adjacent to the bearings. If a vibration level is specified in the technical specifications for a particular piece of equipment, assure that the equipment complies with the specified level. Repair, realign or replace equipment until the measured vibration is less than the specified maximum vibration level. Submit vibration test reports to Engineer for review.

9. The system start-up will be deemed to be completed after:

   a. All structures have been filled with effluent.

   b. All adjustments and operational scenarios as desired by the Owner have been made and simulated, respectively.

   c. Effluent has flowed through the new and modified unit processes at the processes rated capacity for at least 48 consecutive hours without overflows, problems or stoppages to make corrective measures. The effluent may be obtained from the existing plant flow. Flow rate should be varied from minimum to peak hour flow during the course of 48 hours.

   d. Unless otherwise noted, System Testing shall be conducted utilizing plant effluent, have a minimum duration of 48 hours, at that processes' rated capacity and operate successfully to the acceptance of the Owner without instances including but not limited to overflows, problems or stoppages required to make corrective measures.

   e. Demonstrate that the control and/or monitoring signals are properly received or transmitted from/to the interface terminal blocks as shown on the drawings.

E. System Testing

1. General System Testing requirements;

a. After completion of the start-up System Testing, perform the System Testing of the Phase V improvements in the presence of the Engineer and Owner. A successful system test must be completed before substantial completion may be issued. Provide all personnel and equipment except as stated in the paragraph entitled "Interface Between Contractor and Owner" as necessary during the System Testing period to complete the tasks. The Owner will direct the Contractor relative to required unit operation and performance under the varying operating conditions.

b. During the system test period, operate the facilities in a manner to test alarms, controls, and interlocks. Repair or replace equipment that does not respond to the interlocks, alarms, and controls designed.

c. During the System Testing, test the pumps:

(1) Operate the pumps for the duration of the test, during which time no repairs or adjustments shall be required. Assure that pumps operate as designed and specified in response to wet well level controls and variable speed controls, and that programmer operates without evidence of vibration in excess of that allowed by the Hydraulics Institute Standards (Figures 77-76 and 77-8), cavitation, and damage to impellers and shafts. Repair, replace, or realign motors, shafts, and impellers and retest.

(2) Where field tests are required for pumps and no meters are in the associated piping, provide temporary meters and flow recorders.

d. During the System Testing, test all motors for vibration by measuring the vibration on the shaft adjacent to the bearings. If a vibration level is specified in the technical specifications for a particular piece of equipment, assure that the equipment complies with the specified level. Repair, realign, or replace equipment until the measured vibration is less than the specified maximum vibration level.

e. During the System Testing period, operate the Work and cause various operational circumstances to occur, as instructed by designated plant operating personnel. At a minimum, these circumstances will include average and peak daily flows, random equipment failures and tank overflows, surcharges, and bypasses. Acceptability of the Work's performance will be based on the work performing as specified under these actual and simulated operating conditions and producing an effluent as defined in the contract documents. The intent of the start-up System Testing is for the Contractor to demonstrate to the Owner and the Engineer that the work will function as a complete and operable system under normal as well as emergency operating conditions and is ready for acceptance.

f. The System Testing for each process flow stream and instrumentation system will be conducted utilizing the intended media to be processed (i.e. raw wastewater, mixed liquor, secondary effluent, etc). The Work must operate successfully in the manner intended using raw wastewater, mixed liquor, secondary effluent, etc as the media. If the work does not operate successfully, correct the problem(s) and start the test over from day one.

g. Unless otherwise noted, System Testing shall be conducted utilizing the intended media to be processed, have a minimum duration of 7 consecutive days, at that processes rated capacity and operate successfully to the acceptance of the Owner without instances including but not limited to overflows, problems or stoppages required to make corrective measures.

2. Specific Requirements for the Biological Nutrient Removal Processes (Process 210-250, 310-350 and 420-450 & 450);

a. System Start-Up of Supplemental Carbon Feed and Storage System (Process 520). System Testing of Process 520 will be performed concurrent to System Testing for the first BNR in the series to be tested.

b. Collect performance data for the liquid process stream in two stages. The first stage of data collection will consist of seven (7) days beginning on the first day of System Testing and ending with the last day of System Testing. The objective of this first stage of System Testing is to

demonstrate the removal of BOD and total suspended solids.

c. Assuming a successful first stage system test, the second stage of data collection will begin one week after conclusion of the first stage and last for seven (7) consecutive days. The main objective of this second stage of System Testing is to demonstrate the biological nutrient removal of nitrogen and phosphorus.

d. The performance data reports (Stages 1 and 2) shall describe the daily 24 hour composite concentrations of BOD, total suspended and volatile suspended solids, total nitrogen, nitrate nitrogen, ammonia nitrogen, and phosphorus for the following liquid stream process locations:

(1) Raw Sewage Influent

(2) Clarifier Effluent

e. Contractor is responsible for furnishing all required automatic samplers. The Contractor may use the automatic samplers provided in the project to obtain samples. The Contractor shall utilize a laboratory certified in the State of Florida to perform the analyses and prepare the reports. The report shall indicate the 24 hour daily flow for each day.

f. Submit daily laboratory reports to the Engineer as soon as possible following receipt by Contractor. Within two weeks following completion of the data collection period, provide two complete copies of the performance data reports.

g. The Owner will evaluate these performance data reports and evaluate the performance of each unit process. Based on these evaluations, the Owner will direct the Contractor to further investigate and correct unit processes that are believed to be performing below their expected design criteria.

h. The System Testing will be deemed to be completed after effluent has flowed through Phase V improvements at the current daily incoming wastewater flows while producing a clarified effluent with less than 5 mg/L of BOD5, 20 mg/L of total suspended solids, 3 mg/L of total nitrogen, and 1 mg/L of total phosphorus, for at least 7 consecutive days.

F. Interface Between Contractor and Owner

It is the intent of this section that, during Preliminary Matters, and the System Start-Up and System Testing:

1. The ownership of the project shall remain with the Contractor.

2. During System Testing, the Contractor will assist the Owner by performing all work to test, operate and maintain the plant (turning on/off pumps, opening/closing valves, etc.), assuming a 24 hour working day, seven days a week, starting the date a system test is initiated on any respective process.

3. The Owner will furnish certified operators in compliance with FDEP rules.

4. The Contractor shall submit a C.A.R. for correspondence with the Owner and will not perform any activities without first consulting with Owner.

G. Instrumentation and Controls System Testing

1. For those major facilities identified within Part 1.A.5 as designated for an independent facility System Start-up and System Testing procedure, the Contractor is to perform the Operational Readiness Test (ORT), Functional Demonstration Test (FDT) and Performance Acceptance Test (PAT) in conjunction with the Preliminary Matters, System Start-Up and System Testing procedures, respectively.

2. For those facilities not identified within Part 1.A.4 as designated for an independent facility System Start-up and System Testing procedure, the Contractor is to perform the Operational Readiness Test (ORT), Functional Demonstration Test (FDT) and Performance Acceptance Test (PAT) in conjunction with the Preliminary Matters, System Start-Up and System Testing procedures, respectively.

END OF SECTION

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SECTION 01700 CONTRACT CLOSEOUT

A. Clean-Up Operations

See Section 01740.

B. Closeout Submittals

1. At least 2 weeks prior to start-up, the following items shall be submitted:

   a. Service manuals, installation instructions, and operation and maintenance manuals.

   b. Spare parts and special tools ordered as part of this Contract.

   c. All keys to all doors, gates, and equipment.

   d. Statements from the manufacturer's representatives as called for in the Contract Documents.

2. Upon completion of the project, or portions thereof, and prior to final payment, the Contractor shall transfer to the County all applicable items accumulated throughout construction. These include, but are not limited to, the following items:

   a. Manufacturers' guarantees, bonds, and letters of coverage extending them beyond the time limitations of the Contractors' guarantee.

   b. Salvaged materials or materials and equipment borrowed from the County.

   c. Record documents of completed facilities.

   d. Releases of lien. General release from Contractor plus copies of releases from subcontractors and material suppliers.

3. The closeout requirements of this section are in addition to the requirements of the Standard General Conditions and Supplementary Conditions.

END OF SECTION

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SECTION 01720 PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

A. Description

1. The purpose of the Project Record Documents is to provide the County with factual information regarding all aspects of the Work, both concealed and visible, to enable future location, identification and modification of the Work without lengthy and expensive site measurement, investigation or examination.

2. These standards and procedures are for integration of digital engineering CAD drawings and attribute data into the database environments, while maintaining the integrity and positional accuracy of the data. The requirement for digital submittal of approved construction plans is to provide the County GIS with a parcel and utility base for field maintenance and operations.

3. The location of the constructed improvements as depicted in the Contract Drawings is required. To insure the Work was constructed in conformance with the Contract Drawings, the following survey documents are required to be prepared and certified by the Surveyor:

   a. As-Built Asset Attribute Data Table (see Table 01050-2)

   b. Pipe Deflection Table (see Table 01050-3)

   c. Gravity Main Table (see Table 01050-4)

   d. Boundary Survey and Survey Map Report for pump stations and easements with constructed improvements.

B. Definitions

Except where specific definitions are used within a specific section, the following terms, phrases, words and their derivation shall have the meaning given herein when consistent with the context in which they are used. Words used in the present tense include the future tense, words

in the plural number include the singular number and words in the singular number include the plural number.

1. As-Built Drawings: Drawings prepared by the Contractor's Surveyor shall depict the actual location of installed utilities for the completed Work in a full size hard copy and an electronic AutoCAD file (dwg) format.

2. Record Documents: All documents as required in subsections Part 1.D and Part 2.B in this specification section.

3. Boundary Survey: Boundary survey, map and report certified by a Surveyor shall be provided that meets the requirements of Chapter 5J-17 'Minimum Technical Standards', FAC.

4. Surveyor: Contractor's Surveyor that is licensed by the State of Florida as a Professional Surveyor and Mapper pursuant to Chapter 472, F.S.

5. Survey Map Report: As a minimum the Survey Map Report shall identify any corners that had to be reset, measurements and computations made, pump station and easement boundary issues, locations of constructed improvements outside boundaries, and accuracies obtained.

6. Specifications and Addenda: Legibly mark each section to record.

   a. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually installed; and

   b. Changes made by Field Order or by Change Order

C. Quality Assurance

1. Delegate the responsibility for maintenance of the Record Documents to one person on the Contractor's staff as approved by the County.

2. Thoroughly coordinate changes within the Record Documents, making adequate and proper entries on each

page of specifications and each sheet of Drawings and other documents where such entry is required to show progress and changes properly.

3. Make entries within 24-hours after receipt of information has occurred.

D. Record Documents at Site

1. Maintain at the site and always available for County's use one (1) record copy of:

   a. Construction Contract, Drawings, Specifications, General Conditions, Supplemental Conditions, Bid Proposal, Instruction to Bidders, Addenda, and all other Contract Documents

   b. Change Orders, Verbal Orders, and other modifications to Contract

   c. Written instructions by the County as well as correspondence related to Requests for Information (RFIs)

   d. Accepted Shop Drawings, Samples, product data, substitution and "or-equal" requests

   e. Field test records, inspection certificates, manufacturer certificates and construction photographs

   f. Progressive As-Built Drawings

   g. Current Surveyor's tables for the As-Built Assets Attribute Data, Pipe Deflection Data, and Gravity Main Data

2. Maintain the documents in an organized, clean, dry, legible condition and completely protected from deterioration and from loss and damage until completion of the Work, transfer of all record data to the final As-built Drawings for submittal to the County.

3. Store As-Built Documents and samples in Contractor's office apart from documents used for construction. Do not use As-Built document for construction purposes. Label each document "AS-BUILT" in neat large printed letters. File documents and samples in accordance with

CSI/CSC format.

4. Record information concurrently with construction progress. Do not conceal any Work until required information is recorded.

PART 2 - PRODUCTS

A. As-Built Drawings

1. Maintain the electronic As-Built Drawings to accurately record progress of Work and change orders throughout the duration of the Contract.

2. Date all entries. Enter RFI No., Change Order No., etc. when applicable.

3. Call attention to the entry by highlighting with a "cloud" drawn around the area affected.

4. In the event of overlapping changes, use different colors for entries of the overlapping changes.

5. Design call-outs shall have a thin strike line through the design call-out and all As-Built information must be labeled (or abbreviated "AB") and be shown in a bolder text that is completely legible.

6. Make entries in the pertinent other documents while coordinating with the County for validity.

7. Entries shall consist of graphical representations, plan view and profiles, written comments, dimensions, State Plane Coordinates, details and any other information as required to document field and other changes of the actual Work completed. As a minimum, make entries to also record:

   a. Depths of various elements of foundation in relation to finish floor datum and State Plane Coordinates and elevations.

   b. As-Built Asset Attribute Data Table shall be completed in the Drawings.

   c. When electrical boxes, or underground conduits and plumbing are involved as part of the Work, record

true elevations and locations, dimensions between boxes.

d. Actually installed pipe or other work materials, class, pressure-rating, diameter, size, specifications, etc. Similar information for other encountered underground utilities, not installed by Contractor, their owner and actual location if different than shown in the Contract Documents.

e. Details, not on original Contract Drawings, as needed to show the actual location of the Work completed in a manner that allows the County to find it in the future.

f. The Contractor shall mark all arrangements of conduits, circuits, piping, ducts and similar items shown schematically on the construction documents and show on the As-Built Drawings the actual horizontal and vertical alignments and locations.

g. Major architectural and structural changes including relocation of doors, windows, etc. Architectural schedule changes according to Contractor’s records and Shop Drawings.

8. As-Built Drawings shall include certifications from the Surveyor and the Contractor.

9. As-Built Drawings shall show location of all underground and above ground water, wastewater and reclaimed water piping and related appurtenances, based upon Record Survey information. All changes to piping location including horizontal and vertical locations of utilities and appurtenances shall be clearly shown and referenced to permanent surface improvements and road rights-of-way. Drawings shall also show actual installed pipe material, class, etc.

10. As-Built Drawings shall clearly show all details not on original contract drawings but constructed in the field. All equipment and piping relocation shall be clearly shown Drawings shall clearly show all details not on original contract drawings but constructed in the field. All equipment and piping relocation shall be clearly shown.

11. Dimensions between all manholes, slope of gravity mains, invert and top elevations shall be shown.

12. Each As-Built Drawing shall be signed, sealed and dated by the licensed Surveyor as being an As-Built Drawings.

B. Record Documents

1. Three (3) hard copy sets and three (3) digital media sets of the final Record Documents and shall include all of the documents described below under this subsection.

2. The following documents shall be signed and sealed by the Surveyor:

   a. As-Built Asset Attribute Data Table (see Specification Section 01050 "Surveying and Field Engineering," Table 01050-2 for an example)

   b. Boundary Survey of pump station and Survey Map Report

   c. Boundary Survey and Survey Map Report for the location of constructed pipes within any easements and right-of-way. As a minimum the Survey Map Report shall identify or describe the locations where the pipe centerline was constructed within 3- feet of the easement or right-of-way boundary, where the pipe was constructed outside the easement or right-of-way boundary, any corners that had to be reset, measurements and computations made, pump station boundary issues, and accuracies obtained. Survey map report shall be dated after the Work within the right-of-ways or easements have been completed.

   d. Gravity Main Table (see Specification Section 01050 "Surveying and Field Engineering", Table 01050-4 for an example)

   e. Pipe Deflection Table (see Specification Section 01050 "Surveying and Field Engineering" Table 01050-3 for an example). An electronic blank table will be supplied by the County.

3. Digital sets of the final Record Documents including but not limited to:

    a. Scanned digital copies of the final As-Built Drawings

    b. Electronic Survey documents electronically sealed by the Surveyor

    c. Final Record Documents information

    d. Digital As-Built Drawing in the Engineer’s current version of AutoCAD file (dwg) format for the Contract Drawings, updated to match the final Record Drawing information

4. Pump station site Boundary Survey and Map Report.

5. New Boundary Survey to re-establish easement corners, right-of-way monuments, or pump station site corners with monuments if destroyed by the Work.

6. Scanned Documents: Scan the Survey Documents and other Record Documents reflecting changes from the Bid Documents.

7. The scanned "As-Built" Drawing sets shall be complete and include the title sheet, plan/profile sheets, cross-sections, and details. Each individual sheet contained in the printed set of the As-Built Drawings shall be included in the electronic drawings, with each sheet being converted into an individual tif (tagged image file). The plan sheets shall be scanned in tif format Group 4 at minimum of 400 dpi resolution to maintain legibility of each drawing. Then, the tif images shall be embedded into a single pdf (Adobe Acrobat) file representing the complete plan set. Review all Record Documents to ensure a complete record of the Project.

8. Provide an encompassing digital AutoCAD file that includes all the information of the As-Built Drawings and any other graphical information in the As-Built Drawings. It shall include the overall Work, utility system layout and associated parcel boundaries and easements. Feature point, line and polygon information for new or altered Work and all accompanying geodetic control and survey data shall be included. The

surveyor's certified As-Built Asset Attribute Data shall be added to the As-Built Drawings and Surveyor shall electronically seal the data in a comma-delineated ASCII format (txt).

C. Digital Record Drawing Submittal

A Record Drawing of the affected construction area shall be submitted in an encompassing digital CAD file that includes the overall utility system layout and the associated parcel features. Feature point, line and polygon information for new or altered structures in the work area and all accompanying geodetic control and survey data shall be included. The minimum requirements are as follows:

a. State Plane Coordinate System

(1) The drawing shall be submitted using state plane coordinate system with at least two points referenced to the County's geodetic control network with a horizontal accuracy of plus/minus three centimeters relative to the County's geodetic control network points used as reference. The points shall be certified by a surveyor registered in the state of Florida.

(2) Features in drawing files that are stored in drawing units will be translated to real world locations. The geodetic control chosen shall correspond to existing monuments in the County control network.

(3) The new structures and features shall be geographically registered to the geodetic control. State plane coordinates exist for most quarter section corners in Orange County. Control assistance can be obtained from the survey section of Public Works.

(4) If the geodetic control point is located within the project limits, it shall be symbolically indicated and annotated in the design file. If the nearest geodetic control is located well outside of the project area then it shall be tied to one of the other geodetic control points used,

and a reference tie annotated and indicated in the design file. The two geodetic control points described above are the least survey grade geo-referencing information a developer can use to create the plan view drawing. Please refer to the subsection, “Conventional and GPS Survey Standards” to understand the type of structures and survey grade needed for the additional geodetic information contained in this drawing. This document describes which structures need to be surveyed and created within the drawing according to its corresponding horizontal coordinates and vertical elevation.

(5) All drawings need to be geographically registered in the Florida State Plane Coordinate System. A licensed Surveyor shall set the vertical and horizontal control at the project site.

(a) Horizontal Datum: State Plane, Florida East Zone, Transverse Mercator Projection, National NGS Datum NAD of 1983, Re-adjustment of 1990 using the HARN (High Accuracy Reference Network) correction;

(b) Vertical Datum: Vertically corrected to the North American Vertical Datum of 1929.

b. The spatial accuracy of the feature data contained in the digital Record Drawing shall be equal to or better than the graphical data contained in the plan/profile sheets.

c. Pressure piping is to be entered as a single line between tees, wyes, and reducers. Pipe sections should be continuous through structures such as valves and other fittings. Pipes should be broken and joined by a suitable fitting when a line changes its diameter or material properties. For wastewater force mains, the line feature(s) shall be input using the same direction from point to point as the proposed or existing flow. Therefore, the starting point of force main line

segments within these layers shall be the upstream point and the downstream point shall be the endpoint of that segment. This procedure is required to indicate the continuity of flow and connectivity within the wastewater layers.

d. Gravity lines shall be entered as a single line, digitized in the direction of the design flow, and broken at manholes. The beginning point of the line would the upstream end and the ending point would be the downstream end.

e. Text identifying piping shall be aligned with the piping. Point and linear feature attribute text shall be visible on the drawing in a standard font and the lower left-hand corner of the text shall be just clear of the linear or point feature to which it corresponds, unless legibility requires that the label be moved and accompanied by a leader arrow. The labels shall be placed onto a separate layer and not to be placed in the feature layer. For reading from the bottom or right side of the plan sheet, the rotation angle shall be between -90 degrees and 90 degrees.

f. Features shall be placed on their appropriate layers and assigned colors by layer for consistency. Features shown in the AutoCAD files shall be in model space and be contained in the AutoCAD files as opposed to being linked to externally referenced files. CAD systems which use a numbering system for layers instead of names shall also include a conversion chart explaining which layer number corresponds with which layer name.

g. The GIS plan view layer shall be reviewed for duplicate objects, short objects, crossing objects, undershoots, clustered nodes, pseudo nodes, dangling objects or overshoots, and zero-length objects. Lines shall be continuous from structure to structure. Topology is provided by the end points of pipelines snapped to the end points of connecting lines, with a structure node being snapped to the end point. A point feature will be used to represent a structure such as a manhole or valve. The point feature shall be a

symbol block with its block insertion point at the point of intersection or end point of a line.

h. For preparation of the Record Drawings, the County will provide the Contractor the specific language to be utilized on each Drawing for the Record Drawing stamp. At a minimum the Record Dorawing will contain the following language: **"This document is a compiled representation of the constructed project, as prepared by the General Contractor: _____. The source and basis of information used in the preparation of the document, upon which the Engineer reviewed, was the General Contractor: _____. The Engineer did not confirm the accuracy or completeness of the information provided by the General Contractor:_____. This document is believed to be representative of the constructed condition in the opinion of the Engineer, however the accuracy and completeness of the information cannot be guaranteed. The Engineer shall not be held responsible for the accuracy of the material represented or the reuse of the material by others. These statements are required by rule 61G15-30, FAC for record documents that include information provided by others."** The County will provide the Contractor with the final specific wording to be contained within the Record Drawing stamp when project substantial completion is issued.

i. File format shall be AutoCAD (current edition utilized by the County) (dwg) or drawing interchange file (dxf). Dxf files can be created from all major CAD and GIS packages. Standard transfer media will be accepted. This media includes CD, DVD, and Iomega zip disks.

PART 3 - EXECUTION

A. Pre-Construction Meeting

Pre-construction Meeting: It is recommended that the Surveyor attend the Pre-construction meeting. At the pre-construction meeting the Contractor shall be provided with a blank electronic version of the spreadsheet for the tables: Asset Attribute Data and Pipe Deflection. The

Contractor's surveyor shall use these tables to input the data and shall not alter the table format or formulas.

B. Construction Progress Meetings

Contractor shall provide progressive Record Documents described below:

1. Construction Contract, As-Built Drawings, Specifications, General Conditions, Supplemental Conditions, Bid Proposal, Instruction to Bidders, Addenda, and all other Contract Documents.

2. Specifications and Addenda: Record manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed as well as any changes made by Field Order, Change Order or other.

3. Change orders, verbal orders, and other modifications to Contract.

4. Written instructions by the County as well as correspondence related to Requests for Information (RFIs).

5. Accepted Shop Drawings, samples, product data, substitution and "or-equal" requests.

6. Field test records, inspection certificates, manufacturer certificates and construction photographs.

7. As-Built Asset Attribute Data Table: Surveyor shall obtain field measurements of vertical and horizontal dimensions of constructed improvements. The monthly submittal shall include the Surveyor’s certified statement regarding the constructed improvements being within the specified accuracies as described in Specification Section 01050 "Surveying and Field Engineering", Table 01050-1 Minimum Survey Accuracies or if not, indicating the variances.

8. Gravity Main Table: Surveyor shall prepare and update a Gravity Main Table to include as a minimum the pipe segment identification, pipe lengths, manhole inverts and tops, and slopes for gravity mains. Surveyor shall certify the data entered are correct and indicate if the minimum slopes have not been met.

9. Pipe Deflection Table: Surveyor shall input the type of pipe, pipe manufacturer, PVC manufacturer deflection allowance, allowable angle of offset and radius of curvature, laying length of pipe, and coordinates. Surveyor shall certify the data entered are correct and indicate if the deflection allowance, offset or radius of curvature exceeds the manufacturer's recommendations.

C. Final Record Documents Submittal

Submit the Final Record Documents within 20-days after Substantial Completion.

1. Participate in review meetings as required and make required changes and promptly deliver the Final Record Documents to the County.

D. Storage and Preservation

1. Store Record Documents and samples at a protected location in the project field office apart from documents used for construction.

   a. Provide files and racks for storage of documents

   b. Provide locked cabinet or secure space for storage of samples

2. File documents and samples in accordance with CSI format with section numbers matching those in the Contract Documents.

3. In the event of loss of recorded data, use means necessary to again secure the data to the County's approval.

   a. Such means shall include, if necessary in the opinion of the County, removal and replacement of concealing materials.

   b. In such cases, provide replacements of the concealing materials to the standards originally required by the Contract Documents.

END OF SECTION

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SECTION 01740 CLEANING DURING CONSTRUCTION AND FINAL CLEANING

PART 1 - GENERAL

A. General

1. This section includes cleaning during construction and final cleaning on completion of the work.

2. At all times maintain areas covered by the Contract and adjacent properties and public access roads free from accumulations of waste, debris, and rubbish caused by construction operations.

3. Conduct cleaning and disposal operations to comply with local ordinances and antipollution laws. Do not burn or bury rubbish or waste materials on project site. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains. Do not dispose of wastes into streams or waterways.

4. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

B. Cleaning During Construction

1. During execution of work, clean site, adjacent properties, and public access roads and dispose of waste materials, debris, and rubbish to assure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.

2. Wet down dry materials and rubbish to lay dust and prevent blowing dust.

3. Provide containers for collection and disposal of waste materials, debris, and rubbish.

4. Cover or wet excavated material leaving and arriving at the site to prevent blowing dust. Clean the public access roads to the site of any material falling from the haul trucks.

C. Site Cleaning Prior to Landscaping

Remove concrete, concrete wash, stucco splatter, gunite overspray, and all other wastes and debris prior to final grading and landscaping.

D. Final Cleaning

1. At the completion of work and immediately prior to final inspection, clean the entire project site as follows.

2. Clean, sweep, wash, and polish all work and equipment including finishes.

3. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces; polish surfaces.

4. Repair, patch, and touch up marred surfaces to match adjacent surfaces.

5. Broom clean paved surfaces; rake clean landscaped areas.

6. Remove from the site all temporary structures and all materials, equipment, and appurtenances not required as a part of, or appurtenant to, the completed work.

END OF SECTION

DIVISION 2 – SITEWORK

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SECTION 02050 EQUIPMENT, PIPING, AND MATERIALS DEMOLITION

PART 1 - GENERAL

A. Description

This section describes demolition, removal, and replacement of existing mechanical and electrical equipment and piping.

PART 2 – MATERIALS

Refer to other sections of these specifications for material to be used in removing, replacing, and/or abandoning in place equipment.

PART 3 - EXECUTION

A. General

Perform removal, replacement, and demolition work specified and indicated in the drawings. Prepare remaining surfaces to receive new scheduled and specified materials and finishes or finish to match adjacent surfaces if no additional work is scheduled or indicated.

B. Removal

Remove equipment indicated in the drawings.

C. Replacement

Replace equipment indicated in the drawings or listed herein. Unload the removed equipment and store it in the location designated by the County. Install the new equipment in locations as indicated in the drawings and as summarized below:

D. Salvage

E. Equipment salvaged from the premises is the property of the County. Clean and prepare the equipment for storage as designated by the County RPR, including but not limited to flushing, draining of fluids, lubrication, etc… Carefully remove and handle the equipment. Place the equipment on pallets or other means to enable future relocation by

forklift. Wrap the equipment in shrink wrap or other means as designated by the County RPR to protect it. Tag, label or identify the equipment in a manner as designated by the County RPR. Unload the equipment within a storage location as designated by the County RPR. The Contractor shall develop a log in MS Excel of salvaged equipment using an alpha-numerical designation to document the location, identification tags, and other pertinent information as designated by the County RPR.

1. The following are major equipment elements that shall be salvaged as part of the Phase V Improvements. Not all the equipment to be salvaged within the project is identified herein. Reference the drawings for further elements to be salvaged.

Major Salvaged Equipment
1. Disconnect Panels (Process 220)
2. Control Panels (Process 220)
3. RAS Pump No. 4 (Process 240)
4. Composite Samplers (Processes 300 and 390)
5. Mechanical Bar Screens & Screw Conveyors (Process 300)
6. Phase III Blowers (Process 320)
7. Pumps, valves, scum equipment and salvageable appurtenances (Process 352)
8. Submersible Pumps (Process 360)

F. Existing Piping and Electrical Utilities

Shut off or disconnect utilities affecting demolition work. Schedule shutdowns with the County by processing a C.A.R form; notify the County seven (7) working days in advance of any shutdown that is required to perform the work. The County will open/close valves on piping, and electrical disconnects required for the shutdowns.

G. Removal or Relocation of Electrical Materials and Equipment

1. Unless otherwise noted, remove existing electrical materials and equipment from areas indicated for demolition or where equipment is to be relocated. Disconnect circuits at their source. Remove materials no longer used, such as studs, straps, and conduits. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least 3/4 inch below the final finished surface. Remove existing unused wires.

2. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface.

H. Patching

1. Patching shall mean the restoration of a surface or item to a condition as near as practicable to match the existing adjoining surfaces unless otherwise noted, detailed, or specified.

2. When patching involves painting, special coating, vinyl fabric, or other applied finish, refinish the entire surface plane (i.e., wall or ceiling), unless complete refinishing of the entire space is scheduled or specified.

3. Patching includes cleaning of soiled surfaces.

I. Demolition

1. Structures, boxes, pipes, and other items are to be removed, altered, salvaged, and disposed of as specified herein or indicated in the drawings. Remove and dispose of all portions of these items that interfere with project construction.

2. Remove and dispose offsite facilities to be demolished in their entirety including belowground footings, foundations, and other associated appurtenances, as shown in the drawings or as specified herein. Backfill and compact all site areas disturbed by demolition work with earth backfill or gravel material in accordance with Section 02200.

3. Perform the work in a manner that will not damage parts of the structure not intended to be removed or to be

salvaged for the County. If, in the opinion of the County's Representative, the method of demolition used may endanger or damage parts of the structure or affect the satisfactory operation of the facilities, promptly change the method when so notified by the County's Representative. No blasting will be permitted.

4. All equipment, material, and piping, except as specified to be salvaged for the County, or removed by others, within the limits of the demolition, excavations, and backfills, will become the property of the Contractor and shall be removed from the project site. The salvage value of this equipment, materials, and piping shall be reflected in the contract price of the demolition work.

5. Do not reuse material salvaged from demolition work on this project, except as specifically shown.

END OF SECTION

SECTION 02110 CLEARING, GRUBBING, AND STRIPPING

PART 1 - GENERAL

A. Description

This section describes the work included in clearing, grubbing, stripping, and preparing the project site for construction operations.

B. Clearing

Remove and dispose of trees, snags, stumps, shrubs, brush, limbs, and other vegetative growth. Remove all evidence of their presence from the surface including sticks and branches greater than 1 inch in diameter or thickness. Remove and dispose of trash piles and rubbish. Protect structures and piping above and below ground, trees, shrubs, and vegetative growth which are not designated for removal.

C. Grubbing

After clearing, remove and dispose of wood or root matter, including stumps, trunks, roots, or root systems greater than 1 inch in diameter or thickness to a depth of 12 inches below the ground surface.

D. Stripping

1. Remove and dispose of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped.

2. Retain topsoil material onsite for dressing backfill areas before planting.

PART 2 - MATERIALS

A. Trees and Shrubbery

Existing trees, shrubbery, and other vegetative material may not be shown in the drawings. Inspect the site as to the nature, location, size, and extent of vegetative material to be removed or preserved, as specified herein. Preserve in place trees that are specifically shown in the drawings and designated to be preserved.

B. Preservation of Trees, Shrubs, and Other Plant Material

1. Save and protect plant materials (trees, shrubbery, and plants) beyond the limits of clearing and grubbing from damage resulting from the work. No filling, excavating, trenching, or stockpiling of materials will be permitted within the drip line of these plant materials. The drip line is defined as a circle drawn by extending a line vertically to the ground from the outermost branches of a plant or group of plants. To prevent soil compaction within the drip line area, no equipment will be permitted within this area.

2. When trees are close together, restrict entry to area within drip line by fencing. In areas where no fence is erected, protect the trunks of trees 2 inches or greater in diameter by encircling the trunk entirely with boards held securely by 12-gauge wire and staples. This protection shall extend from ground level to a height of 6 feet.

3. Cut and remove tree branches where necessary for construction. Remove branches other than those required to affect the work to provide a balanced appearance of any tree. Treat cuts with a tree sealant.

PART 3 - EXECUTION

A. Clearing and Grubbing Limits

Clear and grub excavation and embankment areas associated with new structures, slabs, and roadways.

B. Disposal of Clearing and Grubbing Debris

Do not burn combustible materials. Remove cleared and grubbed material from the worksite and dispose.

C. Areas to be Stripped

Strip excavation and embankment areas associated with new structures, slabs, walks, and roadways. Strip stockpile areas.

D. Disposal of Strippings

Remove stripped material and dispose offsite, except topsoil.

END OF SECTION

SECTION 02160 TEMPORARY EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

A. Description

1. Design, furnish and install temporary excavation support systems as required to maintain lateral support, prevent loss of ground, limit soil movements to acceptable limits and protect from damage existing and proposed improvements including, but not limited to, pipelines, utilities, structures, roadways, railroads and other facilities.

2. Common types of excavation support system include, but are not limited to singular or multiple stages comprised of cantilevered or internally braced soldier piles and lagging, steel sheetpile wall, timber sheetpile wall, trench box, or combinations thereof. Trench box temporary excavation support system is only acceptable for pipe or utility trench excavations. Temporary unsupported open cut excavation with stable sloping sides is allowed where applicable.

3. Wherever the word "sheeting" is used in this section, it shall be in reference to any type of excavation support system specified except trench box.

4. Construction of the temporary excavation support systems shall not disturb the existing structures or the completed proposed structures. Damage to such structures shall be repaired by the Contractor at no additional cost to the Owner.

5. Adjacent structures are those that bear upon soils above the proposed excavation depth and within a distance equal to twice the total depth of the excavation away from the closest edge of the excavation. Monitor and protect adjacent structures as specified and indicated.

6. Vibration monitoring for excavation support systems will be performed by Contractor’s vibration consultant and monitoring firm. Vibration due to Contractor’s operations shall not exceed specified limits stated in Paragraph D.5.

7. Use only pile driver hammers with mufflers capable of significantly reducing noise and use barriers or shielding techniques to comply with applicable federal, state, and local ordinances.

8. The Contractor shall bear the entire cost and responsibility of correcting any failure, damages, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design of the temporary excavation support systems. The Contractor shall pay for all claims, costs and damages that arise as a result of the work performed at no additional cost to the Owner.

B. References

1. Florida Trench Safety Act

2. American Society for Testing and Materials (ASTM):

   a. A36: Standard Specification for Structural Steel

   b. A416: Standard Specification for Strand Steel, Uncoated Seven-Wire for Prestressed Concrete

   c. A572: Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel

   d. A722: Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete

   e. A615: Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

3. American Wood-Preserves Association (AWPA) Standards.

4. American Welding Society (AWS) Code: D1.1.

5. Federal Standard, FS TT-W-571: Wood Preservation and Treating Practices.

6. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Subpart P - Excavations, Trenching and Shoring.

7. American Concrete Institute (ACI)

8. ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

C. Submittals

1. Submit the following in accordance with the General Conditions, Section 01300, and the following:

   a. Submit the following qualifications four (4) weeks prior to the construction:

(1) Qualifications of independent vibration consulting and monitoring firm as specified in Paragraph D.4. Qualifications of Contractor's temporary excavation support system designer as specified in Paragraph D.7.

(2) Qualifications of Contractor's temporary excavation support system installer as specified in Paragraph D.8.

(3) Qualifications of Contractor's independent tieback testing laboratory as specified in Paragraph D.9, if a tieback system is utilized.

(4) Qualifications of Contractor's temporary excavation support system installation supervisor as specified in Paragraph D.10.

(5) Qualifications of vacuum excavation subcontractor as specified in Paragraph D.6, if DMPs for utilities are utilized.

2. Provide the Owner and Engineer a record of the temporary excavation support plan and calculations sealed and signed by a Registered Professional Structural Engineer in the State of Florida. The copy is to be provided at least four (4) weeks prior to start of the construction of the respective work where the support will be required. The copy will be for documentation of temporary excavation support plan for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. This information will not be reviewed or accepted by the Owner and Engineer in any manner so as to relieve the Contractor from sole responsibility from maintaining the temporary excavation support systems. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:

   a. Proposed temporary excavation support system(s), details, location, layout, depths, extent of different types of support relative to existing features and the permanent structures to be constructed, and methods and sequence of installation and removal.

   b. Certificate of Design: Submit three (3) paper copies of form 02610-1, signed and sealed by the responsible design professional, for each produce and system

specifically assigned to Contractor to be designed or certified by a design professional. Indicate that products and systems comply with performance and design criteria in the contract documents. Include list of codes, loads, and other factors used in performing these services.

c. A list of all design assumptions, including safety factors used for the temporary excavation support system(s) and all lateral pressures used for each system.

d. If utilizing a tieback system, include tieback installation procedures and criteria for acceptance of tiebacks for performance and proof tests. Submit the tieback testing results to the Engineer for information only.

e. Requirements of dewatering during the construction.

f. Minimum lateral distance from the edge of the excavation support system for use for vehicles, construction equipment, and stockpiled construction and excavated materials.

g. List of equipment used for installing the excavation support systems.

3. Monitoring schedule, installation procedures and location plans for movement monitoring, vibration/noise monitoring, geotechnical instrumentation (deformation monitoring points, inclinometers, etc.) and observation wells/ piezometers to monitor ground, excavation support system, adjacent structures and groundwater fluctuation during the entire construction period. The monitoring plan shall include the survey of the temporary support systems by a Registered Professional Surveyor in the State of Florida. The surveyor and structural engineer are to determine a monitoring plan and identify it within the monitoring plan. The monitoring plan shall also include a Construction Contingency Plan for addressing inclement weather and hurricane(s).

4. Submit a Construction Contingency Plan specifying the methods and procedures to maintain temporary excavation support system stability if the allowable movement of the adjacent ground and adjacent structures is exceeded.

5. The Owner’s Representative and Engineer shall be provided with the following information to provide reasonable

assurance that the Contractor is successfully maintaining the temporary excavation support system. This information will not be reviewed or accepted by the Owner and Engineer in any manner so as to relieve the Contractor from sole responsibility from maintaining the temporary excavation support systems. Monitoring data is to be provided within one (1) calendar day of data collection from surveyor, vibration and noise recording equipment, observation wells, deformation monitoring points and offset lines. At a minimum the data shall include:

a. Horizontal and vertical movements by surveyor, geotechnical instruments and groundwater readings.

b. New movements since the initial readings of the geotechnical instruments and surveyor.

c. Weekly summary in tabular and/or graphic form.

d. A schematic plan of excavation and/or relevant construction activities at the time of monitoring.

6. For excavation support systems left in place, submit the following as-built information prior to backfilling and covering the excavation support systems:

a. Survey locations of the temporary excavation support systems, including coordinates of the ends and points of change in direction.

b. Type of the temporary excavation support system.

c. Elevations of top and bottom of the excavation support systems left in place.

7. Prior to preparation of the temporary excavation support plan, the Contractor shall perform subsurface utility exploration in all areas where sheeting is proposed. The temporary excavation support plan shall include the provisions for avoidance of the existing utilities.

D. Quality Assurance

1. The Contractor is responsible for controlling the quality of work, including work of its subcontractors and suppliers and for assuring the quality specified is achieved. Means and methods of construction and installation processes are the responsibility of the Contractor, and at no time is it the intent of the Engineer or Owner to supersede or void that responsibility.

2. Conform to the requirements of the OSHA Standards and Interpretations: "Part 1926 Subpart P - Excavation, Trenching, and Shoring", and all other applicable laws, regulations, rules, and codes.

3. Construction operations to conform to noise regulations provided in the Noise Control Plan and this Section.

4. Retain the services of an independent vibration consulting firm with the following in-house personnel to conduct the following vibration monitoring requirements:

    a. Preparing, reviewing and signing of monitoring plans and daily reports, and overseeing of the monitoring and interpretation of the vibration data shall be performed by personnel with the following qualifications:

        (1) Be a Registered Professional Structural Engineer in the State of Florida.

        (2) Have a minimum of five (5) years experience in the vibration consulting field.

        (3) Have successfully completed at least five (5) projects with vibration-inducing construction operations, pile driving, and noise levels equal to or more severe than those to be encountered.

    b. Assist Contractor in selecting pile driving equipment which will generate the lowest vibration and noise levels.

    c. Installation, monitoring and interpretation of monitoring equipment shall be performed by personnel with the following qualifications:

        (1) Have at least three (3) years of experience in the operation of monitoring equipment proposed for use and interpretation of records produced by such equipment.

        (2) Have installed, operated, monitored and interpreted equipment and records on at least three (3) projects with vibration-inducing construction operations, pile driving, and noise levels equal to or more severe than those to be encountered.

5. The peak particle velocity for pile driving, or other vibration-inducing operations, shall not exceed the following:

Type of Concrete	Age of Concrete, hrs	Peak Particle Velocity in/sec
Mass Concrete (footings, mats, Slab-on-grade, fill concrete, etc.)	0-11	1.0
	11 and over	2.0
Concrete Structures (walls, columns, elevated slabs, etc.)	0-11	0.5
	11-24	1.0
	24 and over	2.0
Existing Structures, - residences or utilities		0.5

6. If utilizing deformation monitoring points (DMPs) for utilities, vacuum excavation shall be performed by subcontractor having five (5) years of experience in non-destructive vacuum excavation methods for utilities.

7. Prepare design, including calculations and drawings, under the direction of a Professional Structural Engineer licensed in the State of Florida having the following qualifications:

   a. Not less than ten (10) years experience in the design of specific temporary excavation support systems to be used.

   b. Completed not less than five (5) successful temporary excavation support system projects of equal type, size, and complexity within the last five (5) years.

8. Temporary Excavation Support System Installer's Qualifications:

   a. Not less than three (3) year experience in the installation of similar types and equal complexity as the proposed system.

   b. Completed not less than three (3) successful excavation support systems of similar type and equal complexity as the proposed system.

9. If utilizing a tieback system, employ an independent testing laboratory to test the tieback system with the following qualifications:

    a. Be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program.

    b. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor tieback systems of similar type and equal complexity, as the proposed system.

    c. Have not less than five (5) years experience in testing of tieback systems of similar type and equal complexity as the proposed system.

    d. Have successfully tested at least three (3) tieback systems of similar type and equal complexity as the proposed system.

10. Install all temporary excavation support systems under the supervision of a supervisor having the following qualifications:

    a. Not less than five (5) years experience in installation of systems of similar type and equal complexity as the proposed system.

    b. Completed at least five (5) successful temporary excavation support systems of similar type and equal complexity as the proposed system.

11. All welding shall be performed in accordance with AWS D1.1.

E. Design Criteria

1. Design of temporary excavation support systems shall meet the following minimum requirements:

    a. Support systems shall be designed for earth pressures, hydrostatic pressure, equipment, temporary stockpiles, construction loads, roadways, railroads, and other surcharge loads.

    b. Design a bracing system to provide sufficient reaction to maintain stability.

c. Limit movement of ground adjacent to the excavation support system to be within the allowable ground deformation as specified.

d. Design the embedment depth below bottom of excavation to minimize lateral and vertical earth movements and provide bottom stability. Toe of braced temporary excavation support systems shall not be less than 5 feet below the bottom of the excavation.

e. Design temporary excavation support systems to withstand an additional 2 feet of excavation below proposed bottom of excavation without redesign except for the addition of lagging and/or bracing.

f. Maximum width of pipe trench excavation shall be as indicated on the drawings.

g. Do not cast permanent structure walls directly against excavation support walls.

h. The design location of the excavation support wall shall be determined such that the installed wall and bracing system components are all located outside the limits of the permanent structure. Construction tolerances (e.g. wall verticality) shall be considered in determining the plan location.

F. Delivery, Storage and Handling

Store sheeting and bracing materials to prevent sagging which would produce permanent deformation. Keep concentrated loads which occur during stacking or lifting below the level which would produce permanent deformation of the material.

G. Project/Site Conditions

Subsurface Conditions: Refer to Appendix B. The geotechnical criteria provided in Appendix B is for general reference information only and not intended to be utilized for the design of the Temporary Excavation Support System. The Structural Engineer responsible for the development of the Temporary Excavation Support System shall utilize geotechnical information as required and procured by the Structural Engineer for purposes of development of the Temporary Excavation Support System.

PART 2 - PRODUCTS

A. Materials

1. Structural Steel: All soldier piles, wales, rakers, struts, wedges, plates, waterstop and accessory steel shapes shall conform to ASTM A36.

2. Steel Sheet Piling: ASTM A572, continuous interlocking type.

3. Timber Lagging Left in Place: Pressured treated per appropriate AWPA standards.

4. Tieback Tendons: Tieback tendons shall be high strength steel wire strand cables conforming to ASTM A416, or bars conforming to ASTM A722. Splicing of individual cables shall not be permitted.

5. Raker Ties: ASTM A615 Grade 60.

6. Cement Grout Materials And Admixtures For Tieback Anchorages: Grout cube strength shall be a minimum 3500 psi at 7 days and 5000 psi at 28 days.

7. Concrete: Section 03300.

8. Tamping tools adapted for backfilling voids after removal of the excavation support system.

9. Provide specific trench box sizes for each pipe and utility excavation with structural capacity of retaining soil types as described in OSHA's 29 CFR Part 1926 Subpart P.

B. Equipment

A vibratory hammer shall be utilized for driving the temporary sheet piling providing that such operations do not exceed vibration/noise requirements of the specifications. Impact hammer shall be utilized when vibratory hammer is unable to drive temporary sheet piling to required depth and/or unable to meet vibration requirements. Impact hammer shall also meet noise requirement.

PART 3 - EXECUTION

A. Installation

1. Installation of the temporary excavation support systems shall not commence until the related earth excavation and dewatering submittals have been reviewed by the Engineer with all Engineer’s comments satisfactorily addressed. Submit Construction Administration Request (CAR) to the Owners Representative a minimum of seven (7) calendar days in advance of the work.

2. Install excavation support systems in accordance with the temporary excavation support plan.

3. If utilizing a tieback system, all performance and proof tests shall be conducted in the presence of the Engineer. Testing performed without the Engineer present will not be accepted. Repeat testing in the Engineer's presence at no additional cost to the Owner.

4. Do not drive sheeting within 100 feet of concrete less than seven (7) days old.

5. Carry out program of temporary excavation support in such a manner as to prevent undermining or disturbing foundations of existing structures of work ongoing or previously completed.

6. Bottom of the trench box excavation support system shall be above the pipe invert prior to installing the pipe.

7. Install and read geotechnical instrumentation in accordance with the temporary excavation support plan. Notify the Owner’s Representative immediately if any geotechnical instrumentation is damaged. Repair or replace damaged geotechnical instrumentation at the sole option of the Engineer and at no additional cost to the Owner.

8. Continuously monitor movements of the ground adjacent to excavation support systems and adjacent structures. In events of the measured movements approaching or exceeding the allowable movements, take immediate steps to arrest further movement by revising procedures such as providing supplementary bracing, filling voids behind the trench box, supporting utilities or other measures (Construction Contingency Plan) as required.

9. Notify the Owner’s Representative if existing utilities interfere with the temporary excavation support system. Modify the existing utility with the Owner’s permission or

have the Owner make the modifications at no additional cost to Owner.

10. If existing utilities span the excavation, the Structural Engineer responsible for the development of the Temporary Excavation Support System shall provide the Contractor the design criteria and details for temporary support of the existing utilities.

B. Ground Deformation Adjacent to Excavation Support Systems

1. Allowable Vertical (heave/settlement) and Lateral Movements: 2 inches maximum for the trench box excavation support system, and 1 inch maximum for other types of excavation support systems at any location behind the excavation support system.

2. Monitoring personnel shall use a procedure for reading and recording geotechnical instrumentation data which compares the current reading to the last reading during data collection to eliminate spurious readings.

3. Plot the observed ground deformation readings versus time. Annotate the plots with construction loading and excavation events having an impact on the readings. Evaluate plots by means of secondary rate-of-change plots to provide early warning of accelerating ground movements.

4. Notify the Owner’s Representative immediately when the allowable ground deformation is exceeded.

5. Implement Construction Contingency Plan under direction of Structural Engineer who is in Responsible Charge for the temporary excavation support system.

C. Removal Of Earth Retention System:

1. Unless required to perform the work in accordance with the Contract Documents, the sheeting shall be left in place.

2. In cases where sheeting must be removed, remove the temporary excavation support system without endangering the constructed or adjacent structures, utilities, or property. Immediately backfill all voids left or caused by withdrawal of temporary excavation support systems with bank-run gravel, screened gravel or select borrow by tamping with tools specifically adapted for that purpose.

3. When tiebacks are used, release tension in tiebacks as the excavation is backfilled. Do not leave tensioned tieback in place at the completion of the work.

4. The excavation support system left-in-place shall be cut-off a minimum of 2 feet below the bottom of the next higher foundation level or a minimum of 5 feet below finished grade, or as directed by the Structural Engineer responsible for the Temporary Excavation Support System.

5. Conduct survey of the locations and final cut-off elevations of the excavation support systems left in place.

D. Contract Closeout

Provide in accordance with Section 01700.

END OF SECTION

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SECTION 02200 EARTHWORK

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of earthwork for excavations, fills, and embankments for roadways, structures, and sites.

B. Submittals

Submit six copies of a report from a testing laboratory verifying that the material contains less than 1% asbestos by weight or volume and conforms to the gradation specified.

C. Testing for Compaction

1. The Owner will test for compaction and relative density as described below.

2. Determine the density of soil in place by the sand cone method, ASTM D 1556. Compaction tests will be performed for each lift or layer.

3. Determine laboratory moisture-density relations of soils per ASTM D 698.

4. Determine the relative density of cohesionless soils per ASTM D 4253 and D 4254.

5. Sample backfill materials per ASTM D 75.

6. "Relative compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density.

D. Disposal of Excess Materials

Excess site excavated or wasted material shall be disposed of offsite by the Contractor at his expense. No prearranged disposal site or related permits have been determined or secured by the Owner.

E. Material Availability

Sufficient earthwork material to complete the work is not available at the site. Secure source of material and permits to complete the project requirements.

PART 2 - MATERIALS

A. Structural Fill & Backfill

1. Structural backfill shall consist of clean, fine to medium sand, contain less than 1% by weight asbestos or organic matter (peat, humus, leaves, and carbon compounds), and conform to the following gradation requirements:

Sieve Size	Percent Passing By Weight
3/4 inch	100
1/2 inch	95 - 100
3/8 inch	50 - 100
No. 4	20 - 65
No. 8	10 - 40
No. 40	0 - 20
No. 200	0 - 5

2. Excavated material may be used for structural backfill provided it conforms to the above specifications for structural backfill material.

B. Sand, Including Imported Sand for Pipe Zone and Pipe Bedding in Pipe Trenches

1. Granular material free from clay balls, organic matter, and other deleterious substances and conforming to the following gradations:

Sieve Size	Percent Passing By Weight
3/8 inch	100
No. 4	75 - 100
No. 30	12 - 50
No. 100	5 - 20
No. 200	0 - 10

2. Sand shall have a coefficient of permeability greater than 0.014 cm/s measured in accordance with ASTM D2434. Native material may be used in lieu of imported sand if it is shown by the Contractor that it is in compliance with the aforementioned requirements.

C. Sand-Cement Slurry Backfill

Sand-cement slurry backfill shall consist of one sack (94 pounds of Type I or II portland cement added per cubic yard of imported sand and sufficient water for workability.

D. Water for Compaction

Water shall be free of organic materials and shall have a pH of 7.0 to 9.0, a maximum chloride concentration of 500 mg/l, and a maximum sulfate concentration of 500 mg/l. Provide all water needed for earthwork. Provide temporary piping and valves to convey water from the source to the point of use. Provide any meters if the water is taken from a County pipeline.

E. Aggregate Base for Hydraulic Structures

Aggregate base shall be No. 57 stone in accordance with the requirements of Section 901 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction, 2010 edition.

F. Drain Material

Drain rock, or crushed rock, shall consist of hard, durable particles of stone, crushed to the required gradation below per AASHTO T-27 or ASTM C136, and shall be free from vegetable matter, lumps of clay, and other deleterious matter size:

Sieve Size	**Percent Passing by Weight**
1 inch	100
3/4 inch	90 – 100
1/2 inch	30 – 60
3/8 inch	0 – 20
No. 4	0 - 5

G. Filter Fabric

1. Filter fabric shall be manufactured from polyester, nylon, or polypropylene material; shall be of woven construction; and shall meet the following requirements:

   a. Grab tensile strength (ASTM D1682): 100 lbs minimum for a 1-inch grip.

   b. Equivalent open sizes (UFGS-02373)

2. Filter fabric shall be MIRAFI, manufactured by Mirafi Inc., Charlotte, North Carolina; or equal

H. Drainpipe

Underdrain or back of wall drainpipe shall be ABS or PVC.

I. Membrane Liner

1. Lexsuco's "Membrane Waterproofing," Rubber and Plastics Compound Company's "Nervastral Seal-Pruf H-D," or equal, PVC plastic membrane sheeting, 30 mils thick.

2. Sheets shall be as wide as practicable for application that will result in the least number of laps.

J. Adhesive for Membrane Liner

Lexsuco M-W, Type A cement, "Nerva-Plast" cement, or equal, synthetic rubber base cement especially manufactured for use with PVC membrane material for cold application. Do not use asphaltic base adhesives.

PART 3 - EXECUTION

A. Dewatering

Provide and operate equipment adequate to keep excavations and trenches free of water. Dewater subgrade to a minimum of 2 feet below bottom of excavation. Remove water during period when concrete is being deposited, when pipe is being laid, and during the placing of backfill. Avoid settlement or damage to adjacent property. Dispose of water in a manner that will not damage adjacent property. When dewatering open excavations, dewater from outside the structural limits and from a point below the bottom of the excavation. Obtain (if necessary) and comply with discharge permit from St. John’s River Water Management District.

B. Excavation

1. Excavation is unclassified. Perform excavation regardless of the type, nature, or condition of the material encountered to accomplish the construction. Do not operate excavation equipment within 3 feet of existing structures or newly completed construction. Excavate with hand tools in these areas.

2. Excavations shall have sloping, sheeting, shoring, and bracing conforming with current State &/or Federal OSHA requirements and the General Conditions.

3. After the required excavation has been completed, the Owner will observe the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation be conducted in all areas within the influence of the structure where unacceptable subgrade materials exist at the exposed subgrade. Overexcavation shall include the removal of all such unacceptable material that exists directly beneath the structure or within a zone outside and below the structure defined by a line sloping at 1-horizontal to 1-vertical from 1 foot outside the edge of the footing. Refill the overexcavated areas with structural backfill material.

4. The Contractor will not receive any additional payment for refill material used for his convenience.

C. Limits of Foundation Excavation

Excavate to the depths and widths needed to accomplish the construction. Allow for forms, working space, structural backfill, and site grading. Do not excavate for footings, slabs, or conduits below elevations indicated. Unless unacceptable material is encountered and overexcavation is authorized by the Owner, backfill overexcavations with compacted structural backfill material. Correct cuts below grade by trimming adjoining areas and creating a smooth transition. The Contractor shall bear all costs for correcting unauthorized overexcavated areas.

D. Preparation of Foundation Subgrade

1. The existing location shall be cleared, stripped and grubbed as specified within Section 02110.

2. The finished subgrade shall be within a tolerance of ±0.08 of a foot of the grade and cross section indication, shall be smooth and free from irregularities, and shall be at the specified relative compaction. The subgrade shall extend over the full width and area extending a minimum of 5-feet beyond the edges of the foundations.

3. Scarify the final subgrade surface and compact the top 24 inches of the subgrade to a minimum density equivalent to 98% of the maximum modified Proctor dry

density (ASTM D-1557) to a depth of 24-inches below the bottom elevation of the foundation.

4. Remove soft material encountered and replace with structural backfill. Fill holes and depressions to the required line, grade, and cross sections with structural backfill.

5. If rock is encountered at final grade, overexcavate to a depth of 6 inches and place structural backfill to establish final grade.

E. Preparation for Placing Structural Fill and Backfill

1. After excavation of existing material or removal of unacceptable material at the exposed subgrade, scarify the final subgrade surface to a depth of 12 inches and compact to a minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557).

2. Remove foreign materials and trash from the excavation before placing any fill material. Obtain the specified compressive strength and finish of concrete work per Sections 03300 before backfilling.

F. Placing and Compacting Fill and Structural Fill

1. Excavated material may be used for fill providing all deleterious materials have been removed from the stockpiled material.

2. Place backfill in maximum 8-inch lifts and compact each lift to a minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557).

3. Where fill is to be constructed on slopes steeper than 3:1, bench the fill into competent undisturbed materials as the fill progresses up the slope. Benches shall be sloped at least 2% into the slope and shall be of a width at least equal to the height of fill lift.

G. Placing and Compacting Structural Backfill

1. Place structural backfill material around piping, structures, channels, and other areas, including authorized overexcavation areas, to the lines and grades shown or specified. Do not exceed loose lifts of 8 inches in depth.

2. Limits of Structural Backfill: Limits of structural backfill shall be a minimum of 5.0 feet from edge of foundation and shall extend at a 1:1 slope to the finish grade.

3. Compact each lift to a minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557). Stop structural backfill at least 6 inches below finished grade in all areas where topsoil is to be replaced.

4. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides. Comply with backfill preparation around concrete structures as specified in Section 03300.

5. Do not backfill the walls of structures that are laterally restrained or supported by suspended slabs or slabs on grade until the slab is poured and the concrete has reached the specified compressive strength.

6. Do not operate earthmoving equipment within 7 feet of walls of concrete structures. Place and compact fill or backfill adjacent to concrete walls with hand-operated tampers or other equipment that will not damage the structure.

7. Backfill adjacent to water-holding basins and channels only after leakage tests have been conducted as specified in Section 03800.

8. Monitor concrete structures during all backfill operations and stop work if there is damage to or a resultant reaction observed within structure.

H. Moisture Control of Backfills and Embankments

During the compacting operations, maintain optimum practicable moisture content required for compaction purposes in each lift of the backfill material. Maintain uniform moisture content throughout the lift. Insofar as practicable, add water to the material at the site of excavation. Supplement by sprinkling the backfill material. At the time of compaction, the water content of the material shall be at optimum water content or within 2 percentage points above optimum. Aerate material containing excessive

moisture by blading, discing, or harrowing to hasten the drying process.

I. Site Grading

Perform earthwork to the lines and grades shown in the drawings. Shape, trim, and finish slopes of channels to conform with the lines, grades, and cross sections as shown. Remove exposed roots and loose rocks exceeding 3 inches in diameter. Round tops of banks to circular curves of not less than a 3-foot radius. Neatly and smoothly trim rounded surfaces. Do not overexcavate and backfill to achieve the proper grade.

J. Vapor Barrier Installation

1. Place vapor barrier with adjacent sheets bonded per manufacturer's requirements.

2. Lay vapor barrier sheets directly over the compacted subgrade just before sand cushion is placed and concrete is poured. Carefully install to avoid puncture or tear. Patch punctures and tears occurring during subsequent operations. Lap edges at least 4 inches and lap end joints at least 6 inches, with laps continuously sealed with tape. Carry barrier over any pipes laid on the fill and seal in waterproof manner to any pipes or conduits which penetrate the fill. Turn up membrane a minimum of 2 inches at the edges and secure to exterior wall foundations or footings with adhesive. Apply vapor barrier to walls with the same adhesive. Do not place stakes through vapor barrier membranes for screeding of concrete slabs.

END OF SECTION

SECTION 02222 PROTECTING EXISTING UNDERGROUND UTILITIES

PART 1 - GENERAL

A. Description

This section includes materials and procedures for protecting existing underground utilities.

PART 2 - MATERIALS

A. Replacement in Kind

Except as indicated below or as specifically authorized by the County's Representative, reconstruct utilities with new material of the same size, type, and quality as that removed.

PART 3 - EXECUTION

A. General

1. Replace in kind street improvements, such as curbs and gutters, barricades, traffic islands, signalization, fences, signs, etc., that are cut, removed, damaged, or otherwise disturbed by the construction.

2. Where utilities are parallel to or cross the construction but do not conflict with the permanent work to be constructed, follow the procedures given below. Notify the utility owner 48 hours in advance of the crossing construction and coordinate the construction schedule with the utility owner's requirements. For utility crossings not shown in the drawings, refer to the General Conditions and the instructions of the Owner's Representative for guidance.

3. Determine the true location and depth of utilities and service connections which may be affected by or affect the work. Determine the type, material, and condition of these utilities. In order to provide sufficient lead time to resolve unforeseen conflicts, order materials and take appropriate measures to ensure that there is no delay in work.

B. Procedures

1. Protect in Place: Protect utilities in place, unless abandoned, and maintain the utility in service, unless otherwise specified in the drawings or in the specifications.

2. Cut and Plug Ends: Cut abandoned utility lines and plug the ends. Plug storm drains and sewers with an 8-inch wall of brick and mortar. Cap waterlines with a cast-iron cap or install a 3-foot-long concrete plug. Dispose of the cut pipe as unsuitable material.

3. Remove and Reconstruct: Where so indicated in the drawings or as required by the County's Representative, remove the utility and, after passage, reconstruct it with new materials. Provide temporary service for the disconnected utility.

C. Compaction

1. Utilities Protected in Place: Backfill and compact under and around the utility so that no voids are left.

2. Utilities Reconstructed: Prior to replacement of the utility, backfill the trench and compact to an elevation 1 foot above the top of the ends of the utility. Excavate a cross trench of the proper width for the utility and lay, backfill, and compact.

3. Alternative Construction--Sand Slurry: Sand slurry consisting of one sack (94 pounds) of portland cement per cubic yard of sand and sufficient moisture for workability may be substituted for other backfill materials to aid in reducing compaction difficulties. Submit specific methods and procedures for the review of the County's Representative prior to construction.

D. Special Construction

1. Reinforced Concrete Beam: Where indicated in the drawings or as determined by the County's Representative, support utilities by a reinforced concrete beam. The primary purpose of the beam is to prevent settlement of the utility line after construction. The Contractor is responsible for the protection of the utility during construction and shall incorporate the beam as part of the protection.

2. Concrete Support Wall: Where indicated in the drawings or as determined by the County's Representative, support the utilities by a concrete support wall as shown on the utility support details in the drawings. The purpose of the concrete support wall is to prevent settlement of the utility line after construction. The Contractor is responsible for the protection of the utility during construction.

E. Thrust Blocks on Waterlines

1. The Contractor's attention is called to thrust blocks for pipelines throughout the project whose thrust is in the direction of the new excavation and, therefore, may be affected by the construction. These pipelines are owned and operated by the County. Protect thrust blocks in place or shore to resist the thrust by a means accepted by the County's Representative and reconstruct. If the thrust blocks are exposed or rendered to be ineffective in the opinion of the County's Representative, reconstruct them to bear against firm unexcavated or backfill material or restrain pipe mechanically.

2. Provide firm support by backfilling that portion of the trench for a distance of 2 feet on each side of the thrust block to be reconstructed from the pipe bedding to the pavement subgrade, with either:

   a. Sand-cement slurry (94 pounds of cement per cubic yard).

   b. The native material compacted to a relative compaction of 95%.

3. Then excavate the backfill material for construction of the thrust block.

4. Test compaction of the backfill material before pouring any concrete thrust block. Use Class A concrete per Section 03300 for reconstruction.

END OF SECTION

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SECTION 02223 TRENCHING, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation for pipeline trench excavation, backfilling, and compacting.

B. Submittals

1. Submit six copies of a report from a testing laboratory verifying that material conforms to the specified gradations or characteristics for pea gravel, granular material, imported sand, rock refill for foundation stabilization, and water.

2. Submit method of compaction in pipe zone including removal sequence of shoring where used.

C. Testing for Compaction

The County will test for compaction as described in Section 02200.

D. Pavement Zone

The pavement zone includes the asphalt concrete and aggregate base pavement section placed over the trench backfill.

E. Street Zone

The street zone is the top 30 inches of the trench immediately below the pavement zone in paved areas.

F. Trench Zone

The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the street zone in paved areas or to the existing surface in unpaved areas.

G. Pipe Zone

The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level above the top of the pipe, as specified below. Where

multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipes to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe shall be as follows unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed.

Pipe Diameter	Thickness of Pipe Zone Above Top of Pipe
6 inches or smaller	6 inches
8 inches and larger	10 inches

H. Pipe Base or Bedding

The pipe base or bedding shall be defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded. Thickness of pipe base shall be as follows unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed.

Pipe Diameter	Thickness of Pipe Base
16 inches or smaller	4 inches
18 inches and larger	6 inches

PART 2 - MATERIALS

A. Pea Gravel

Pea gravel shall be rounded gravel, graded with less than 10% passing a No. 200 sieve, less than 50% passing a No. 4 sieve, and having a maximum particle size as follows:

Type of Pipe	Maximum Particle Size (inches)
Ductile iron	¾

B. Granular Material for Backfill--Street and Trench Zones

Granular material or granular soil for backfill used above the pipe zone shall be lean bank-run or pit-run gravel, or

native soil. The maximum particle size shall be 2 inches. A maximum of 10% shall pass a No. 200 sieve.

C. Common Fill

1. Native earth backfill used above the pipe zone shall be excavated fine-grained materials free from roots, debris, rocks larger than 3 inches, asbestos, organic matter, clods, clay balls, broken pavement, and other deleterious materials. Less than 50% shall pass a No. 200 sieve. At least 40% shall pass a No. 4 sieve. The coarser materials shall be well distributed throughout the finer material.

2. Backfill materials that are obtained from trench excavated materials to the extent such material is available shall be either screened directly into the trench or screened during the trenching operation. If screened during trenching, the material shall be maintained free of unscreened material during the handling and backfilling process. Hand selecting of rocks from earth as it is placed into the trench will not be permitted in lieu of the specified screening. Under no circumstances will native earth backfill be allowed or used in the pipe base or pipe zone areas. Backfill shall be moisture conditioned to within approximately 2% of the optimum moisture content prior to being placed in trench.

D. Imported Sand--Pipe Zone and Pipe Base

See Section 02200.

E. Gravel and Crushed Rock--Pipe Zone and Pipe Base

Gravel or crushed rock material shall conform to the Florida DOT Section 901, "Coarse Aggregate," Grade 357.

F. Permeable Material for Underdrains--Pipe Zone and Pipe Base

1. Permeable material shall consist of hard, durable, clean sand, gravel, or crushed stone and shall be free of organic material, clay balls or other deleterious substances. Gradation shall be:

Sieve Size	Percent Passing By Weight
3/4 inch	100
1/2 inch	95 - 100
3/8 inch	70 - 100
No. 4	0 - 55
No. 8	0 - 10
No. 200	0 - 3

2. Durability Index shall be at least 40 per ASTM D 3744.

G. Sand-Cement Slurry--Pipe Zone

Sand-cement slurry backfill shall consist of one sack (94 pounds) of Type I or II portland cement added per cubic yard of imported sand and sufficient water for workability.

H. Rock Refill for Foundation Stabilization

Rock refill shall be crushed or natural rock containing less than 1% asbestos by weight or volume, having the following gradation:

Sieve Size	Percent Passing By Weight
3 inches	100
1-1/2 inches	70 - 100
3/4 inch	60 - 100
No. 4	25 - 55
No. 30	10 - 30
No. 200	0 - 10

I. Water for Compaction

See Section 02200. Water shall be free of organic materials injurious to the pipe coatings.

J. Underground Plastic Warning Tape for Metal Pipe

See Section 15075.

K. Underground Detectable Metallic Pipe Warning Tape

See Section 15075.

PART 3 - EXECUTION

A. Compaction Requirements

Unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

1. Pipe Zone: minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557).

2. Backfill in Trench Zone Not Beneath Paving: minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557).

3. Backfill in Trench Zone to Street Zone in Paved Areas: minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557).

4. Backfill in Street Zone in Paved Areas: minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557).

5. Refill for Overexcavation: minimum density equivalent to 98% of the maximum modified Proctor dry density (ASTM D-1557).

B. Sidewalk, Pavement, and Curb Removal

Cut bituminous and concrete pavements regardless of the thickness and curbs and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Width of the pavement cut shall be at least equal to the required width of the trench at ground surface. Haul pavement and concrete materials from the site. Do not use for trench backfill.

C. Material Replacement

Remove and replace any trenching and backfilling material which does not meet the specifications, at the Contractor's expense.

D. Trench Widths

Trench widths in the pipe zone shall be as shown in the drawings. If no details are shown, maximum width shall be 18 inches greater than the pipe outside diameter. Comply with

29CFR Part 1926 Subpart P--Excavations. Trench width at the top of the trench will not be limited except where width of excavation would undercut adjacent structures and footings. In such case, width of trench shall be such that there is at least 2 feet between the top edge of the trench and the structure or footing.

E. Trench Excavation

Excavate the trench to the lines and grades shown in the drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base or special bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the County with imported sand. Place the refilling material over the full width of trench in compacted layers not exceeding 6 inches deep to the established grade with allowance for the pipe base or special bedding.

F. Location of Excavated Material

1. During trench excavation, place the excavated material only within the working area or within the areas shown in the drawings. Do not obstruct any roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material.

2. Remove and store excavated topsoil separately. Replace topsoil in the top 24 inches of the trench zone.

3. Locate trench spoil piles at least 15 feet from the tops of the slopes of trenches. Do not operate cranes and other equipment on the same side of the trench as the spoil piles.

G. Trench Excavation in Backfill and Embankment Areas

1. Construct and compact the embankment to an elevation of 1 foot minimum over the top of the largest pipe or conduit to be installed.

2. Excavate trench in the compacted backfill or embankment. Place pipe base material, install pipe or conduit, and backfill with pipe zone material. Compact backfill above the pipe zone to the same relative compaction as the adjacent embankment as specified in Section 02200.

H. Foundation Stabilization

1. After the required excavation has been completed, the County will inspect the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation be conducted in all areas within the influence of the pipeline where unacceptable materials exist at the exposed subgrade. Overexcavation shall include the removal of all such unacceptable material that exists directly beneath the pipeline to a width 24 inches greater than the pipe outside diameter and to the depth required.

2. Backfill the trench to subgrade of pipe base with rock refill material for foundation stabilization. Place the foundation stabilization material over the full width of the trench and compact in layers not exceeding 8 inches deep to the required grade. Foundation stabilization work shall be executed in accordance with a change order.

3. Rock refill used by the Contractor for his convenience will not receive any additional payment.

I. Installing Buried Piping

1. All buried piping shall be mechanically restrained. All existing piping requiring a new connection is to be mechanically restrained.

2. No pipe deflection of buried piping is allowed unless approved by the County's Representative. Approval will be on a case by case basis.

3. Backfill per the detailed piping specification for the particular type of pipe and per the following.

4. Handle pipe in such a manner as to avoid damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

5. Inspect each pipe and fitting before lowering the buried pipe or fitting into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the field with material recommended by the protective coating manufacturer. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installation.

6. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Place the specified thickness of pipe base material over the full width of trench. Grade the top of the pipe base ahead of the pipelaying to provide firm, continuous, uniform support along the full length of pipe, and compact to the relative compaction specified herein. Before laying each section of the pipe, check the grade and correct any irregularities.

7. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint. Fill the area excavated for the joints with the bedding material specified or indicated in the drawings for use in the pipe zone. If no bedding material is specified or indicated, use imported sand.

8. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 8-inch lifts, keeping the level of backfill the same on each side. If no pipe zone material is specified or indicated, use imported sand. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.

9. Compact each lift to the relative compaction specified herein.

10. Push the backfill material carefully onto the backfill previously placed in the pipe zone. If no backfill material is specified or indicated, use native earth backfill. Do not permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment over the pipe until at least 3 feet of backfill has been placed and compacted over the pipe.

J. Backfill Compaction

1. Compact per the detailed piping specification for the particular type of pipe and per the following.

2. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction or hand tamping. Do not use high impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe.

3. Compact material placed within 12 inches of the outer surface of the pipe by hand tamping only.

4. Do not use any axle-driven or tractor-drawn compaction equipment within 3 feet of building walls, foundations, and other structures.

END OF SECTION

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SECTION 02231 SOIL-CEMENT BASE COURSE

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing to construct a compacted base course composed of a combination of soil, Portland Cement and water.

PART 2 - PRODUCTS

A. Portland Cement

1. Except where a particular type of cement might be specifically called for on the plans, the cement used in the work may be of any one of the following AASHTO designated Types:

   Type I, II, or III (AASHTO M 85) or Type IS (AASHTO M 240).

   For all types specified the cement shall be subject to either the compressive or the tensile strength test. The air content test will be made at the option of the Engineer.

2. The cement used shall conform to the requirements of the AASHTO Designations shown therefore, with additional requirements as shown below.

3. Different brands of cement, cement of the same brand from different mills, or different types of cement, shall not be mixed during any continuous pour. Different brands or types of cement shall be stored separately.

4. Only portland cements containing less than 0.6 percent alkali, calculated as Na_2O (percent Na_2O plus 0.658 percent K_2O), shall be used in combination with coarse or fine aggregates from the Montgomery, Alabama, area, the Tuscaloosa formation or any other alkali reactive aggregate.

5. The cement may be delivered in bags or in bulk. The storage building, bin or silo shall be weatherproof and shall be located convenient to the work to be performed. On small jobs, storage in the open may be permitted by the Engineer, in which case a raised platform and adequate waterproof covering shall be provided.

If conditions warrant, a competent storekeeper may be required who shall have charge of the cement storehouse and shall keep suitable records of the delivery and use of all cement. Copies of such records shall be delivered to the Engineer at the close of each day's work or eight-hour run, showing in such details as he may reasonably require, the quantity used during the day or run, at each part of the work.

6. Cement varying more than five percent from designated weights (94 pounds per sack) shall be rejected (1) in carload lots if the average of 50 sacks taken at random is less than the designated weights, and (2) in individual sacks, if tests disclose that sacks vary more than five percent from designated weights and still the average of 50 sacks is greater than the designated weight. In the second instance, the cement may be used provided the proper adjustment per sack is made; such adjustment to be made by weight only.

   Cement which has been damaged, which is partially set, or which is lumpy or caked, shall not be used, and the entire contents of the sack of cement or the container of bulk cement, which contains damaged, partially set, or lumps of caked cement, will be rejected for use. Cement salvaged from discarded or used sacks shall not be used.

7. When, under the provisions of these specifications, it becomes necessary to transport loose cement, it shall be kept in a weatherproof compartment, separate from other aggregates.

B. Water

1. Water for use with cement shall be clean and practically free of oil, acid, alkali, chlorides, organic matter, and other deleterious substances.

   Water supplies which are approved by a public health department may be accepted without being tested. Water from all other sources shall be tested and approved by a public health department before use and shall not contain impurities in excess of the following limits:

Acidity or alkalinity calculated in Terms of calcium carbonate	0.05%
Total organic solids	0.05%
Total inorganic solids	0.08%
Total chlorides as sodium chloride	0.05%

C. Material

Use local or hauled-in clean sand or sand and clay.

D. Concrete

All concrete for base repair will be Class 1 concrete, minimum 28-day compressive strength of 2,500 psi as specified in Section 03300.

E. Curing Material

1. Rapid-curing, cut-back asphalt shall conform to the requirements of AASHTO M 81 except that the penetration range shall be from 60-120 instead of 80-120.

2. Cut-Back Asphalt, Grade RC-70 shall not be more than 15 units deficient in viscosity requirements. (The designation, "deficient," shall be considered as any variation, either under or over, from the minimum and maximum limitations for the viscosity, in the number of units by which the viscosity is measured.)

PART 3 - EXECUTION

A. Composition and Proportioning

1. Submit the name of an independent testing laboratory for review by the Engineer. Submit a design mix prepared by the testing laboratory for review by the Engineer.

2. Do not process the base until all tests of the soil to be used have been completed and the exact proportion of cement required for the particular soil has been determined according to "Expanded Short-Cut Test Methods for Determining Cement Factors for Sandy Soils", Highway Research Bulletin 61, 1952, and/or, when applicable, methods of "Wetting and Drying Test of Compacted Soil-Cement Mixtures", ASTM D559 (AASHTO T-135).

3. The quantity of water required will be the amount necessary for optimum moisture content in the compacted mixture. This quantity will vary with the nature of the soil and shall have been determined according to "Methods of Test for Moisture-Density Relation of Soil-Cement Mixtures", ASTM D558 (AASHTO T-134).

B. Preparation of Soil Aggregate

Remove unsuitable material and add suitable material as necessary prior to the application of cement. Pulverize the

soil to be treated for sufficient width and depth to give the compacted cross section shown on the plans. Pulverizing shall continue until 80 percent of the soil, by dry weight, exclusive of gravel, shell or stone larger than 3/4 inch, will pass a No. 4 sieve. Manipulate the pulverized soil until the moisture in the soil does not exceed the percentage of the optimum moisture specified for the soil-cement mixture.

C. Application of Cement

Shape the soil to the approximate cross section shown on the plans, and spread the designated quantity of cement uniformly over the surface in one operation.

D. Mixed-In-Place Method

Immediately after the cement has been distributed, mix it with the loose soil with a machine that will produce the proper homogeneous mixture. Shape the mixture to the approximate lines and grades shown on the plans.

E. Central Plant Mixed Method (Optional)

1. Mix the soil, cement and water in a pugmill either of the batch of continuous flow type. Equip the plant with feeding and metering devices which will add the soil, cement and water into the mixer in the specified quantities. Mix soil and cement sufficiently to prevent cement balls from forming when water is added, and continue until a uniform and intimate mixture of soil, cement and water is obtained.

2. Haul the mixture to the roadway in trucks equipped with protective covers. Place the mixture on the moistened subgrade in a uniform layer by an approved spreader and in such quantity that the completed base will conform to the required grade and cross section. Do not permit dumping of the mixture in piles or windrows upon the subgrade.

F. Compacting and Finishing

1. Compact the base to a density of 95 percent of the maximum density as determined by AASHTO T-180 to the line, grade and thickness shown in the plans.

2. After the mixture is compacted, reshape the surface of the base to the required lines, grades and cross section, and then lightly scarify to loosen imprints left by the compacting or shaping equipment until a

uniform, even surface mulch of approximately 1 inch in thickness is obtained. Then thoroughly roll and compact the surface.

3. Complete all of the above mixing, compacting and finishing within six (6) hours.

G. Construction Joints

1. At the end of each day's construction, form a straight transverse joint by cutting back into the completed work to form a true vertical face. This joint shall be located such as to exclude all that part of the base at the end of the run which does not have full depth, is not thoroughly compacted, not properly proportioned, or not properly mixed.

2. Build soil-cement for large, wide areas in a series of parallel lanes of convenient length and width meeting the approval of the Engineer. Form straight longitudinal joints at the edge of each day's construction by cutting back into the completed work to form a true vertical face free of loose or shattered material.

H. Weather Limitations

During seasons of probability of freezing temperature, do not apply cement unless the temperature is at least $40^{O}F$ in the shade and rising.

I. Surface Requirements (Scalping or Hardplaning)

After compacting and finishing have been completed, and not later than the beginning of the next calendar day after the construction of any section of base, test the surface with a template cut to the required crown and/or with a 10-foot straight-edge laid parallel to the centerline. Correct all irregularities greater than 1/4 inch. Additional wetting before, during and after this final shaping operation shall be required to keep the base continuously moist until the cure coat is applied.

J. Protecting and Curing

Within not more than three daylight hours after the hardplaning operations have been completed, the base shall be covered and protected against rapid drying by curing.

K. Opening to Traffic

Completed sections may be opened to all traffic after seven days.

L. Maintenance

Maintain the base to a true and satisfactory surface until the wearing surface is constructed. Should any repairs or patching be necessary, they shall extend to the full depth of the base and shall be made in a manner that will assure restoration of a uniform base course conforming to the requirements of these specifications. In lieu of repairing with soil-cement, Class 1 concrete may be used.

M. Testing

1. Monitor the construction procedure with the same independent testing laboratory that prepared the reviewed design mix and perform the following tests during placement:

   a. Determine cement content, moisture content, "inplace" density and thickness (maximum spacing of test holes 300 feet). Notify the Engineer immediately of any deviation from the design mix.

   b. Perform a laboratory density test and prepare two 4 inch-diameter by 4.6-inch-high compression test cylinders for each 300 feet of roadway. Moist cure by 7 days and test for compressive strength. Minimum acceptance standards are as follows:

      Thickness: Average in 1,000 ft.-1/4 inch variation
      Maximum variation in one hole-1/2 inch

      Compressive Strength: 300 psi in 7 days
      (molded laboratory specimens)
      350 psi in 14 days
      430 psi in 28 days

2. Send two copies of all field and laboratory test results to the Engineer within 10 days of completion of said tests. Include the cost of mix design and testing in the unit price bid for the soil-cement base.

END OF SECTION

SECTION 02232 LIMEROCK BASE COURSE

PART 1 - GENERAL

A. Description

The work specified in this section consists of the construction of a base course composed of limerock constructed on the prepared subbase in accordance with these specifications and in conformity with the lines, grades, notes, and typical cross sections shown on the plans.

B. Submittals

Submit copies of a certification from a testing laboratory that the material used for the base meets the specified criteria and contains less than 1% by weight asbestos.

PART 2 - PRODUCTS

A. Materials

1. Use limerock having a minimum percentage of carbonates of calcium and magnesium of 70, a maximum percentage of water-sensitive clay mineral of 3, and a liquid limit not exceeding 35. The material shall be non-plastic and contain less than 1% by weight asbestos.

2. Limerock material shall not contain cherty or other extremely hard pieces, or lumps, balls or pockets of sand or clay size material in sufficient quantity as to be detrimental to the proper bonding, finishing, or strength of the limerock base.

3. At least 97 percent (by weight) of the material shall pass a 3-1/2 inch sieve and the material shall be graded uniformly down to dust. The fine material shall consist entirely of dust of fracture. All crushing or breaking-up which might be necessary in order to meet such size requirements shall be done before the material is placed on the road.

4. Limerock material used in construction of limerock base shall have an average LBR value of not less than 100.

PART 3 - EXECUTION

A. Transporting Limerock

Transport limerock to the point where it is to be used, over rock previously placed and dumped on the end of the preceding spread. In no case shall rock be dumped directly on the subbase.

B. Spreading Limerock

1. Spread limerock uniformly. Remove and replace all segregated areas of fine or coarse rock with well-graded rock. Place limerock 12” minimum outside of asphalt width.

2. Construct base in courses between 4 inches and 6 inches in thickness.

3. For double-course base, spread rock in two courses. Thickness of the first course shall be approximately one-half the total thickness of the finished base, or enough additional to bear the weight of the construction equipment without disturbing the subgrade.

C. Compacting and Finishing Grade

1. For double-course base, blade the first course if necessary to secure a uniform base and compact to the density specified below immediately prior to spreading the second course. No other finishing of this course is required.

2. After spreading is completed, scarify the entire surface and shape to produce the specified grade and cross section after compaction. For double-course bases, scarifying shall penetrate by at least 1/2-inch the surface of the first course.

3. As soon as proper moisture conditions are attained, compact the material to an average density of 98 percent of the maximum density obtainable under AASHTO Method T-180 (modified). Take density readings after grading and cross sectioning have been completed.

4. "Hard-plane" the surface with a blade immediately prior to the application of prime coat to remove thin-glazed or cemented surface, leaving a granular or porous condition that will allow free penetration of prime material. Remove materials planed from the base area.

5. If at any time, the subbase material becomes mixed with the base course material, excavate and remove the mixture, reshape and compact the subbase, and replace the materials removed with clean base material, shaped and compacted as specified above.

D. Testing Surface

1. Check the finished surface of the base course with a templet cut to the required cross section and with a 15-foot straight edge laid parallel to the center line of the road or other approved testing devices. Correct all irregularities greater than ±1/4 inch by scarifying and removing or adding rock, as may be required, after which the entire areas shall be compacted as specified herein.

2. During final compacting operations, if blading of any areas is necessary to obtain the true grade and cross section, complete the compacting operations for such areas prior to making the density tests on the finished grade.

E. Thickness Testing

After the base is completed, test holes or cores shall be taken by an independent testing laboratory at intervals of not more than 300 feet in roadways or 2,400 sq. ft. in area paving. The average thickness of three consecutive holes must be equal to at least the specified thickness. Where the base is more than 1/2 inch deficient in thickness, or does not meet the average thickness requirement, rework the area covered by this deficient base by scarifying to a depth of at least 3 inches and adding more base material, so that after proper compacting the thickness and shape will conform to the plans.

F. Density Testing

1. After the base is completed, the density shall be checked at intervals of not more than 300 feet of roadway or 2,400 sq. ft. of area paving. If any field density tests are below the specified density, rework and recompact the area until the minimum density is achieved.

2. MAKE AT LEAST THREE DENSITY DETERMINATIONS ON EACH DAY'S FINAL COMPACTION OPERATIONS ON EACH COURSE. The density determinations shall be made at more frequent intervals if deemed necessary by the Engineer.

END OF SECTION

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SECTION 02270 EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

A. Description

The work specified in this Section consists of measures required to control erosion on the project, right-of-way, and in areas outside the project area where work is accomplished in conjunction with the project, so as to prevent pollution of water, detrimental effects of public or private property adjacent to the project area and damage to work on the project. These measures will consist of construction and maintenance of temporary erosion control features or, where practical, the construction and maintenance of permanent erosion control features.

Effective May 1, 2003 construction sites that will result in a disturbance of one acre or more are required to seek coverage from FDEP under the Generic Permit for Stormwater Discharge from Large and Small Construction Activities - DEP document 62-621.300(4)(a). Accordingly, the Contractor shall be required to submit a Notice of Intent (NOI) along with the application fee to the FDEP Stormwater Notices Center to use the Generic Construction NPDES permit. This will also require the Contractor to develop and implement a Stormwater Pollution Prevention Plan (SWPPP) for this project; the requirements of which shall be followed by the Contractor for the duration of the project.

B. Control of Contractor's Operations Which May Result in Water Pollution

1. In addition to the erosion control measures specified herein, the Contractor shall comply with all requirements of the final approved Stormwater Pollution Prevention Plan (SWPPP) for the project.

2. Take sufficient precautions to prevent pollution of streams, canals, lakes, reservoirs, and other water impoundments, with fuels, oils, bitumens, calcium chloride, or other harmful materials. Conduct and schedule operations so as to avoid or otherwise minimize pollution or siltation of such streams, etc. Do not dump the residue from dust collectors or washers into any water body.

3. Construction operations in stormwater ponds and other impoundments shall be restricted to those areas where it is necessary to perform filling or excavation to

accomplish the work shown in the Contract Documents and to those areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, promptly clear impoundments of all obstructions placed therein or caused by construction operations.

4. Except as necessary for construction, do not deposit excavated material in rivers, streams, canals, or impoundments, or in a position close enough thereto, to be washed away by high water or runoff.

C. Start of Work

Do not start work until erosion control measures are in place.

PART 2 - PRODUCTS

A. General

1. No testing of materials used in construction of temporary erosion control features will be required.

2. Materials used for the construction of the temporary erosion and sedimentation control measures not to be incorporated into the completed project may be new or used.

3. Coordinate with the conditions of the FDEP NOI permit.

PART 3 - EXECUTION

A. General

1. Temporary erosion control features shall consist of, but not be limited to, temporary grassing, temporary sodding, temporary mulching, sandbagging, slope drains, sediment basins, artificial coverings, berms, baled hay or straw, floating silt barriers, staked silt barriers and staked silt fences. Design details for some of these items may be found in the Water Quality Section of the applicable edition of the FDOT Roadway and Traffic Design Standards.

2. Incorporate permanent erosion control features into the project at the earliest practical time. Correct conditions, using temporary measures, that develop during construction to control erosion prior to the time it is practical to construct permanent control features.

3. Construct temporary and permanent erosion and sediment control measures to prevent the pollution of adjacent water ways in conformance with the laws, rules and regulations of Federal, State and local agencies.

B. Installation

1. Temporary Sod: This work shall consist of furnishing and placing sod in accordance with the Contract Documents.

2. Temporary Mulching: This work shall consist of furnishing and applying a two-inch to four-inch thick blanket of straw or hay mulch and then mixing or forcing the mulch into the top two inches of the soil in order to temporarily control erosion. Only undecayed straw or hay, which can readily be cut into the soil, shall be used. Other measures for temporary erosion control such as hydromulching, chemical adhesive soil stabilizers, etc., may be substituted for mulching with straw or hay. When permanent grassing operations begin, temporary mulch materials shall be plowed under in conjunction with preparation of the ground.

3. Sandbagging: This work shall consist of furnishing and placing sandbags in configurations, so as to control erosion and siltation.

4. Slope Drains: This work shall consist of constructing slope drains, utilizing pipe, fiber mats, rubble, cement concrete, asphaltic concrete plastic sheeting, or other acceptable materials, in accordance with the details shown in FDOT's Roadway and Traffic Design Standards or as may be approved as suitable to adequately perform the intended function.

5. Sediment Basins: Sediment basins shall be constructed in accordance with the details shown in FDOT's Roadway and Traffic Design Standards or as suitable to adequately perform the intended function. Sediment basins shall be cleaned out as necessary.

6. Artificial Coverings: This work shall consist of furnishing and applying fiber mats, netting, plastic sheeting, or other approved covering to the earth surfaces.

7. Berms: This work shall consist of construction of temporary earth berms to divert the flow of water from an erodible surface.

8. Baled Hay or Straw:

a. This work shall consist of construction of baled hay or straw dams to protect against downstream accumulations of silt. The baled hay or straw dams shall be constructed in accordance with the details shown in FDOT's Roadway and Traffic Design Standards.

b. The dam shall be placed so as to effectively control silt dispersion under conditions present on this project. Alternate solutions and usage of materials may be used if approved.

9. Temporary Silt Fences and Staked Silt Barriers: This work shall consist of furnishing, installing, maintaining and removing staked turbidity barriers in accordance with the manufacturer's directions, these specifications and the details as shown in FDOT's Roadway and Traffic Design Standards.

C. Removal of Temporary Erosion Control Features

In general, remove or incorporate into the soil any temporary erosion control features existing at the time of construction of the permanent erosion control features in such a manner that there will be no detrimental effect.

D. Maintenance of Erosion Control Features

General: Provide routine maintenance of permanent and temporary erosion control features until the project is completed and accepted.

E. Protection During Suspension of Contract Time

In the event that it is necessary that the construction operations be suspended for any appreciable length of time, shape the top of the earthwork in such a manner as to permit runoff of rainwater and construct earth berms along the top edges of embankments to intercept runoff water. Provide temporary slope drains to carry runoff from cuts and embankments which are located in the vicinity of rivers, streams, canals, lakes, and impoundments. Should such preventive measures fail, immediately take such other action as necessary to effectively prevent erosion and siltation.

END OF SECTION

SECTION 02276 GRAVEL AND CRUSHED ROCK BASE FOR STRUCTURES

PART 1 - GENERAL

A. Description

This includes materials, testing, and installation of gravel and crushed rock bases for structures such as manholes and vaults.

B. Submittals

Submit six copies of a report from a testing laboratory verifying that material contains less than 1% asbestos by weight or volume and conforms to the specified gradations or characteristics.

C. Testing for Compaction

1. The Owner will test for compaction or relative density as described below.

2. Determine the density of gravel and rock in place by the sand cone method, ASTM D 1556 or 2167.

3. Determine the relative density of gravel and rock per ASTM D 4253 and D 4254.

4. Sample backfill materials per ASTM D 75.

5. Compaction shall be deemed to comply with the specifications when no more than one test of any three consecutive tests falls below the specified relative compaction. The one test shall be no more than three percentage points below the specified compaction. The Contractor shall pay the costs of retesting work not conforming to the specifications.

PART 2 - MATERIALS

A. Crushed Rock and Gravel

1. Crushed rock base and gravel are defined as natural or crushed rock, free from organic matter and containing less than 1% asbestos by weight or volume, and meeting the following gradation:

Sieve Size	Percent Passing By Weight
1-1/2 inches	100
3/4 inch	90 to 100
No. 4	35 to 55
No. 30	10 to 30
No. 200	0 to 5

2. Durability Index shall be at least 40 per ASTM D 3744.

B. Crushed Rock

Crushed rock base shall be No. 57 stone conforming to Section 901, "Coarse Aggregate" of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 3 - EXECUTION

A. Placement of Crushed Rock or Gravel

1. Place crushed rock or gravel base beneath structures where shown in the drawings, 6 inches thick unless otherwise indicated. Excavate below the required grade for the bottom of the structure and refill with crushed rock or gravel as specified above. The rock base shall extend a minimum of 12 inches beyond the structure base, floor slab, or footing.

2. Compact base as follows unless otherwise indicated:

   a. Lower Lift: 80% relative density.

   b. Upper Lifts: 85% relative density.

3. Place base material in maximum lifts of 12 inches.

END OF SECTION

SECTION 02282 CONNECTIONS TO EXISTING BURIED PIPELINES

PART 1 - GENERAL

A. Description

This section includes materials and installation of connections to existing buried utilities; including connections by hot tap, line stop and connections to existing Prestressed Concrete Cylinder Pipe (PCCP).

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following;

2. Submit appropriate reference material and documentation as specified herein.

3. Submit manufacturer's catalog data for tapping sleeves and appurtenances. Show coatings. Submit materials of construction for all components indicating ASTM standards with which they comply

4. Submit confirmation of field investigation of the existing pipeline material, size and condition, as specified herein and illustrated in the Drawings.

5. Submit the qualifications and reference material of the Contractor, or Subcontractor, who will be performing the hot taps and line stops on the Project.

6. Submit the qualifications and reference material of the Engineer who the Contractor, or Subcontractor, is required to retain for detailing each of the respective line stops and hot taps illustrated in the Drawings.

7. Submit the qualifications and reference material of the Engineer who the Contractor, or Subcontractor, is required to retain for detailing the connections between the existing Prestressed Concrete Cylinder Pipe (PCCP) and the new sections of Welded Steel Cylinder Pipe (WSP) and Ductile Iron Pipe (DIP).

8. Submit the qualifications and reference materials from PCCP Manufacturer at Hanson Pipe and Precast (formerly known as Price Brothers Company) who will provide

services from the PCCP Manufacturer regarding the details of connection to the PCCP pipe.

9. The Contractor’s, or Subcontractor’s, Engineer preparing the detailed shop drawings for each line stop and hot tap shown in the Drawings shall include the following at a minimum. The submittal shall be signed and sealed by that Engineer;

    a. Dimensional Drawings of each location with identification of all respective fittings, valves and appurtenances required.

    b. Details of the existing utility as determined from field exploration; including but not limited to depth, size, and material, method of restraint and current service condition.

    c. Calculations for the sizing of and the dimensional drawings illustrating the limits of the encasement for the tapping sleeve.

    d. Calculations for the determination and dimensional drawings illustrating the method of restraint of the existing piping including mechanical restraint devices and/or concrete thrust collars or blocks.

    e. Bypass piping arrangement.

    f. Shoring/Sheeting or means of maintaining the excavation in compliance with the Trench Safety Act.

    g. Method of support of the existing utility within the excavation if required.

    h. Schedule and sequence for the execution of the Work.

10. Submit results of field evaluation of existing Prestressed Concrete Cylinder Pipe (PCCP) and recommendations of PCCP Manufacturer for the connections.

11. The Contractor’s, or Subcontractor’s, Engineer preparing the detailed shop drawings for detailing the connections between the existing Prestressed Concrete Cylinder Pipe (PCCP) and the new sections of Welded Steel Cylinder Pipe (WSP) and Ductile Iron Pipe (DIP) shall include the following at a minimum. The submittal shall be signed and sealed by that Engineer;

a. Shop Drawings from the existing PCCP originally installed during the Phase III Effluent Disposal Improvements as provided by the original PCCP pipe manufacturer, Hanson Pipe and Precast (formerly known as Price Brothers Company).

b. Dimensional Drawings of each location with identification of all respective fittings, pipe, valves and appurtenances required to perform the Work as defined in the Contract Documents.

c. Field determination of the existing PCCP bell and spigot locations in vicinity to the proposed points of connection as illustrated in the Drawings.

d. Detailing of the Bell End and Spigot End connections with the existing PCCP as recommended per the PCCP Manufacturer.

e. Welded Steel Cylinder Pipe (WSP) as submitted per Sections 15201 and 15255.

f. The Contractor’s, or Subcontractor’s, Engineer preparing the details for the connections to the PCCP pipe shall prepare a detailed dimensional shop drawing including the following at a minimum;

    (1) Detailing from the PCCP manufacturer for connection with the Welded Steel Cylinder Pipe to PCCP at the respective Bell and Spigot locations illustrated in the Drawings.

    (2) The detailed Welded Steel Cylinder Pipe (WSP) shop drawings for interconnecting the PCCP to the DIP.

    (3) Calculations for the sizing of the thrust blocks or thrust collars required to restrain the piping system.

    (4) Detailing for cutting out an existing section of PCCP and protection of the existing bell and spigots.

    (5) Detailing for capping and grout filling the existing sections of PCCP to be abandoned in place.

(6) Shoring/Sheeting or means of maintaining the excavation in compliance with the Trench Safety Act.

(7) Method of support of the existing utility within the excavation if required.

(8) Schedule and sequence for the execution of the Work.

12. For all connections with existing utilities, the Contractor, or Subcontractor, shall prepare an Emergency Contingency Plan if the existing pipeline is damaged or fails during the anticipated operation. At a minimum it shall include the process that will be used for spill protection, maintaining service within the existing pipeline and/or emergency bypass. The Owner's Representative and Engineer shall be provided with this information as reasonable assurance that the Contractor or Subcontractor is prepared in the event an emergency should arise.

C. Qualifications

1. The Contractor, or Subcontractor, performing the line stop and hot taps shall meet the following minimum experience requirements:

   a. Completed not less than twenty-five (25) successful hot taps and/or line stops of similar type, size, and complexity performed within the last ten (10) years, from the date that Bids are opened, and located within the United States of America.

   b. Submit references for projects of equal type, size, and complexity to demonstrate experience. Include Work type, size, and contact information for Owner four (4) weeks prior to the construction.

2. The Contractor's, or Subcontractor's Engineer, preparing the detailed shop drawings for each line stop and hot tap shown in the Drawings shall meet the following minimum experience requirements. The Engineer shall be a Registered Professional Engineer in the State of Florida;

   a. Designed not less than ten (10) hot taps and/or line stops of similar type, size, and complexity which were constructed within the last five (5) years,

from the date that Bids are opened, and located within the United States of America.

3. The Contractor's, or Subcontractor's Engineer, preparing the detailed shop drawings for detailing the connections between the existing Prestressed Concrete Cylinder Pipe (PCCP) and the sections of Welded Steel Cylinder Pipe (WSP) and Ductile Iron Pipe (DIP) shall meet the following minimum experience requirements. The Engineer shall be a Registered Professional Engineer in the State of Florida;

   a. Designed not less than four (4) similar connections with PCCP within the last ten (10) years, from the date that Bids are opened, and located within the United States of America.

PART 2 - MATERIALS

A. Utility Exploration and Materials Verification:

1. Expose all existing pipelines at points of construction to confirm size, material and condition, prior to procurement or preparation of submittals. Determine if each existing pipeline is mechanically restrained. All existing piping requiring a new connection is to be mechanically restrained. Support the pipeline in a manner that will not damage the pipe and provide Temporary Excavation Support Systems per Section 02160.

B. Verification of Pipe O.D. and Condition

Expose the existing pipeline and determine the pipe diameter and wall thickness prior to ordering the line stop materials. Utilize pipe thickness testing using ultrasonic technology or other no destructive means.

C. Tapping Sleeves for Ductile-Iron, and PVC (Cast-Iron O.D.) Pipes

1. Tapping sleeves shall comply with MSS SP-60, and MSS SP-113.

2. Tapping Sleeves shall be furnished and installed as specified per the respective existing utility and the Orange County Approved Product List, see Attachment A, unless otherwise noted (i.e. tapping sleeves greater than 24 inches)

3. Pressure rating shall be at least 200 psi for piping 12 inches and smaller and at least 150 psi for piping 14 through 24 inches. For piping larger than 24 inches up to 42 inches pressure rating shall be at least 100 psi.

4. For potable water service, tapping sleeve shall be NSF 61 certified.

D. Test Plug

Test plug shall be ¾-inch NPT Type 304 stainless steel. Coat threads to prevent galling.

E. Gaskets for Water Service

For potable water service, gaskets shall be NSF 61 certified. Gaskets shall be full face, 1/8-inch thick, cloth-inserted rubber, with a Shore "A" hardness of 75 to 85. Gaskets shall be suitable for a water pressure of 200 psi at a temperature of 180°F. Gaskets shall have "nominal" pipe size inside diameters not the inside diameters per ASME B16.21. Products: Garlock Style 19 or equal.

F. Gaskets in Other than Potable Water

Gaskets shall be full face, 1/8-inch thick, Buna-N having a hardness of 55 to 65 durometer. Gaskets shall be suitable for a water pressure of 200 psi at a temperature of 250°F. Gaskets shall have "nominal" pipe size inside diameters not the inside diameters per ASME B16.21. Provide Garlock Style 9122 or equal.

G. Coating for Tapping Sleeves

Coat with fusion-bonded epoxy per Section 09961.

H. Tapping Gate Valves

Type V137 per Section 15100 unless otherwise noted.

I. Bolts and Nuts

Bolts and nuts shall be Type 304 stainless steel conforming to ASTM A193 (Grade B8) for bolts and ASTM A194 (Grade 8) for nuts.

J. Rubber Stopper for Line Stop

Fully expandable rubber, minimum 100 psi pressure rating or carbon steel pivoting head with Buna-N sealing element, minimum 100 psi pressure rating.

PART 3 - EXECUTION

A. Owner RPR Notification

Following the acceptance of the respective submittal for a connection to an existing utility, submit a Construction Administration Request (CAR) to the Owner's RPR to schedule the Work. The request shall be made a minimum of fourteen (14) calendar days prior to performing the Work. This request shall include the following:

1. Copy of the accepted submittal.

2. The Contractor's, or Subcontractor's, Emergency Contingency Plan.

3. Scheduled date and time to have meeting with the RPR(s) to discuss the Work, at a minimum of five (5) days prior to performing the Work.

Connections shall only be made on the agreed upon date and time. If the work is not performed in the agreed upon manner or schedule, the work shall be rescheduled by following the above procedure.

B. General Procedure – Hot Taps

Follow the procedure outlined within the accepted submittals for a respective location. The following is intended as a general procedure for performing a hot tap procedure;

1. All existing piping requiring a new connection shall be restrained prior to the connection being made.

2. Install mechanical restraint devices on the existing pipelines or place reinforced concrete thrust collars against undisturbed soil on either side of collars by keeping over-excavation to a minimum. Allow all concrete to reach design strength (4,000 PSI).

3. Support the pipeline in a manner that will not damage the pipe.

4. Provide Temporary Excavation Support Systems per Section 02160.

5. Excavate around the pipe at the proposed line stop or hot tap location. Limit excavation to area immediately beyond the limits of the tapping sleeve. Clean the existing pipeline and smooth any roughness that may inhibit sealing with the tapping sleeve.

6. Install the tapping sleeve.

7. Install reinforced concrete encasement around the pipe and tapping sleeve. Allow all concrete to reach design strength (4,000 PSI).

8. Install the tapping valve.

9. Tap pipeline, remove coupon, close tapping valve and remove tapping machine.

10. Connect the new utility to the tapping valve and perform respective pressure testing requirements for the new utility.

11. Repair damage that occurs due to the Contractor's, or Subcontractor's, work at the Contractor's, or Subcontractor's expense.

12. Dispose of the reclaimed water and existing pipe at no additional cost to the Owner. Comply with FDEP permit requirements.

C. General Procedure – Line Stops

Follow the procedure outlined within the accepted submittal for a respective location. The following is intended as a general procedure for performing a line stop procedure;

1. All existing piping requiring a new connection shall be restrained prior to the connection being made.

2. Install mechanical restraint devices on the existing pipelines or place reinforced concrete thrust collars against undisturbed soil on either side of collars by keeping over-excavation to a minimum. Allow all concrete to reach design strength (4,000 PSI).

3. Support the pipeline in a manner that will not damage the pipe.

4. Provide Temporary Excavation Support Systems per Section 02160.

5. Excavate around the pipe at the proposed line stop or hot tap location. Limit excavation to area immediately beyond the limits of the tapping sleeve. Clean the existing pipeline and smooth any roughness that may inhibit sealing with the tapping sleeve.

6. Install the tapping sleeve.

7. Install reinforced concrete encasement around the pipe and tapping sleeve. Allow all concrete to reach design strength (4,000 PSI).

8. Install the tapping valve.

9. Tap pipeline, remove coupon, close tapping valve and remove tapping machine.

10. Attach the line stop valve, connect the bypass or new pipeline, and close the line stopping valve.

11. Construct the new in-line isolation valve, cap or appurtenance as illustrated within the Drawings.

12. Repair damage that occurs due to the Contractor's, or Subcontractor’s, work at the Contractor's, or Subcontractor’s expense.

13. Dispose of the reclaimed water and existing pipe at no additional cost to the Owner. Comply with FDEP permit requirements.

END OF SECTION

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SECTION 02361 TERMITE CONTROL

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Soil treatment with termiticide.

b. Polymer barrier fittings with termiticide for installation around utility penetrations.

C. ACTION SUBMITTALS

1. Product Data: For each type of termite control product.

a. Include the EPA-Registered Label for termiticide products.

D. INFORMATIONAL SUBMITTALS

1. Qualification Data: For qualified Installer.

2. Product Certificates: For termite control products, from manufacturer.

3. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

a. Date and time of application.

b. Moisture content of soil before application.

c. Termiticide brand name and manufacturer.

d. Quantity of undiluted termiticide used.

e. Dilutions, methods, volumes used, and rates of application.

f. Areas of application.

g. Water source for application.

4. Polymer Barrier Fittings with Termiticide Application Report: After installation of polymer barrier fittings with termiticide is completed, submit report for Owner's records and include the following:

a. Plan drawing showing number and locations of each type of polymer barrier fitting with termiticide.

b. Termiticide brand name and manufacturer.

c. Schedule of inspections for one year from date of Substantial Completion.

5. Warranties: Sample of special warranties.

E. QUALITY ASSURANCE

1. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.

2. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

3. Source Limitations: Obtain termite control products from single source from single manufacturer.

F. PROJECT CONDITIONS

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

2. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

3. Install polymer barrier fittings with termiticide around utility penetrations prior to pouring concrete and after installation and inspection of plumbing and electrical

pipes and conduits, slab vapor barrier, and concrete slab reinforcement.

G. WARRANTY

1. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

    a. Warranty Period: Five years from date of Substantial Completion.

2. Polymer Barrier Fittings with Termiticide Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of installation of polymer barrier fittings with termiticide, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat and repair or replace damage caused by termite infestation.

    a. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

A. SOIL TREATMENT

1. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

    a. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

B. POLYMER BARRIER FITTINGS

1. Pipe/Conduit Fitting: Integral 2-1/2-inch- (65-mm-) long polymer sleeve and 1-inch- (25-mm-) wide circular flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.

2. Tub Trap Fitting: Integral polymer boot and 23-by-23-inch (585-by-585-mm) flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

2. Proceed with application only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

2. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

a. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

C. APPLICATION, GENERAL

1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

D. APPLYING SOIL TREATMENT

1. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

   a. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.

   b. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.

2. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

3. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

4. Post warning signs in areas of application.

5. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

E. INSTALLING POLYMER BARRIER FITTINGS

1. Remove any pipe wrap material so that the polymer barrier fittings can be applied directly to the pipe or conduit. After installing the barrier, reapply pipe wrap material both below and above the blocker to protect the pipe from contact with concrete.

2. Install polymer barrier fittings around each utility pipe and conduit penetrating concrete slab and foundation walls according to the EPA-Registered Label for the product and manufacturer's written instructions.

END OF SECTION

SECTION 02362 AUGERED CAST-IN-PLACE PILES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install eighteen (18) - inch diameter Auger Cast Piles with 30 ton design capacities in tension and load test piles complete as shown on the Drawings and as specified herein.

B. Furnish all surveys including layout, inspection and record keeping incident to piles and specified herein.

C. A tensile load test shall be completed on at least one (1) test pile at the Chlorine Contact Tank.

1.02 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation and installation equipment as follows:

1. Installation procedures for pile indicating proposed equipment, methods of installation of reinforcing cages, and estimated time to install reinforcement cage into pile.

2. Grout mix design information and description of materials to be used.

3. Reinforcing steel details and centralizers in accordance with section 03200.

4. The contractor shall submit two copies of the installation record of each pile after installation of each pile is complete. Each daily report shall include:

a. Project Name

b. Name of Contractor

c. Identification Mark

d. Date and Time of Installation

e. Pile Type and Size

f. Elevation and point

g. Elevation of butt – before and after cut-off or extension

h. Pile reinforcing steel

i. Pump stoke per pile; total strokes and strokes per foot

j. Ground elevation

k. Horizontal deviation from plan location

l. Plumbness deviation

m. Nature and location of obstructions

n. Location of deg-legs crimping or buckling

o. Water condition in pile, if applicable.

5. Submit a pile plan showing the location and batter of each pile to be installed identified with mark numbers. The estimated length of each pile shall be shown on the plan or on a separate schedule, cross-referenced to the pile mark numbers on the plan. When test piles are specified, the estimated lengths of production piles shall reflect the test pile results.

6. Within 3 working days after any installed pile has been deemed to be permanently obstructed or when an installed pile has been observed to exceed the specified tolerances, provide a sketch showing the as-installed location of all piles in the same pile group or supporting the same structural element and all piles immediately adjacent to the pile group.

7. Within 1 week after completion of the installation of all piles, provide Engineer with a drawing, sealed by a surveyor registered in the State of Florida, showing the designation numbers of all piles and their as-built location with respect to the specified tolerances.

Referenced all as-built locations to established building lines as shown on the drawings.

B. Submit, in accordance with Section 01300, Design drawings and calculations for the proposed pile test apparatus sealed by a registered professional engineer in the State of Florida. The design drawings shall include details of pile load test equipment and methods, a sketch of the proposed arrangement of the load reaction system and a schedule for the test. Any proposed departures from the specified apparatus, methods, equipment or procedures shall be specifically noted on the submitted details and in the letter of transmittal.

C. The pressure gauge, pump and jack shall be calibrated as a unit or the load cell shall be calibrated by a certified testing laboratory within 30 days of the load test. Submit a certificate of the calibration record to the Engineer before commencing load tests.

D. Submit a pile location plan showing location of proposed test piles to be selected by the Engineer for load testing.

1.03 REFERENCE STANDARDS

A. American Society for Testing Materials (ASTM):

1. A36, Specification for Carbon Structural Steel

2. A252, Specification for welded and Seamless Steel Pipe Piles

3. C33, Specification for Concrete Aggregates

4. C143, Standard Method for Test for Slump of Portland Cement Concrete

5. C150, Standard Specifications for Portland concrete

6. C173, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method

7. C231, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method

8. C260, Specification for Air Entraining Admixtures for Concrete.

9. C494, Specification for Chemical Admixtures for Concrete.

10. ASTM D3689 - Standard Test Method for Individual Piles Under Static Axial Tensile Load

B. Augured Cast-in-Place Piles Manual, Latest Edition by Deep Foundation's Institue.

C. When referenced is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

A. Engineer:

1. Pile operation will be continuously observed, and installed piles inspected by a qualified Engineer, selected and paid for by the Owner.

B. Testing Agency:

1. All grout testing during pile operation will be done by an approved independent testing laboratory selected and paid by the Owner.

a. Furnish testing agency access to work, facilities, and incidental labor required for testing and inspection.

2. The Contractor shall coordinate all testing of piles with the Owner hired testing agency. The Contractor shall ensure that the testing engineer and Engineer are present during all pile testing.

C. Contractor Qualifications:

1. Regularly engaged in the installation of augured pressure grouted pile foundation systems.

2. Minimum of five (5) years previous experience on projects of similar size, complexity, and subsurface conditions.

   a. The job supervisor directly responsible for pile installation shall have a minimum of five (5) years previous experience on augered pressure grouted pile installation.

3. The crane operator or “keymen” who give directions to the crane operators shall have at least two (2) years of experience.

4. Forward qualification of crew to the Engineer for review prior to commencement of work.

1.05 DELIVERY, STORAGE AND HANDLING

A. Reinforcing Steel:

1. Unload and store reinforcing bars in such a manner that they will be kept free of mud. Store on timber skids while awaiting use.

B. Miscellaneous:

1. Store other materials in a weather tight and dry place until ready to use. Store packaged materials in their original unbroken package or container.

1.06 EQUIPMENT

A. The equipment provided for the installation of augured grouted piles, is subject to acceptance by the Engineer.

1. At least 10 working days prior to mobilization, provide the Engineer a complete list of technical description of the equipment.

B. Auger:

1. A full-size continuous-flight, 18-inch diameter (less a maximum wear of 1/2 inch) hollow-shaft to be rotated into the ground to the specified pile depth.

a. The injection opening in the auger shaft shall be at the bottom of the auger head and below the cutting teeth.

C. Auger Drive:

1. Use auger drive head having a minimum static weight of 4,000 pounds and drive of 150 horsepower

D. Auger Leads:

1. Prevent auger leads from rotating by a suitable stabilizing arm.

E. Crane:

1. Use crane equipped with torque converter drive system to permit a slow, continuous auger lifting (grouting) operation.

F. Pumping and Mixing:

1. Use approved pumping and mixing equipment for preparation and handling of the grout.

G. Grout Pump:

1. Positive displacement pump capable of developing and maintaining a pressure of 350 pounds per square inch-gauge at the pump discharge.

   a. The combination of pump, diameter of hose, length of hose, and height of crane shall be such that the grout pressure is at least 100 pounds per square inch-gauge at the tip of the auger.

2. The grout pump shall be provided with a pressure gauge in clear view of the equipment operator and Owner’s Engineer. The grout pump shall be calibrated at the beginning of the work to determine the volume of grout pumped per stroke. A positive method of counting grout pump strokes shall be provided close to the auger rig where it can be readily observed by monitoring personnel.

H. Measuring Equipment:

1. The Contractor will supply and install the load cell and "ball and socket" plate. Provide approximately 11-in of clearance between the ram and the reaction member to allow the placement of a load cell and "ball and socket" plate.

2. The Contractor will supply and install the dial indicators each having a range of 2-in and graduated to 0.001-in divisions. Three dials will be spaced equally around the pile and one on each telltale. Provisions shall be made for free axial movement should it become necessary to reset the micrometer dials.

1.07 LINES AND GRADES

A. Employ a registered land surveyor licensed in the State of Texas, experienced in this type of work. The surveyor shall establish lines and levels, and be responsible for the correct location of piles. The surveyor shall keep a record of piles installed as well as a record of the amount of uplift of individual piles. Records of uplift measurements shall be provided to the Engineer’s pile installation inspector.

B. Establish a base line and datum elevation as approved by the Engineer. Locate and stake out pile. Maintain all location stakes and establish all elevations required, including the elevation of the top of the pile immediately after installation and prior to cutting off any length of pile.

C. Within 1 working day after all piles in a cluster have been installed, provide the pile Inspector with a written tabulation indicating the following information for piles in that cluster:

1. Pile location and mark number.

2. Deviation from plan location at cut off grade (measured to nearest 0.01-ft)

3. At least 10 working days prior to mobilization, provide the Engineer a complete list of technical description of the equipment.

PART 2: PRODUCTS

2.01 MATERIALS

A. Portland cement: ASTM C150, Type II

B. Fly ash: ASTM C618, Class F

C. Fluidifier:

1. USACE CRD C-619; expansion not to exceed 5 percent.

2. Fluidifier shall be a compound which will increase the flowability of the mix and assist in neutralizing the setting shrinkage of the grout.

a. Contractor’s choice of fluidifier will be subject to acceptance by the engineer.

3. Water: Clean and free from matter injurious to the mix.

4. Reinforcing steel: ASTM A615, Grade 60.

5. Grout:

a. Mixture of Portland cement, a grout fluidifier, sand, and water so proportioned and mixed to provide a grout capable of maintain the solids in suspension without appreciable water gain, but which may be pumped without difficulty and will penetrate laterally to fill voids in the soil.

b. Proportion to provide a hardened mortar having an ultimate compressive strength of 4,000 pounds per square inch minimum at 28 days as determined by standard 2-inch cubes.

(a) Submit proposed mix design to the Engineer for acceptance not less than 3 weeks prior to the time of its first use.

PART 3: EXECUTION

3.01 GENERAL

A. Installation:

1. A continuous helical-flight hollow-shaft shall be drilled into the ground to the required depth.
   a. Inject specified grout under pressure, through the auger shaft as the auger is being withdrawn, using the earth-filled auger to retain the shape of the hole.

   b. Positively rotate the auger as it is being withdrawn.

2. The amount of spoils should not exceed the volume of the augured hole by more than 15%.

3. The total volume of grout shall be at least 115% of the theoretical volume for each 5ft segment of pile. If less than 115% is placed, the pile shall be reinstalled by advancing the auger ten (10) feet, or to the bottom of the pile if that is less, followed by a controlled removal and grout injection.

4. The volume of grout per lineal foot of pile shall not be less than the volume of the augured hole per lineal foot.

5. Do not install within 16 hours of the installation of an adjacent pile which is within 20 feet unless accepted in writing by the Engineer.

6. Dip piles down to cut-off elevation while grout is still fluid. If required, place a metal sleeve in the top of each pile to become a permanent part of the pile.

7. The spoil that accumulates around the auger during injection of the grout shall be cleared away continuously, so that the installation can be properly inspected.

8. Distribute concentrated loads from the equipment properly to prevent collapsing of the hole until grout has set.

9. Should any obstruction (including boulders or timbers) be encountered which prevent a pile from being installed to the desired depth at the design location,

stop work on that pile until corrective measure instructions are revived from the Engineer.

10. Install piles to the depths indicated on the contract drawings or auger refusal whichever occurs first.

B. Grout:

1. Prepare grout carefully in the proportions of accepted mix design.

   a. Inject grout during withdrawal of auger maintaining minimum head of 10ft of grout above the injection tip to ensure lateral penetration and to prevent the hole from collapsing.
   b. Do not pump grout until Soils Engineer has accepted the final tip elevation.

2. Use only approved mixing and pumping equipment.

   a. Remove oil or rust inhibitors from mixer parts in contact with grout prior to use.

   b. To produce a homogeneous grout of the desired consistency, if there is a lapse in the operation of pumping, re-circulate grout through pump, mixer drum or agitator, and pump.

3. Determine the quantity of grout pumped into each pile hole.

   a. Calibrate the grout pump by pumping grout into a 55-gallon drum.

C. Reinforcing:

1. Install reinforcing, including dowels, as shown on the drawings while the grout is in a fluid state.

   a. Field bending of dowels is not permitted unless specifically shown.

D. Damaged or Mislocated pile:

1. Use piling procedures to avoid excessive or undue abuse.

2. Repair or replace damaged piles, or piles located outside the required placing tolerances, at the direction of the Engineer.

3. Install additional pile or piles where the pile centerline deviates from the specified tolerances and where a redesign indicates a load of any pile exceed 110 percent of the design load.

4. Piles rejected after installation may, when acceptable to Engineer be abandoned, cut off, and replaced by additional piles instated at new, designated locations indicated by a redesign accounting for the actual installed pile capacities and locations.

5. All required redesign shall be at the Contractor's expense.

E. Tolerances:

1. Vertical Piles:

a. Plan location: Plus or minus 3 inches from location indicated for pile in a group, or plus or minus 1 inch from location indicated for individual piles, measured at the cut-off elevation.

b. Plumbness: Deviation from plumb shall not exceed 2 percent of the pile length.

c. Cut off: Pile shall be cut off level to within plus 1 inch or minus 1 inch of the specified elevation.

3.02 FIELD QUALITY CONTROL

A. Grout Testing:

1. Test grout in accordance with ASTM C109. Prepare a minimum of 6 cubes per day and test 2 cubes at 3 days, 2 at 7 days, and 2 at 28 days.

2. Check each batch of grout with a USACE flow CRD-C79

cone having a 3/4-inch opening.

a. Grout fluidity shall be such that the grout flows out of the cone in 17 to 25 seconds.

3.03 TENSILE CAPACITY TESTS

A. Pile load tests for uplift capacity shall conform to the requirements in ASTM D3689 except as modified by this Section. The standard procedures shall be used.

3.04 ACCEPTANCE CRITERIA

A. Piles that are rejected because of damage, mislocation or misalignment, or failure to meet the criteria, shall be cut off below the limits of the structure and abandoned and additional piles shall be installed as directed by the Engineer.

B. Upon comparing a pile’s performance with that of other piles and based on his/her knowledge of subsurface conditions, the Engineer shall determine if the pile has been damaged sufficiently to make it unacceptable, if this is the case he/she will reject the pile. If the Contractor does not agree the pile is incapable of performing satisfactorily, a load test may be required.

C. The Contractor shall be compensated only for rejected piles that are installed within the specified tolerances and whose damage is not attributable to the Contractor’s error in the opinion of the Engineer.

D. Where piles, as installed, exceed the specified lateral deviation tolerances, the Engineer shall then determine analytically the total loads on the individual piles, base on the survey information. If the load on any pile exceeds 110 percent of the specified load capacity, correction shall be made in accordance with a design provided by the Engineer at no additional cost to the Owner.

E. The Installation of replacement piles and other corrective measures shall in all cases be in accordance with design provided by the Engineer at no additional cost to the Owner.

F. The load test shall be completed and the data evaluated by the Engineer, prior to the installation of production piles.

G. If the load test on the pile designated for load testing by the Engineer fails to meet the criteria, the Engineer will modify the design as required to account for the load test results. The maximum pile movement shall be 1/2″.

3.05 CLEAN UP

A. Remove from the site all waste and surplus materials and debris from the operation. The debris and waste materials shall be legally disposed of off-site.

END OF SECTION

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SECTION 02530 LEAKAGE AND INFILTRATION TESTING

PART 1 - GENERAL

A. Description

1. These specifications cover the testing and inspection for acceptance of gravity pipelines, sewers, culverts, drains, and manholes not intended to be pressurized in excess of 5 psi or 12 feet head of water.

2. Gravity Mains:

Shall be inspected with CCTV for alignment, grade variations, separated pipes, leaks, deflection, cracked, broken or otherwise defective pipe to ensure overall pipe integrity. An approved CCTV inspection contractor shall perform the CCTV inspection(s) and submit the report(s) to the Owner as required.

3. Pressure Mains:

Hydrostatic tests shall be conducted for pressure pipes, joints and valves for allowable limits of pressure and leakage. Air testing of pressure pipes will not be permitted under any circumstance.

PART 2 - MATERIALS

A. Approved List of CCTV Contractors

The current “List of Approved CCTV Inspection Contractors for Wastewater Gravity Systems” can be found on our website at www.ocfl.net/utilities/. For more information, please contact a Standards Committee representative at 407-254-9900.

B. CCTV Inspection Equipment

1. Closed Circuit Television Camera:

The television camera used for the inspection shall be one specifically designed and constructed for sanitary sewer inspection. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in

100 percent humidity/submerged conditions. The CCTV camera equipment will provide a view of the pipe ahead of the equipment and of features to the side of the equipment through turning and rotation of the lens. The camera shall be capable of tilting at right angles along the axis of the pipe while panning the camera lens through a full circle about the circumference of the pipe. The lights on the camera shall also be capable of panning 90-degrees to the axis of the pipe.

If the equipment proves to be unsatisfactory, it shall be replaced with adequate equipment. The camera unit shall have sufficient quantities of line and video cable to inspect two complete, consecutive sewer reaches with access approximately 750 feet apart.

The camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of the Owner. The television camera, electronic systems and monitor shall provide an image that meets the following specifications, or approved equal.

a. The gray scale shall show equal changes in brightness ranging from black to white with a minimum of five stages.

b. With the monitor control correctly adjusted, the six colors - Yellow, Cyan, Green, Magenta, Red, and Blue, plus black and white shall be clearly resolved with the primary colors in order of decreasing luminance. The gray scale shall appear in contrasting shades of gray with no color tint.

c. The picture shall show no convergence or divergence over the whole of the picture. The monitor shall be at least 13 inches diagonally across the picture tube.

d. The live picture on the CCTV monitor shall be capable of registering a minimum of 470 lines horizontal resolution and be a clear, stable image with no interference.

e. Lighting intensity shall be remote controlled and shall be adjusted to minimize reflective glare. Lighting and camera quality shall provide a clear, in-focus picture of the entire inside periphery of

the sewers and laterals for all conditions except submergence. Under ideal conditions (no fog in the sewer) the camera lighting shall allow a clear picture up to five pipe diameter lengths away for the entire periphery of the sewer. The lighting shall provide uniform light free from shadows or hot spots.

f. Camera focal distance shall be remotely adjustable through a range of 6 inches to infinity.

g. The monitor and software shall also be able to capture and save screen images of typical sewer details and all defects. Screen images shall be embedded into the pipe inspection report document submitted with the inspection video. The video camera shall be capable of displaying on screen data.

2. Lateral Video Camera

Lateral cameras may be push type or launched from the sewer main line. Lateral cameras shall be color, shall be self-leveling, and equipped with a footage counter to provide on screen display of footage measurement. Monitor resolution shall be as specified above in paragraph 2.A A Close Circuit Television Camera, or approved equal.

3. Video Capture System:

The video recordings of the sewer inspections shall be made using digital video equipment. A video enhancer may be used in conjunction with, but not in lieu of, the required equipment. The digital recording equipment shall capture sewer inspection on DVD disks or hard drive, with each sewer reach inspection recorded as an individual movie file (.MPEG, .MPG, or .WMV) or approved equal.

a. The video file names will be referenced in the inspection database and in an inspection report generated in PDF format. The pipeline collection and real time video capture and data acquisition systems shall be provided.

b. The system shall use the most current PACP compliant application software and shall be fully object

oriented or approved equal. It shall be capable of printing pipeline inspection reports with captured images of defects or other related significant visual information on a standard color printer.

c. The imaging capture system shall store digitized color picture images and be saved in digital format on a DVD, hard drive or approved equal. Also, this system shall have the capability to supply the Owner with inspection data reports for each line segment.

d. The Contractor shall have the ability to store the compressed video files in industry standard and approved Owner’s format and be transferable with the PACP compliant inspection database.

e. The contractor's equipment shall have the ability to "Link". “Linking” is defined as storing the video time frame code with each observation or defect with the ability to navigate from/to any previously recorded observation or defect instantaneously.

f. The system shall be able to produce data reports to include, at a minimum, all observation points and pertinent data. All data reports shall match the defect severity codes in accordance with PACP naming conventions

g. The data-sorting program shall be capable of sorting all data stored using generic sort key and user defined sort fields.

h. Camera footage, date & manhole numbers shall be maintained in real time and shall be displayed on the video monitor as well as the video character generators illuminated footage display at the control console.

i. Depth gage: The camera shall have a depth gage or approved method to measure deflection in the pipe and joint separation approved by the Owner.

C. Gravity Main Inspection CCTV Data

1. CCTV data shall be recorded and saved in MPEG format or Windows Media video format.

2. CCTV inspections shall use unique identification numbers established and provided by the Owner in pipe segment reference, upstream manhole number and the downstream manhole number fields.

3. The video files will be named in accordance with the Owner file naming convention: Upstream MH ID _ Downstream MH ID _ Inspection Date (year_month_day).wmv. Example: 39540008_39540007_2009_08_05.wmv

4. Reports shall be submitted in an electronic version (.pdf) generated by the computer software shall be consistent with PACP requirements, observation report with still images; and CCTV inspection results.

   a. PACP export pipe inspection database (.mdb) saved on CD-R's, DVD, or portable hard drives

   b. Inspection digital photographs in JPEG format saved on CD-Rs, DVD or portable hard drives

   c. QA/QC report

5. The video file names will be referenced in the inspection database and in an inspection report generated in PDF format. The pipeline collection and real time video capture and data acquisition systems shall be provided

6. The system shall use the most current PACP compliant application software and shall be fully object oriented or approved equal. It shall be capable of printing pipeline inspection reports with captured images of defects or other related significant visual information on a standard color printer.

7. The imaging capture system shall store digitized color picture images and be saved in digital format on a DVD, hard drive or approved equal. Also, this system shall have the capability to supply the UTILITIES with inspection data reports for each line segment.

8. The Contractor shall have the ability to store the compressed video files in industry standard and approved Owners format and be transferable with the PACP compliant inspection database.

9. The Contractor's equipment shall have the ability to "Link". “Linking” is defined as storing the video time frame code with each observation or defect with the ability to navigate from/to any previously recorded observation or defect instantaneously.

10. The system shall be able to produce data reports to include, at a minimum, all observation points and pertinent data. All data reports shall match the defect severity codes in accordance with PACP naming conventions

11. The data-sorting program shall be capable of sorting all data stored using generic sort key and user defined sort fields.

12. Camera footage, date and manhole numbers shall be maintained in real time and shall be displayed on the video monitor as well as the video character generators illuminated footage display at the control console.

D. Test Plugs

Inflatable and expandable type, braced to contain 5 psi over the pipe cross-section area.

E. Pressure-Relief Valve

Set to limit the internal pipe test pressure to 5 psi.

PART 3 - EXECUTION

A. Leakage Testing Of Gravity Mains

1. The Contractor, with the Owners representation present, shall perform the leakage testing. The Contractor shall be responsible for furnishing all necessary labor and equipment to conduct such testing.

    a. Leakage tests shall be by a low-pressure air test. Each test section shall not exceed 400 feet in length and shall be tested between adjacent manholes. Leakage testing shall be conducted in accordance with the procedure for “Recommended Practice for Low Pressure Air Testing of Installed Sewer Pipe” as established by the Uni-Bell PVC Pipe Association. The pipe shall pass the current most stringent UNI-B-6 Uni-Bell standards for testing

gravity sewers and shall have no evidence of leaks in the pipe or connections.

B. Gravity Main Requirements Before CCTV Inspection

1. All manhole flow channels and benching per specifications shall be constructed and coated (if applicable) prior to CCTV inspection.

2. CCTV inspections shall be received, reviewed and approved by the Owner prior to installation of pavement.

3. The Contractor shall clean gravity mains to remove debris and stains from the pipe prior to televising. Flushing water or debris will not be allowed to enter pump station wet wells. Water will be pumped from the sewer system during flushing to an acceptable discharge location. A visual inspection shall be made and all obstructions removed.

4. Gravity Mains/Pipes that are dirty (dirty walls and/or debris in the inverts) shall be re-flushed and cleaned before rescheduling a CCTV inspection. If necessary, swabbing may be required of specific sections of pipe.

5. The Contractor shall pass a mandrel through the PVC pipe to confirm ring deflection in excess of five percent (5%). The base inside diameter shall be used to determine mandrel size as per ASTM D 3034.

6. Dewatering system shall not be operated within 48 hours prior to CCTV inspection.

7. Backfill from the gravity main to the subgrade shall be compacted and stabilized for inspection and cleaning vehicle access prior to CCTV.

C. Notification

Contractor shall notify the Owner a minimum of 48 hours prior to performing any CCTV gravity main inspection work.

D. Televising Of Gravity Mains

1. Wherever possible, gravity mains shall be televised in the downstream direction.

2. Sufficient water shall be run through each section of main until water runs through each downstream manhole no

more than 24 hours prior to televising. Lines that are dry or that enough water has not run through to reach the downstream manhole shall not be televised.

3. Gravity mains shall be televised from manhole to manhole utilizing a 360-degree pan and tilt color camera driven through at a moderate rate of speed not more than 30 feet per min. The camera shall be of the self-propelled tractor type with a measuring device mounted to the front capable of being read as the tractor moves and capable of accurately measuring depth of standing water up to, and including, three inches.

4. Begin video recording at the top of the manhole to see the condition of the manhole and any pipe that is connected to the manhole. Record going down into the manhole all the way to the preset footage with continuous recording until the downstream manhole.

5. Lighting should be set to allow for clear visibility without excessive reflection and should allow realistic colors to be visible.

6. The iris of the camera should be adjusted to allow for a sharp focused image and the lens should be kept clean and free of obstructions.

7. The operator should follow the manufacturer’s instructions to achieve the proper color correction.

8. All notes or coded references shall have footages recorded with them .

9. The camera should be centered within the pipe.

10. The distance between manhole centers shall be accurate within 0.5 percent.

11. The camera shall be stopped at all laterals adjusted for a clear picture and an orbital scan of the lateral taken pausing at the invert at the service lateral to detect dirt or infiltration.

12. All laterals shall be televised when reaching the lateral if a launch type camera is utilized.

13. The camera shall also be stopped at any suspected or confirmed defects, the focus properly adjusted and a clear digital video taken.

14. Areas suspected of leaking shall be paused long enough to determine if a leak exists currently or if deposits have occurred.

15. A digital photo shall be taken of all areas noted on the report including laterals and any confirmed or suspected defects.

16. Manholes upstream and downstream shall be measured from rim to invert and the depth recorded on the inspection header in feet and inches.

17. Manhole material and defects shall be noted.

18. Manholes that have laterals tied into them shall have sufficient water ran through them and a CCTV inspection to the property line will be conducted.

E. CCTV QA/QC Inspection Procedures And Causes For Rejection Of CCTV Work

1. The Contractor shall submit their Quality Assurance Plan and Quality Control procedures to the Owner. The Contractor shall ensure data quality and submit the results of the internal quality control checks performed on submitted data.

2. The Owner will perform quality control checks on submitted inspection data. Failure to meet the minimum accuracy noted below will be cause for rejection of submitted data. The following is the QC procedure to be employed by the Owner and serves as the minimum requirements for the Contractor.

   a. The Contractor shall review of a minimum of 5% of the total inspections by each PACP certified operator entering the field CCTV data. The Contractor shall number the inspection reports in the order they were inspected.

   b. The Contractor shall number the inspection reports in the order they were inspected.

c. Each inspection report that corresponds to the random numbers will be marked for review, the inspection report printed and the video copied to the QA/QC directory.

d. Each selected inspection report will be reviewed in detail against the inspection digital video.

e. Each field that is populated and those that should have been populated will be counted to produce a "number of fields checked" for the required header information and detailed inspection information. The fields with errors, or missing data, regardless of the error will be totaled to determine the "error count". The accuracy level will then be calculated as follows: 100-((error count/number of fields checked)*100) = accuracy percentage

f. Utilities will review contractor's quality control report and review an additional 5% or more inspections to insure contractor's quality of work has been met.

g. The accuracy of each PACP certified operator entering the field CCTV data shall meet or exceed 90%. Submittals where the accuracy level falls below 90% will be returned in their entirety for re-inspection and/or resubmittal.

F. Gravity Main Inspection CCTV Report

a. A. The Contractor will be required to submit the following deliverables on a weekly basis.

(1) Inspection Reports to include:

(a) Inspection session header information (see required fields above)

(b) Defect log report including photo captures from CCTV video

(c) Schematic drawing of pipe showing defects

(d) Format: Adobe Acrobat PDF files – 1 report PDF per pipe

File name: <upstream MH ID>_<downstream MH ID>_<Date(year_mo_day format)>.PDF Example:30060002_30060001_2010_02_16.pdf

(2) The Contractor shall submit quality control forms that include a hard copy print out of the inspection reports checked with errors and omissions clearly marked.

(3) Inspection video files on DVD or portable hard drive, labeled as follows: DVD/Hard drive Labels - Typed labels shall be attached to the face of each DVD. The typed index labels shall include the following information:

(a) Content (CCTV)

(b) Contractor name

(c) Purpose of Survey

(d) Tributary Pump station number

(e) Reaches included (from Manhole Number ## to Manhole Number ##)

(f) Date of survey

(g) Contract Number / Delivery Order Number (if applicable)

- Electronic Inspection Data stored and exported in a NASSCO Pipeline Assessment and Certification Program (PACP) compliant Microsoft Access database (.MDB) version 4.4 delivered on DVD or portable hard drive.

- Inspection photograph digital files (jpeg) indexed to NASSCO PACP compliant database.

G. Causes For Rejection Of Gravity Mains

1. The Contractor shall be required to replace the pipeline if the acceptance or bond CCTV inspection reveals cracked, broken or defective pipe, and/or in the case of PVC pipe a ring deflection in excess of five percent (5%).

2. Joint separation shall be no greater than two inches between the spigot and bell of the pipe.

3. No evidence of leakage will be acceptable for private gravity mains connecting to Owners' collection system.

4. The following NASSCO PACP codes or notes shall be cause for rejection of gravity sewer systems

   a. PACP coding of "Line" (L) shall be accompanied by a measurement of the line, grade or angular deviation. Variance of established line and grade at any point along the length of the pipe shall not be greater than 1 inch, provided such variation does not result in a level or reverse sloping invert. An approved method shall be used to determine this deviation. A PACP coding of MWLS with a percentage of pipe greater than 12.5% on 8-inch sewer, 15% on 10-inch sewer etc. will be corrected by excavation and repair.

   b. PACP coding of "Infiltration" (I) for pipe joints shall be replaced or the pipe joint shall be reseated at the joint. Grouting shall not be considered a method of repair and will not be accepted. Replace the leaking gravity main segment if there is visible infiltration at any point other than the pipe joint.

   c. Any PACP coding in the category of "Structural Family".

   d. PVC pipe having ID tears will be rejected.

   e. PACP condition grading of "OB" (obstruction) in pipe shall be rejected, the obstruction shall be removed and the line cleaned and re-televised.

H. Acceptance

1. Successful passage of both the leakage test and CCTV inspection is required before acceptance by the Owner.

2. Prior to repair or replacement of failed sewer pipe, the method of repair or replacement shall be submitted to the Owner for approval. Pressure grouting of pipe or manholes shall not be considered as an acceptable method of repair.

I. Testing And Inspection Of Manholes

1. Leakage Test:

There shall be no visible leakage through the walls or pipe connections.

2. Vacuum Test:

All manholes shall be required to meet the requirements of the vacuum test as per the current ASTM C 1244 “Standard Test Method for Concrete Sewer Manholes by the negative Air Pressure (Vacuum) Test” prior to acceptance. Manholes that fail the vacuum test or that develop a leak during the one year warranty period shall be rejected, removed and replaced with new material at no cost to the Owner. No field repair shall be approved.

3. Manhole Inspections:

a. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Owner. Such inspection may be made at the place of manufacture and/or at the site after delivery, or at both places. The sections shall be subject to rejection at any time due to failure to meet any of the specification requirements; even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the job shall be marked for identification and shall be immediately removed from the job. All sections or joints, which have been damaged, will be rejected, removed from the site and replaced with new material. If already installed, rejected section shall be removed and replaced entirely at the Contractor’s expense.

b. At the time of inspection, the sections will be carefully examined for compliance with the specified ASTM 478 “Standard Specification for Precast Reinforced Concrete Manhole Sections”, and with the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, “scratch-strength” blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured. Installed manholes shall be inspected for proper filling and coating of the

lifting holes and proper installation of any liner, coating or shrink-wrap.

J. Testing Of Wastewater Force Mains

1. Tracing Wire System:

All wastewater force mains shall be installed with a continuous green insulated copper wire. Locating wire installed as per the drawings shall pass a continuity check with an approved tracing system before acceptance by the Owner.

2. Inspection of Wastewater Air Release Valves:

After completion of the pressure test the ARV shutoff valve shall be opened and the Owner shall test the ARV for proper connection and operation.

3. Inspection of Plug Valves and Valve Boxes:

Valves shall be opened wide, then tightly closed and the various nut and bolts shall be tested for tightness. Any valve that does not operate correctly shall be replaced. Valve boxes shall be properly marked and checked for installation as per the drawings. Operating nuts, extensions and upper guides shall not interfere with valve operation. Before acceptance by the Owner valve boxes shall be adjusted to finished grade with the operating nut properly centered and shall have a “V” notched in the curb or street in the absence of a curb directly opposite the valve box.

4. Hydrostatic Pressure Testing:

a. Hydrostatic tests shall consist of pressure and leakage tests. Air testing of pressure pipes will not be permitted under any circumstance. Testing shall be performed from in-line valve to in-line valve with a depressurized section behind each valve. The Contractor shall pressure test both sides of the valve. The Contractor shall furnish all necessary testing material and equipment to perform this test. The Owner will monitor and approve a satisfactory test. Multiple sections may be tested simultaneously providing there are dead sections in between each pressure tested section.

b. All pipe sections to be pressure tested shall be subjected to a hydrostatic pressure of 100 psi. The duration of each pressure test shall be for a period of two hours. If during the test, the integrity of the tested line is in question, the Owner may require a 6-hour pressure test. The basic provisions of AWWA C600 shall be applicable.

c. Procedure for Pressure Test:

Each section of pipe, inclusive of all appurtenances to be tested, as determined by the Owner, shall be slowly filled with water and the specified test pressure shall be applied by means of a pump connected to the pipe in a satisfactory manner. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made and appropriate valves installed to ensure bleeding of all air from the main. If defective pipes, fittings or valves are discovered during this pressure test, all such items shall be removed and replaced by the Contractor with sound material and the test shall be repeated until satisfactory results are obtained. Provisions of the current AWWA C600, where applicable, shall apply.

d. Hydrostatic Leakage Testing:

(1) Procedure for Leakage Test:

After completion of the pressure test, a leakage test shall be conducted to determine the quantity of water lost by leakage under the specified test pressure. Applicable provisions of AWWA C600 shall apply.

(a) Allowable leakage in gallons per hour for pipeline shall not be greater than that determined by the formula:

$$L = \frac{SD\,(P)^{0.5}}{148{,}000}$$

Note:
L = Allowable leakage in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of the pipe in inches.
P = Average test pressure, psi

(2) Leakage is defined as the quantity of water to be supplied in the installed pipe or any valve section under test, which is necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. Should any test of pipe installed disclose leakage greater than that allowed, the Contractor shall locate and replace or repair the defective joints, pipe or valve until subsequent testing is within the specified leakage allowance.

END OF SECTION

SECTION 02534 PVC GRAVITY SEWER PIPE

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of PVC gravity sewer pipe conforming to ASTM D3034 or ASTM F789.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit reports on testing per ASTM D3034 or ASTM F789 ASTM D3212, and ASTM F477.

3. Submit cut sheets showing invert elevations, ground elevations, and cuts every 25 feet. Show lateral locations.

PART 2 - MATERIALS

A. PVC Material

Additives and fillers, including stabilizers, antioxidants, lubricants, colorants, etc., shall not exceed 10 parts by weight per 100 of PVC resin in the compound.

B. Pipe

Pipe shall conform to ASTM D3034, SDR 35, or ASTM F789.

C. Joints

Provide elastomeric gasket joints of the push-on type, conforming to ASTM D3212.

D. Gaskets

Gaskets for push-on joints shall conform to ASTM F477.

E. Fittings

Fittings shall conform to ASTM D3034, SDR 35, or ASTM F789.

F. Mandrel for Field Testing of Pipe Deflection

The mandrel shall:

1. Be a rigid, nonadjustable, odd-numbering-leg (nine legs minimum) mandrel having an effective length not less than its nominal diameter.

2. Have a minimum diameter at any point along the full length as follows:

Pipe Material	Nominal Size (inches)	Minimum Mandrel Diameter (inches)
PVC-ASTM D3034 (SDR 35)	6	5.619
	8	7.524
	10	9.405
	12	11.191
	15	13.849

3. Be fabricated of steel; be fitted with pulling rings at each end; be stamped or engraved on some segment other than a runner indicating the pipe material specification, nominal size, and mandrel outside diameter (e.g., PVC, D 3034-8"-7.524"); and be furnished in a carrying case labeled with the same data as stamped or engraved on the mandrel.

4. All costs incurred by the Contractor attributable to mandrel and deflection testing, including any delays, shall be borne by the Contractor at no cost to the Owner.

PART 3 - EXECUTION

A. Laboratory Testing

1. Conduct tests required in ASTM D3034 or F789, D3212, and F477.

2. The acceptable rates of failure for quality control tests shall be as follows:

a. Outer Diameter: 0%.

b. Minimum Wall Thickness: 0%.

c. Other Dimensions: 0%.

d. Flattening: 0%.

e. Impact: Six of six samples must pass; if one fails, test six more; all six must pass.

B. Installing PVC Sewer Pipe

1. Install in accordance with Section 02223, ASTM D2321, and as described below.

2. Pipe shall not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.

3. Minimum bedding thickness shall be 4 inches.

4. Lay pipe without break, upgrade from structure to structure, with the socket ends of the pipe upgrade.

5. Do not use the pipe as a drain for removing water that has infiltrated into the trench.

6. After joint assembly, bring the bedding material up to pipe spring line. Bedding material shall be imported sand per Section 02223. Place the bedding material on each side of the pipe. Tamp the bedding material into final position at pipe spring line and continue to the top of the pipe. Relative compaction shall be in conformance with Section 02223.

7. Then place bedding material to 1 foot above the top of the pipe and compact to the same relative compaction as in the pipe zone per Section 02223. The remainder of the trench backfill shall be native material, installed per Section 02223.

8. Do not use hydro-hammers to compact bedding or backfill.

C. Installing Pipe at Manholes and Structures

1. Place a 2-foot PVC length of pipe of the same inside diameter as the adjoining pipe at the inlet and outlet to each manhole or structure. Use one of the following methods:

a. Directly cast a manhole coupling into the manhole base. Provide rubber-ring gasket in the coupling.

b. Stretch a rubber-ring gasket around the pipe to serve as a water stop when cast into the structure wall.

2. Do not cast pipe bells into manholes or structures. Cut off the bell so that no recess or offset appears on the exposed face from the inside wall of the pipe to the outside wall of the pipe. The pipe shall have a plain end, flush with the inside wall of the manhole or structure, or as shown in the drawings.

D. Testing for Defects of Installed Pipe

Following placement and compaction of backfill and prior to placing permanent pavement, ball and mandrel the pipe to measure for obstructions (excessive deflections, joint offsets, and lateral pipe intrusions).

E. Field Testing for Pipe Deflection

1. Test installed pipe to ensure that vertical deflections for plastic pipe do not exceed the maximum allowable deflection. Maximum allowable deflections shall be governed by the mandrel requirements stated herein and shall nominally be:

Nominal Pipe Size	Percentage
Up to and including 12 inches	5.0
Over 12 to and including 15 inches	4.0

2. The maximum average inside diameter shall be equal to the average outside diameter per applicable ASTM standard minus two minimum wall thicknesses per applicable ASTM standards. Manufacturing and other tolerances shall not be considered for determining maximum allowable deflections.

3. Perform deflection tests not sooner than 30 days after completion of placement and compaction of backfill. Clean and inspect the pipe for offsets and obstructions prior to testing.

4. Pull a mandrel through the pipe by hand to verify that maximum allowable deflections have not been exceeded.

Prior to use, the mandrel shall be certified by an independent testing laboratory. Use of an uncertified mandrel or a mandrel altered or modified after certification will invalidate test. If the mandrel fails to pass, the pipe will be deemed to be overdeflected.

5. Uncover any overdeflected pipe and, if not damaged, reinstall. Remove damaged pipe from the site. Any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any overdeflection, shall be uncovered, removed from the site, and replaced with new pipe.

F. Leakage Test

See Section 02530.

G. Testing for Alignment and Grade

After the pipe has been installed, tested for leakage, backfilled to existing grade, and manholes raised to grade and resurfaced, "ball" the pipe from manhole to manhole with a sewer scrubbing ball. After balling the pipe, perform the following:

1. Provide television inspection. Make a videotape or DVD and defects requiring correction shall be noted. Upon completing the corrective work, notify the Owner; the affected portion of the pipeline system will be retelevised at no additional cost to the Owner.

END OF SECTION

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SECTION 02551 PRIME AND TACK COATS

PART 1 - GENERAL

A. Description

This section includes materials, testing and application of bituminous material on a previously prepared base and on an existing pavement surface.

B. Submittals

Submit shop drawings in accordance with the General Conditions and Section 01300 showing the materials to be used and manufacturer's certificates showing compliance with the specifications.

PART 2 - PRODUCTS

A. Prime Coat

The material used for prime coat shall be:

1. Cut-back Asphalt Grade RC-70 or RC-250 meeting the requirements of AASHTO M81 except that the penetration range shall be from 60-120 instead of 80-120.

   For Grade RC-3000, in addition to the requirements shown in Table I of AASHTO M81 the following values shall be added to the requirements for Distillation Test:

Distillate, percentage by volume of total distillate to 680 deg. F.	Grade RC-3000 Max.
to 320 deg. F	0
to 374 deg. F	10
to 437 deg. F	40

   All other requirements for the distillation test (and for other properties included in the table) shall be as shown in Table I of AASHTO M81.

2. Emulsified Asphalt Grades SS-1 or CCS-1, SS-1H or CCS-1H diluted in equal proportion with water; asphalt emulsified asphalt grade AE-60, AE-90, AE-150 or AE-200 diluted at the ratio of 6 parts emulsified asphalt to 4 parts water; special MS-Emulsion diluted at the ratio of

6 parts emulsified asphalt to 4 parts water; Asphalt Emulsion Prime (AEP) meeting the following:

a. Anionic Emulsified Asphalt shall meet the requirements of AASHTO M140 with the exception that the cement mix test will be waived when the asphalt is used in non-mix application, such as tack coats and primes.

b. Cationic Emulsified Asphalt shall meet the requirements of AASHTO M208.

c. Emulsified Asphalt Grades AE-60, AE-90, AE-150 and AE-200 shall meet the following requirements:

HIGH FLOAT EMULSIONS

	Asphalt Emulsion Grade			
	AE-60		AE-90	
	Min	Max	Min	Max
Tests on Emulsion:				
Saybolt Furol Viscosity at 122°F, sec.	75	400	75	400
Settlement 5 days, %		5		5
Storage Stability 24 Hr., %		1		1
Sieve Test, %		0.10		0.10
Demulsibility, 50 ml CaC12 0.10N, %	75		75	
Residue by Distillation, %	65		65	
Oil Portion, % by Volume (500°F Dist)		1		2
Tests on Residue:				
Penetration 77°F 100 g 5 sec	40		70	
Absolute Viscosity, poise 140°F	3200		1600	
Ductility 77°F 5 cm/min, cm	40		40	
Float Test 140°F, sec	1200		1200	
Solubility in Trichloroethylene, %	97.5		97.5	

	AE-150		AE-200	
	Min	Max	Min	Max
Tests on Emulsion:				
Saybolt Furol Viscosity at 122°F, sec.	75	400	75	
Settlement 5 days, %		5		5
Storage Stability 24 Hr., %		1		1
Sieve Test, %		0.10		0.10
Demulsibility, 50 ml CaC12 0.10N, %	75			
Residue by Distillation, %	65		62	
Oil Portion, % by Volume (500°F Dist)		3		8
Tests on Residue:				
Penetration 77°F 100 g 5 sec	125		150	
Absolute Viscosity, poise 140°F	800		400	
Ductility 77°F 5 cm/min, cm	40			
Float Test 140°F, sec	1200		1200	
Solubility in Trichloroethylene, %	97.5		97.5	

d. Special MS-Emulsion shall meet the following requirements with a minimum application temperature of 170°F:

SPECIAL MS-EMULSION

	Min	Max
Tests on Emulsion:		
Saybolt Furol Viscosity at 77°F, sec.	45	--
Storage Stability 24 Hr., %	--	1
Sieve Test, %	--	0.10
Demulsibility, 50 ml CaC12 0.10N, %	65	--
Residue by Distillation, %	62	--
Oil Portion, % by Volume (500°F Dist)	--	8
Tests on Residue:		
Penetration 77°F 100 g 5 sec	60	--
Ductility 77°F 5 cm/min, cm	40	--
Absolute Viscosity, poise 140°F	800	--
Solubility in Trichloroethylene, %	97.5	

e. Emulsified Asphalt Grade CRS-2H shall meet the following requirements:

EMULSIFIED ASPHALT GRADE CRS-2H

	Min	Max
Tests on Emulsion:		
Saybolt Furol Viscosity at 122°F, sec.	100	400
Settlement 5 days, %	--	5
Storage Stability 24 Hr., %	--	1
Demulsibility, 35 ml 0.8% Sodium dioctyl Sulfosaccinate, %	40	
Particle Charge	Positive	
Sieve Test, %	--	0.1
Residue, %	65	--
Tests on Residue:		
Penetration 77°F 100 g 5 sec	80	140
Ductility 77°F 5 cm/min, cm	40	--
Solubility in Trichloroethylene, %	97.5	--

f. Asphalt Emulsion Prime shall meet the following requirements:

ASPHALT EMULSION PRIME (AEP)

	Min	Max
Tests on Emulsion:		
Saybolt Furol Viscosity at 77°F, sec.	20	150
Settlement 5 days, %	--	5
Storage Stability 24 Hr., %	--	1
Sieve Test, %	--	0.1
Demulsibility, 50 ml CaC12 0.10N, %	65	--
Residue, %	55	--
Oil Portion, % by Volume (500°F Dist)	--	12
Tests on Residue:		
Penetration 77°F 100 g 5 sec	40	200
Ductility 77°F 5 cm/min, cm	40	--
Solubility in Trichloroethylene, %	97.5	--

Where Emulsified Asphalt is deficient from the minimum percentage of residue required in the applicable specifications, payment for such material will be made at reduced rates as shown in the following table:

Deficiency from Minimum Percent Residue	Percentage of Original Contract Price
1 - 3	95
4 - 6	85
7 - 9	75
*More than 9	50

*At the discretion of the Engineer, the asphaltic mixture, the base material, the surface treatment, or the mineral seal coat containing this material may be left in place with 50 percent payment made therefore, or be removed to the extent required by the Engineer and acceptably replaced.

The viscosity requirements for all Grades of Emulsified Asphalt used as tack coat or prime coat may be waived by the Engineer if satisfactory results are being obtained.

B. Cover Material for Prime Coat

1. If an emulsified asphalt is used for prime coat, the cover material shall be hot-asphalt coated (mix to contain from two to four percent asphalt-cement) to achieve a prime coat which will remain reasonably intact until the surface course is placed.

2. If material other than emulsified asphalt is used for the prime coat, the cover material shall be either sand (bare or hot-asphalt coated) or screenings. The sand shall be nonplastic and free from any appreciable amount of silt, clay balls and root particles, and from any noticeable sticks, trash, vegetation or other organic matter. Screenings shall be Miami Oolitic rock screenings as specified in FDOT Specification Section 902-5.2.3.

C. Tack Coat

1. Unless a specific type or grade of material is called for in the plans or specifications, the material used for tack coat may be any of the following: Emulsified Asphalt, Grades RS-1, RS-2, CRS-2, SS-1, CSS-1, SS-1H, CSS-1H, AE-60, AE-90, AE-150, or CRS-2H, Special MS Emulsion, or Asphalt Emulsion Prime (AEP). The materials specified above shall not be diluted prior to use.

2. Emulsified asphalt (RS Type) shall meet the following requirements:

	Min.	Max.
Tests on Emulsion:		
Saybolt furol viscosity at 77°F, sec.	75	--
Storage stability 24 Hr., %	--	1.0
Sieve test, %	--	0.1
Naptha content, % by volume	5	15
Residue, %	55	--
Tests on Residue:*		
Penetration at 77°F, 100g, 5 sec.	50	--
Viscosity at 140°F (poises)	800	--
Solubility in trichloroethylene, %	97.5	--

* Residue by distillation shall be in accordance with AASHTO T-59 except that the maximum temperature shall be 329° + 10°F (165° + 5°C) and the sample shall be maintained at this temperature for 20 minutes.

PART 3 - EXECUTION

A. Equipment

Pressure Distributor: The pressure distributor shall be equipped with pneumatic tires having a sufficient width of rubber in contact with the road surface to avoid breaking the bond or forming a rut in the surface. The distance between the centers of openings of the outside nozzles of the spray bar shall be equal to the width of the application required, within an allowable variation of two inches. The outside nozzle at each end of the spray bar shall have an area of opening not less than 25 percent nor more than 75 percent, in excess of the other nozzles. All other nozzles shall have uniform openings. When the application covers less than the full width, the normal opening of the end nozzle at the junction line may remain the same as those of the interior nozzles.

B. Cleaning Base and Protection of Adjacent Work

1. Before any bituminous material is applied, all loose material, dust, dirt, caked clay and other foreign materials which might prevent proper bond with the existing surface shall be removed for the full width of the application. Particular care shall be taken in cleaning the outer edges of the strip to be treated, to insure that the prime or tack coat will adhere.

2. When the prime or tack coat is applied adjacent to curb and gutter, valley gutter or any other concrete surfaces, such concrete surfaces (except where they are to be covered with a bituminous wearing course) shall be covered with heavy paper, or otherwise protected while the prime or tack coat is being applied. Any bituminous material deposited on such concrete surfaces shall be removed.

C. Weather Limitations

Prime and tack coats shall be applied when the air temperature, in the shade, is above 40°F, and when all other weather conditions and the condition of the surface are suitable.

D. Application of Prime Coat

1. General: The surface to be primed shall be clean and the moisture content of the base shall not exceed 90 percent of the optimum moisture. The temperature of the prime material shall be between 100°F and 180°F. The actual

temperature shall be that which will insure uniform distribution. The material shall be applied by means of a pressure distributor. The amount to be applied will be dependent on the character of the surface and shall be sufficient to coat the surface thoroughly and uniformly, with no excess. A prime coat is required on newly constructed limerock, shell, and sand clay bases.

2. Rate of Application

   a. Limerock, Limerock Stabilized, and Local Rock Bases: For these bases, the rate of application shall be not less than 0.10 gallon per square yard.

   b. Sandy-Clay, Shell and Shell Stabilized Bases: The rate of application for these bases shall be not less than 0.15 gallon per square yard.

3. Partial Width of Application: If warranted by traffic conditions, the application may be made on only one-half of the width of the base at one time, in which case positive means shall be used to secure the correct amount of bituminous material at the joint.

4. Sanding

   a. If emulsified asphalt is used to prime coat, the primed base shall be uniformly covered by an application of sand-bituminous hot mix or screenings at an approximate rate of ten pounds per square yard. The entire surface of the sand-bituminous hot mix or screenings cover material shall be rolled with a traffic roller as required to produce a reasonable dense mat.

   b. If material other than emulsified asphalt is used for prime coat, the primed base shall be covered by a light uniform application of cover material. If considered necessary for proper distribution of spread, the cover material shall be lightly dragged with a drag broom, after which it shall be rolled with a traffic roller, for at least ten passes over the entire area.

E. Application of Tack Coat

1. General: Where a bituminous surface is to be laid and a tack coat is required, the tack coat shall be applied as specified herein below.

2. Use a tack coat on existing pavement to be resurfaced, primed bases in areas which have become excessively dirty and cannot be cleaned, or in areas where the prime has cured and lost its bonding effect.

3. Method of Application: The tack coat shall be applied with a pressure distributor except that, on small jobs if approved by the Engineer, application may be by other mechanical devices or by hand methods. The bituminous material shall be heated to a suitable temperature and shall be applied in a thin, uniform layer.

4. Rate of Application: The rate of application shall be between 0.02 and 0.08 gallon per square yard. For tack coat applied on concrete pavement which is to be surfaced, the rate of application may exceed the upper limit.

5. Curing and Time of Application: The tack coat shall be applied sufficiently in advance of the laying of the bituminous mix to permit drying but shall not be applied so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material.

6. Protection: The tack coat surface shall be kept free from traffic until the subsequent layer of bituminous hot mix has been laid.

END OF SECTION

SECTION 02576 ASPHALT PAVEMENT

PART 1 - GENERAL

A. Description

This section specifies requirements for material, testing and installation of plant mix asphalt pavement.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following:

2. A design mix for the asphalt including gradation of all materials, content of mix, Marshall stability, and laboratory density.

3. Certifications showing that the materials comply with the specifications and contain less than 1% by weight asbestos.

PART 2 - PRODUCTS

A. Asphaltic Concrete

1. Composition, design mix and physical properties shall meet the requirements of the following:

Bituminous Concrete Mixtures
(Gradation Design Range)

Percent by Weight Total Aggregate Passing Sieves

Type	3/4	1/2	3/8	No. 4	No. 10	No. 40	No. 80	No. 200
S-I	100	88-100	75-93	47-75	31-53	19-35	7-21	2-6
S-III		100	88-100	60-90	40-70	20-45	10-30	2-6

(1) 100% passing 1-1/4-inch sieve and 94-100% passing 1-inch sieve.

Marshall Design Properties for
Bituminous Concrete Mixes

Mix Type	Minimum Marshall Stability (lbs)	Flow[1] (0.01 in.)	Minimum VMA (%)	Air Voids (%)	Minimum Effective Asphalt Content (%)
S-I	1500	8-14	14	3-5	5.0
S-III	1500	8-14	15	3-7	5.5

(1) The maximum flow for the mix design shall be one point less than shown. The maximum flow values shown apply only during production.

B. Asphaltic Concrete Type S-I and S-III

1. Type S-I and S-III shall meet the above requirements and the requirements in the following paragraphs.

2. The Asphalt Cement, Viscosity Grade AC-20 or AC-30, shall meet the following except that no spot test is required:

Test	AC-20 Min.	AC-20 Max.	AC-30 Min.	AC-30 Max.
Viscosity, 140°F (60°C), poises	(2000 ± 400)		(3000 ± 600)	
Viscosity, 275°F (135°C), Cs	300	--	350	--
Penetration, 77°F (25°C), 100 gm, 5 Sec.	60	--	50	--
Flash Point, COC, °F (°C)	450	--	(232)	--
Solubility in Trichloroethylene, percent	99.0	--	99.0	--
Tests on Residue from Thin Film Oven Test:				
Viscosity Ratio= Visc. 140°F after TFOT / Visc. 140°F before TFOT	--	4	--	4
Ductility 77°F (25°C) 5 cm per min, cm.	80	--	50	--
Loss on Heating, %	--0.5	--	0.5	

3. Mineral filler shall consist of limerock dust, portland cement, slag dust or hydrated lime. It shall be thoroughly dry and free from lumps, consisting of aggregations of fine particles. The filler shall meet the following gradation requirements:

Sieve Number	Total % Passing
30	100
80	95 (min)
200	65 (min)

Mineral filler may be provided from process screenings from stone or slag provided that the loss in processing under the Los Angeles Abrasion Test does not exceed 45%. The gradation of this filler shall be such that all of it shall pass the No. 10 sieve, and not more than 35% shall pass the No. 200 sieve. The material passing the No. 200 sieve shall be free of organic impurities and clay minerals shall not exceed 4.0%. The plasticity index of the material passing the No. 200 sieve shall not exceed 4.

4. Coarse Aggregate:

   a. Coarse Aggregate shall consist of gravel, rock or slag and contain less than 1% by weight asbestos. All coarse aggregate shall be washed and shall be free from disintegrated pieces, clay lumps, soft and friable particles, salt, alkali, organic matter and adherent coatings. The weight of deleterious substances shall not exceed the following percentages:

Coal and lignite	1.00
Clay lumps	2.00
Soft and friable particles	2.00
Cinders and clinkers	0.50
Free Shell	1.00
Organic matter (wet)	0.03
Material passing the No. 200 Sieve	1.75
Chert	3.00

      In addition, the sum of the percentages of all substances listed above shall not exceed ten.

   b. Coarse aggregate shall have a maximum loss of 45% when subjected to the Los Angeles Abrasion Test, a maximum loss of 12% when subjected to the Soundness (Sodium Sulfate) Test and contain a maximum of 10% flat or elongated pieces.

   c. Natural Stones: Coarse aggregate may be processed from gravels, granites, limestones, dolomites, sandstones, or other naturally occurring hard, sound, durable materials meeting the requirements of this paragraph.

      (1) Gravel shall be composed of naturally occurring quartz. The loss when the material is subjected to the Los Angeles Abrasion Test (AASHTO T96), shall be no more than 45%. The dry-rodded weight per cubic foot of the gravel, tested according to AASHTO T19, shall

be not less than 95 pounds. Crushed gravel shall consist of 85%, by weight, of the material retained on the No. 4 sieve, having three crushed faces.

(2) Granites: Coarse aggregate produced from the crushing of granites shall be sound and durable. For granites to be used in bituminous mixtures and surface treatments, the Los Angeles Abrasion requirement is modified to permit a maximum loss up to 50 (Manual of Florida Sampling and Testing Methods FM 1-T 096). Maximum amount of mica schist permitted is 5% (AASHTO T-189).

(3) Limestones, Dolomites and Sandstone: Coarse aggregates may be produced from limestone, dolomites, sandstones, and other naturally occurring hard, durable materials meeting the requirements of this paragraph.

(4) Pre-Cenozoic limestones and dolomites shall not be used as crushed-stone aggregates, either coarse or fine, for wearing courses of asphaltic concrete surface courses. This specifically includes materials from the Ketona Dolomite (Cambrian), Newala Limestone (Lower Ordovician), Bangor Limestone (Mississippian), and other formations of similar composition and origin occurring in central and northern Alabama and Georgia.

d. Slag shall be clean, tough and durable. It may be either air-cooled blast-furnace slag or phosphate slag. It shall be reasonably uniform in density and quality, and free from deleterious substances. It shall contain not more than 1.5% of sulphur. The dry-rodded weight shall be not less than 70 pounds per cubic foot. The loss, when the slag is subjected to the Los Angeles Abrasion Test, shall not exceed 45%. It shall contain not more than 10% glassy particles.

e. Unless written permission from the Owner is obtained, coarse aggregates of different types shall not be mixed, nor be used alternately in sections of less than one mile.

f. Grading shall be in accordance with FDOT Specification Section 901-1.4 Table 1.

g. Lightweight expanded aggregate shall be clean and durable material produced by firing shale, clay, or slate in a rotary kiln. It shall be reasonably uniform in quality and density and free from deleterious substances, except that the term cinders and clinkers shall only apply to those particles clearly foreign to the expanded aggregate in question and the maximum percentage of material passing the No. 200 sieve shall be 3.00. The dry-loose unit weight of the material, determined in accordance with AASHTO T19, shall not be less than 33 or more than 55 pounds per cubic foot. The burning process shall be carefully controlled. As an indication of the control of burning, the producer shall obtain and test samples of material at frequent intervals. Control shall be considered adequate if the dry-loose unit weight of such samples does not differ by more than ±6% from the average weight established from the producer's quality control testing records. When subjected to the Los Angeles Abrasion Test, the loss shall not exceed 35%.

5. Fine Aggregate:

a. Fine aggregate shall consist of natural silica sand, screenings, or a combination thereof, composed of clean, tough, angular grains, free from clay, soft or flaky particles, salt, alkali, organic matter, loam and other foreign matter. As delivered to the mixer it shall be free from clayey lumps of loosely bonded aggregations and the individual particles shall be free from adhering dust. Stone of slag screenings shall be produced from material complying with the abrasion requirements specified for coarse aggregate. The weight of deleterious substances (shale, coal and lignite, cinders and clinkers, clay lumps) shall not exceed 1.0, 1.0, 0.5 and 1.0% respectively.

b. The following additional limitation shall apply for stone used as aggregate in all asphaltic concrete used as a wearing coarse. Pre-Cenozoic limestones and dolomites shall not be used as crushed-stone aggregates, either coarse or fine, for wearing courses of asphaltic concrete surface coarses. This specifically includes materials from the Ketona Dolomite (Cambrian), Newala Limestone (Lower Ordovician), Bangor Limestone (Mississippian), and

other formations of similar composition and origin in central and northern Alabama and Georgia.

c. Any screenings used in the combination of aggregate shall contain not more than 15% of material passing the No. 200 sieve and, if necessary to meet this requirement, they shall be washed.

d. Any natural sand portion of the fine aggregate other than screenings shall be siliceous and shall contain not more than 10% of material passing the No. 200 sieve.

e. Silica sand, when tested by means of laboratory sieves, shall meet the following requirements:

Passing Sieve	Percent by Weight
No. 4	95-100
No. 8	85-100
No. 16	65- 97
No. 30	25- 70
No. 50	5- 35
No. 100	0- 7
No. 200	Max. 4

f. Screenings: Screenings shall be composed of hard, durable particles, either naturally occurring, such as gravel screenings, or resulting from the crushing or processing of the parent rock, to include natural rock, slags, expanded clays or shales (lightweight aggregates), or other approved inert materials with similar characteristics.

Aggregates classified as screenings shall conform to the following gradation requirements:

Sieve Size	Passing Percent
3/8"	100
No. 4	85 to 100
No. 200	Maximum 15

PART 3 - EXECUTION

A. Hot Bituminous Mixtures

1. Plant operations shall not begin unless all weather conditions are suitable for the laying operations.

2. The mixture shall be spread only when the surface upon which it is to be laid has been previously prepared, is intact, firm and properly cured, and is dry. No mixture shall be spread that cannot be finished and compacted during daylight hours. The mixture shall be spread only when the air temperature (the temperature in the shade away from artificial heat) is above 40°F for layers greater than one inch (100 lbs per square yard) in thickness and 45°F and above for layers one inch (100 lbs per square yard) or less in thickness (this includes leveling courses). No mixture shall be placed when there is evidence of a frozen base. The mixture shall not be spread when the wind is blowing to such an extent that proper and adequate compaction cannot be maintained or when sand, dust, etc., are being deposited on the surface being paved, to the extent that the bond between layers will be diminished.

3. Mixing at the asphalt plant shall be sufficient to produce a thoroughly and uniformly coated mixture. The ingredients of the mix shall be heated and combined in such a manner as to produce a mixture, which shall be at a temperature, when discharged from the pugmill or surge bin, within the range of 230°F to 310°F and within the tolerance shown in the following table:

Temperature Tolerance From
Job Mix Formula

Any Single Measurement	±25°F
Average of Any Five Consecutive Measurements . .	±15°F

However, the temperature of the mixture, in all cases, shall be such that will yield an asphalt Kinematic viscosity within the range of 280 and 150 centistokes. The mix temperature will be taken at the plant on the first five loads each day and on an average of once every five loads thereafter. Take corrective action if the temperature fails to fall within the specified tolerance.

4. The maximum time that any mix may be kept in a hot storage or surge bin is 72 hours. Produce a homogeneous mixture, free from moisture and with no segregated materials, that meets all requirements of the specifications for the mixture, including compliance with the design limits. These requirements shall apply also to all mixes produced by the drum mixer process and all mixes processed through a hot storage or surge bin, both before and after storage.

5. The mixture shall be transported in tight vehicles previously cleaned of all foreign material and each load shall be covered. The inside surface of the truck bodies shall be thinly coated with soapy water or an emulsion containing not over 5% of oil. Kerosene, gasoline or similar products shall not be used. After the truck bodies are coated and before any mixture is placed therein, they shall be raised so that all excess liquids will be drained out.

6. Prior to the laying of the mixture, the surface of the base or pavements to be covered shall be cleaned of all loose and deleterious material by the use of power brooms or blowers, supplemented by hand brooming where necessary.

7. All asphaltic concrete mixtures (including leveling courses), other than adjacent to curb and gutter or other true edges, shall be laid by the string-line method, to assure the obtaining of an accurate, uniform alignment of the pavement edge. The temperature of the mix at the time of spreading shall be within $\pm$25°F of the actual mix temperature. The minimum frequency for taking mix temperatures on the road will be an average of one per five trucks. Take corrective action if the temperature range fails to fall within the specified tolerance range. Any mixture caught in transit by a sudden rain may be laid at risk. Should such mixture prove unsatisfactory, it shall be removed and replaced with satisfactory mixture at no additional expense to the Owner. In no case shall the mixture be laid while rain is falling or when there is water on the surface to be covered. The forward speed of the spreader shall be as established by the manufacturer of the equipment and sufficient for an even application. For each paving machine being operated, a separate crew will be required; each crew operating as a full unit. The depth of each layer shall be checked at frequent intervals of approximately 25 feet. Any deviation below the design thickness as shown on the drawings shall be immediately

corrected. In limited areas where the use of the spreader is impossible or impracticable, the mixture may be spread and finished by hand. Straight-edging and back-patching shall be done after initial compaction has been obtained and while the material is still hot.

8. For courses other than leveling, upon arrival, the mixture shall be dumped into a mechanical spreader and immediately spread and struck-off to the full width required and to such loose depth for each course that, when the work is completed, the required weight of mixture per square yard, or the specified thickness, will be secured. An excess amount of mixture shall be carried ahead of the screed at all times. Hand raking shall be done behind the machine as required. If necessary due to the traffic requirements, the mixture shall be laid in trips in such manner as to provide for the passage of traffic. Where the road is closed to traffic, the mixture may be laid to the full width, by machines traveling in echelon. Before any rolling is started the surface shall be checked, any irregularities adjusted, and all drippings, fat sandy accumulations from the screed, and fat spots from any source shall be removed and replaced with satisfactory material. No skin patching shall be done. When a depression is to be corrected while the mixture is hot, the surface shall be well scarified before the addition of fresh mixture.

9. For leveling courses, all depressions in the existing surface more than one inch deep shall be filled by spot patching with leveling course mixture and then thoroughly compacted prior to spreading any leveling course. All leveling courses shall be placed by the use of two motor graders (one of which is equipped with a spreader box) unless otherwise shown in the plans. When the total asphalt mix provided for leveling exceeds 50 pounds per square yard, the mix shall be placed in two or more layers, with the average spread of any layer not to exceed 50 pounds per square yard. When Type S-III Asphaltic Concrete is used for leveling, the average spread of a layer shall not be less than 50 lbs per square yard not more than 75 pounds per square yard. The quantity of mix for leveling shown in the plans represents the average for the entire project; however, the rate of application may vary throughout the project. When leveling in connection with base widening, all the leveling mix must be placed prior to the widening operation. When a leveling course is specified to be placed over cracked concrete pavement (including existing concrete pavement covered with an asphaltic

surface), the first layer of leveling shall be placed as soon as possible but no later than 48 hours after cracking the concrete. The remainder of the leveling course shall be placed in the normal sequence of operations. Where a leveling course is to be placed over existing concrete pavement or bridge decks, the excess joint filler in the cracks and joints shall be trimmed flush with the surface prior to placing the first layer of the leveling course.

10. For each paving or leveling train in operation, furnish a separate set of rollers, with their operators. The following equipment, sequence and coverage are only suggested for use based on past successful performance. Utilizing whatever equipment selected, the sequence and coverage of rolling shall meet the minimum density requirements specified:

    a. Seal rolling by using tandem steel rollers weighing 5 to 12 tons, following as close behind the spreaders as is possible without pick-up, undue displacement or blistering of the material.

    b. Rolling with self-propelled pneumatic-tired rollers, following as close behind the seal rolling as the mix will permit. The roller shall cover every portion of the surface with at least five passes.

    c. Final rolling with the 8- to 12-ton tandem steel rollers, to be done after the seal rolling and pneumatic-tired rolling have been completed, but before the internal pavement temperature has dropped below 175°F.

11. The initial rolling shall be longitudinal. Where the lane being placed is adjacent to a previously placed lane, the center joint shall be pinched or rolled, prior to the rolling of the rest of the lane. After the rolling or pinching of the center joint, the rolling shall continue across the mat by overlapping each previous roller path by at least one-half the width of the roller wheel. The motion of the roller shall be slow enough to avoid displacement of the mixture, and any displacement shall be corrected at once by the use of rakes, and the addition of fresh mixture if required. Final rolling shall be continued until all roller marks are eliminated. Rolling with the self-propelled, pneumatic-tired rollers shall proceed at a speed of 6 to 10 miles per hour, and the area covered by each roller shall not be more than 4,000 square yards per hour,

except that for Type S Asphaltic Concrete, this maximum rate of coverage shall be 3,000 square yards per hour.

a. A sufficient number of self-propelled pneumatic-tired rollers shall be used such that the rolling of the surface for the required number of passes will not delay any other phase of the laying operation nor result in excessive cooling of the mixture before the rolling is complete. In the event that the rolling falls behind, the laying operation shall be discontinued until the rolling operations are sufficiently caught up.

b. Areas which are inaccessible to a roller (such as areas adjacent to curbs, headers, gutters, bridges, manholes, etc.) shall be compacted by the use of hand tamps or other satisfactory means.

c. Self-propelled pneumatic-tired rollers shall be used for the rolling of all patching and leveling courses. Where the initial leveling course is placed over broken concrete pavement, the pneumatic-tired roller shall weigh at least 15 tons. For Type S-III Asphaltic Concrete leveling courses, the use of a steel-wheel roller, to supplement the traffic rollers, will be required. On other leveling courses, the use of a steel-wheeled roller will be required on all passes after the first.

d. The rollers shall not be allowed to deposit gasoline, oil or grease onto the pavement, and any areas damaged by such deposits shall be removed and replaced. While rolling is in progress, the surface shall be tested continuously and all discrepancies corrected to comply with the surface requirements. All drippings, fat or lean areas and defective construction of any description shall be removed and replaced. Depressions which develop before the completion of the rolling shall be remedied by loosening the mixture and adding new mixture to bring the depressions to a true surface. Should any depression remain after the final compaction has been obtained, the full depth of the mixture shall be removed and replaced with sufficient new mixture to form a true and even surface. All high spots, high joints and honeycomb shall be corrected. Any mixture remaining unbonded after rolling shall be removed and replaced. Any mixture which becomes loose or broken, mixed or coated with dirt or in any way defective, prior to laying the wearing course

shall be removed and replaced with fresh mixture which shall be immediately be compacted to conform with the surrounding area. Areas of defective surface may be repaired by the use of indirect heat. No method of repair involving open-flame heaters shall be used.

12. Shoulder pavements wider than 5-1/2 feet shall be compacted by the use of equipment of the type required for other asphaltic concrete pavements. Compaction of asphaltic concrete 5-1/2 feet or less in width, shall be done by the use of tandem steel rollers not exceeding 12 tons in weight. Other compaction in such restricted widths shall be by the use of rubber-tired equipment.

13. The density of a completed course shall be at least 94% of the laboratory density.

14. Placing of the mixture shall be as continuous as possible and the roller shall not pass over the unprotected end of the freshly laid mixture except when the laying operation is to be discontinued long enough to permit the mixture to become chilled. When the laying operation is thus interrupted, a transverse joint shall be constructed by cutting back on the previous run to expose the full depth of the mat.

15. Where only a portion of the width of pavement is to be laid and opened to traffic, longitudinal joints shall be formed by rolling the exposed edge of the strip first laid. When the adjacent strip is constructed, the Engineer may require the edge of the mixture in place to be trimmed back to expose an unsealed or granular vertical surface. Where the strip first laid is closed to traffic, the edge shall not be sealed but shall be left vertical and the adjacent strip placed against it without trimming.

16. When fresh mixture is laid against the exposed edges of joints (trimmed or formed as provided above), it shall be placed in close contact with the exposed edge so that an even, well-compacted joint will be produced after rolling.

17. The finished surface shall be of uniform texture and compaction and shall be smooth. The surface shall have no pulled, torn, or loosened portions and shall be free of segregation, sand streaks, sand spots, or ripples. Any area of the surface which does not meet the foregoing requirements shall be corrected.

18. All pavements (both intermediate and final courses), intersections, acceleration lanes, deceleration lanes, tapers, crossovers, transitions at beginning and end of project, and similar areas shall be tested with a straightedge for surface tolerance. Any individual surface irregularity in these areas in excess of 3/16-inch as determined by a 15-foot straightedge shall be corrected and retested. Provide a 15-foot manual straightedge at the job site at all times during the paving operation for checking joints and surface irregularities.

19. If the Owner elects to waive corrections, the appropriate pay quantity for Asphaltic Concrete shall be reduced by the equivalent quantity of materials which would have been removed and replaced if the correction had been made.

    a. Where the pay quantity is in square yards, the reduction is based on the area which would have been removed multiplied by the ratio of the layer thickness to the total thickness of the type of mix specified.

    b. Where the pay quantity is in tons, the reduction is based on the volume which would have been removed (length x lane width x layer thickness) multiplied by the laboratory density for the mix.

    c. Where the project is a lump sum pay quantity based on amount completed, the appropriate reduction in percent complete shall be calculated based on the total amount of paving.

20. Select one of the following correction methods unless overlaying is prohibited.

    a. Removing and Replacing: If correction is made by removing and replacing the pavement, the removal must be for the full depth of the course and extend at least 50 feet on either side of the defective area, for the full width of the paving lane.

    b. Overlaying: If correction is made by overlaying, the overlaying shall cover the length of the defective area and taper uniformly to a featheredge thickness at a minimum distance of 50 feet on either side of the defective area. The overlay shall extend full width of the roadway. Care shall be taken to maintain the specified cross and lengthwise slopes.

21. All corrective work, either by removing and replacing or by overlaying, including the bituminous material, shall be provided at no additional cost to the Owner.

22. Sections of newly compacted asphaltic concrete which are to be covered by additional courses shall be kept clean until the successive course is laid.

23. Blade graders operating adjacent to the pavement during shoulder construction shall have a 2-inch by 8-inch (or larger) board (or other attachment providing essentially the same results) attached to their blades in such manner that it extends below the blade edge, in order to protect the pavement surface from damage by the grader blade.

24. Vehicular traffic shall not be permitted on any pavement which has not hardened sufficiently to prevent rutting or other distortion.

25. The specified thickness and density is the minimum to be supplied and any deficiency(s) shall be corrected either by replacing the full thickness for a length extending at least 50 feet from each end of the deficient area, or (when permitted by the Owner) by overlaying with a minimum thickness of 75% of the specified thickness..

B. Saw-Cutting

Where existing pavement is to be removed, except brick, saw-cut the surface leaving a uniform and straight edge with minimum disturbance to the remaining adjacent surface.

C. Settlement of Pavement

All settlement of pavement repairs occurring within a period of one year after final acceptance of the project by the Owner shall be repaired or replaced as required by and at no cost to the Owner.

D. Testing

1. Unless otherwise stipulated on the plans, the following tests will be made by an independent testing laboratory.

   a. Extraction of the asphaltic concrete and sieve analysis of the aggregate.

   b. Determination of bitumen content of the asphaltic concrete.

c. Core borings (approximately every 200 feet) to determine thickness and density.

d. Marshall stability.

E. Repairs

Repair holes made to test the finished asphalt.

END OF SECTION

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SECTION 02610 STABILIZED SUB-BASE

PART 1 - GENERAL

A. Description

This section includes materials, testing, and construction of a firm and unyielding stabilized sub-base.

B. Submittals

Submit copies of a certification from a testing laboratory that the material used for the base meets the specified criteria.

PART 2 - PRODUCTS

A. Materials

Use local or hauled-in clean sand or sand and clay.

B. Stabilizers

Use high-bearing-value soil, sand-clay, or rock screenings. Do not use muck, trash, hardpan, material having a plasticity index of more than 10 or a liquid limit greater than 40.

PART 3 - EXECUTION

A. Construction Methods

Test local material for compliance with the required Florida Bearing Value. If the natural in-place soils do not meet the required stability, uniformly mix to depth shown in plans sufficient borrow material for stabilization with the in-place soils to produce the required bearing value. Compact the stabilized sub-base in both cuts and fills to a density of 98 percent of the maximum density as required by AASHTO T-180 (modified). Shape the sub-base to within 1/4 inch of the cross section grade shown in the plans prior to making the density tests. MAKE THE DENSITY TESTS BEFORE OTHER WORK PROCEEDS. Maintain the required density and cross section until the base or pavement has been laid or until the aggregate materials for the base or pavement course have been spread in place.

B. Required Bearing Value

Unless otherwise specified or shown in the plans, stabilized sub-base shall have a minimum Florida Bearing Value of 50.

C. Tests

Density and bearing value tests shall be made by an independent testing laboratory at intervals not more than 300 feet in roadways or 2,400 sq. ft. in area paving. If any test results are unsatisfactory, re-excavate and re-compact the sub-base until the desired compaction is obtained. Make additional tests on each side of an unsatisfactory test to determine the extent of re-excavation, re-mixing and re-compaction necessary.

END OF SECTION

SECTION 02615 REINFORCED CONCRETE CULVERT PIPE

PART 1 - GENERAL

A. Description

This section includes materials, fabrication, testing, and installation of circular reinforced concrete culvert pipe complying with ASTM C76 or C655.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following:

2. Prior to delivery of pipe from each manufacturing lot or run, submit:

a. Test results for external load crushing strength test per Section 11 of ASTM C76 or 10 of ASTM C655.

b. Certification of compliance with cited ASTM specifications of cement, aggregate, and reinforcement.

c. Manufacturer's description of admixtures used.

d. Manufacturer's report of visual inspection.

PART 2 - MATERIALS

A. Circular Reinforced Concrete Culvert Pipe

1. Comply with ASTM C76 or C655. Method of manufacture shall be either cast or spun. Obtain class or D-load rating from drawings. If no class or D-load is shown, use D-2000 pipe.

2. Cement shall comply with ASTM C150, Type II.

3. Acceptance shall be on the basis of plant load-bearing tests, material tests, and inspection of manufactured pipe for visible defects and imperfections as defined in ASTM C76 or C655. Conduct three-edge bearing test for load to produce a 0.01-inch crack. Conduct tests on 2% of the number of each size of pipe furnished for the

project. For extended delivery schedules, conduct tests on two pipe sections for each size preliminary to delivery of pipe. Conduct remainder of tests during extended delivery schedule.

B. Joints

1. Use push-on rubber-gasketed watertight type.

2. Bells, spigots, and rubber gaskets shall conform to ASTM C361 or C443 and shall be compatible with ASTM C76 or C655 pipe barrel. Use flared or flush bell design.

3. Connect storm drain structures and the storm drain piping, per ASTM C1478, Standard Specifications for Storm Drain Resilient Connectors Between Reinforcement Concrete Drain Storm Sewer Structures, Pipes and Laterals.

C. Base, Bedding, and Backfill Material

Use the following materials as specified in Section 02223:

Zone	**Material**
Base, Pipe Zone, Trench Type	1-inch gravel
Street Zone	Native earth backfill

PART 3 - EXECUTION

A. Product Marking

Letter on the interior of each section of pipe the following:

1. Class designation or corresponding D-load to produce a 0.01-inch crack.

2. Date of manufacture.

3. Name of manufacturer and plant.

4. For quadrant reinforcement, the vertical axis in which the pipe is to be laid.

B. Rejection

Reject and replace pipe exhibiting any of the following:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2. Defects that indicate imperfect proportioning, mixing, and molding.

3. Surface defects indicating honeycombed or open texture.

4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.

5. Any continuous crack having surface width of 0.01 inch or more and extending for a length of 12 inches or more, regardless of position in the wall of the pipe.

6. Exposure of any reinforcement indicating incorrect placement.

7. Any tested pipe that fails to meet the specified D-load.

C. Installing Buried Pipe

1. Install in accordance with Section 02223 and as follows.

2. When installing pipe in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure elevation at the pipe invert.

3. Lay pipe upgrade from structure to structure, with the bell ends of the pipe upgrade.

4. After joint assembly, bring the pipe zone and bedding material up to 1 foot above the top of pipe. Place the material in even lifts on each side of the pipe.

D. Leakage and Infiltration Testing of Rubber Gasket Joints

See Section 02530.

END OF SECTION

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SECTION 02665 FLEXIBLE PVC GEOMEMBRANE LINER

PART 1 - GENERAL

A. Description

1. Furnish all labor, materials, tools and equipment and perform all operations necessary for the detailed design and installation and testing of the PVC geomembrane, as described herein, in associated specifications, and shown on the drawings.

2. Provide quality assurance as described in this specification for the manufacture, fabrication, and installation of PVC geomembrane as specified.

3. A 40 mil PVC geomembrane liner system shall be utilized as shown on the drawings.

B. Quality Assurance

1. Manufacturing: The Manufacturer of the PVC geomembrane shall have successfully manufactured a minimum of 10,000,000 square feet of PVC material and shall be listed by the National Sanitation Foundation (NSF) Standard 54 as meeting all the requirements for flexible geomembranes.

2. Fabrication: The Fabrication Contractor (Fabricator) shall have assembled a minimum of 2,000,000 square feet for containment purposes. Fabricator shall submit a letter from the PVC Geomembrane Manufacturer stating that they are an approved Fabricator of their material.

3. Installation: The Installation Contractor (Installer) shall be the manufacturer, or an agent licensed by the manufacturer and specially trained to install the manufacturer's material. The Geomembrane Installer shall designate a Certified Welding Technician. The Certified Welding Technician shall be present during all seaming operations and shall have a minimum of 1,000,000 square feet of field seaming experience and hold an International Association of Geosynthetic Installers (IAGI) for flexible membranes Approved Installation Contractor (AIC) and Certified Welding Technician (CWT) certification in fusion welding of PVC membranes.

4. Liner System Engineer: Submit the qualifications and reference material of the Liner System Engineer who the Contractor, or Subcontractor, is required to retain for providing a detailed shop drawing submittal for the liner system and respective liner appurtenances. The Engineer shall also provide field services to oversee the installation of the liner system as specified herein. The Engineer shall have the following minimum experience in design and construction of lining systems;

    (1) Have a minimum of ten (10) years professional design and construction experience in the design and construction of liners for landfills, reservoirs or similar projects.

    (2) Have successfully completed at least three (3) projects with similar liner systems in the United States of America within the last ten (10) years, from the date that Bids are opened.

    (3) Is a Registered Professional Engineer in the State of Florida.

C. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following four weeks prior to geomembrane installation:

    a. Installer to furnish a Panel Layout Plan identifying all seams and details.

    b. Certification from the manufacturers resin supplier that all resin used in the manufacturing of the material for this job meets the specification.

    c. Copies of quality control certificates issued by the resin supplier.

    d. Certified quality control certificates to show conformance with Parts 2.A and 2.B of this specification.

    e. Written instructions from the manufacturer for the storage, handling, installation, seaming, and repair of the geomembrane material.

f. Certification from the Contractor's on site representative that the surface on which the geomembrane is to be installed is acceptable for liner installation.

g. Documentation of Fabricator and Installer experience:

(1) Submit a list of ten completed facilities. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the geomembrane installation; type and thickness of geomembrane, type of field seaming and surface area of installed geomembrane.

(2) Submit resumes or qualifications of Fabrication manager.

(3) Fabrication quality control program.

(4) Installation quality control program.

(5) Example of Material Warranty and Fabricated Seam Warranty.

(6) Copy of Manufacturer’s and Fabricator’s quality control program.

2. Submit the qualifications and reference material of the Liner System Engineer who the Contractor, or Subcontractor, is required to retain for providing a detailed shop drawing submittal for the liner system and respective liner appurtenances.

3. The Contractor’s, or Subcontractor’s, Liner System Engineer is required to prepare a detailed shop drawing submittal for the liner system and respective appurtenances which shall include the following at a minimum. The submittal shall be signed and sealed by the Liner System Engineer;

(1) Calculations for the sizing and spacing of the high water table check valves and slope ventilation details.

(2) Detailed shop drawings showing the specific location and interval for the high water table check valves and slope ventilation details in plan view.

(3) Calculations for and the type of geocomposite drainage material to be placed under the PVC geomembrane for the adequate propagation of gases and water to the high water check valves and slope ventilation details.

(4) Detailed shop drawings showing the specific location and limits of the geocomposite drainage material in plan view.

(5) Minimum slope requirements of the liner system for the adequate propagation of gases and water to the high water check valves and slope ventilation details.

(6) Embankment detailing of the PVC geomembrane, non-woven geogrid fabric and geocomposite draiange material.

(7) Detailing of the termination of the lining system at existing and new structures.

(8) Detailing of the lining system at the high water check valves, RIB overflow structures, influent piping/rip-rap and slope ventilation details.

(9) Detailing of the liner system at pipeline penetrations and rip-rap armoring.

4. Submittals Upon Completion of Installation:

a. Written documentation from Contractor's Installation Supervisor for each day's work. As a minimum, the documentation should contain the following:

(1) Subgrade acceptable for liner placement (i.e., no rocks, roots, or other protrusions that could damage the cap).

(2) Temperature weather conditions and statement that conditions were suitable, during field seaming.

(3) Field seams:

(a) Seams clean and dry.

(b) Minimum overlap for seaming method utilized met.

(c) Wrinkles in same repaired.

(d) Field seams inspected and tested in accordance with this specification.

(e) Geomembrane:

1. Free of punctures, tears, scuffing.

2. Location of repairs shown on the Panel Layout Plan.

3. Location of pipe penetrations and boots installed properly.

i. Results of all daily field tests as required in this specification.

a) Written certification as to occurrence of Final Walk Over and any remedial action taken as a result of faults discovered.

b) At completion of backfilling, the Contractor shall issue written certification that backfilling operations have proceeded as directed and are acceptable.

D. Delivery, Storage And Handling

1. Comply with the Manufacturer’s recommendations.

2. Deliver PVC liner to site in largest sizes possible to minimize field seaming.

3. Protect from sunlight and other ultraviolet light sources during storage.

4. Keep cements and adhesives from extreme cold or heat.

5. Keep materials clean and dry.

E. Warranties

Prior to completion of installation, the Contractor shall issue a written prorated warranty from the PVC supplier to the Owner for the quality of the material for a period of 20 years.

PART 2 - PRODUCTS

A. Materials

1. The material shall consist of a single ply PVC geomembrane of a minimum 72 inches seamless width. The material shall be manufactured of new, first quality resin compounded and manufactured specifically for the intended purpose.

2. The PVC geomembrane shall have the following minimum or maximum physical properties (as indicated) as determined by the appropriate test method:

ASTM Test Property	**Performance Method**	**Minimum Requirements**
Average Thickness	D5199	40 mil
Specific Gravity	D792	1.20
Tensile Strength @ break	D882	97 lb/in.
-Elongation @ break (%)	D882	430
Modulus	D882	40 lb/in.
Tear resistance, min	D1004	10.5 lbs
Resistance to soil burial (%, max)	G160	
-Breaking Factor	G160	5
-Elongation at break	G160	20
-Modulus at 100% elongation	G160	20
Low temperature brittleness	D1790	-29 degrees C
Dimensional Stability	D1204	3 at 100 degrees C/

ASTM Test Property	Performance Method	Minimum Requirements
(%, max)		15 minutes
Water extraction (%, max)	D1239	0.20
Volatile Loss (%, max)	D1203	0.50
Hydrostatic resistance (min)	D751 Method A	120 psi
Plasticizer Min Molecular Weight	D2124	400

3. The finished sheet will have an average thickness as defined in Part 2.A.2 with no greater variation than 5 percent anywhere across the sheet in any direction. The surfaces shall not have striations, pinholes or bubbles.

4. The PVC shall be supplied as rolls with labels on each roll which shall identify the thickness of material, the length and width of the roll, batch and roll numbers, and name of manufacturer.

B. Related Materials

All seams shall demonstrate a Film Tearing Bond (FTB) in peel and shear. The factory and field fabricated seams shall meet the following specifications:

Seam Property	ASTM Test Method	Performance Requirements
Shear Strength (@ yield)	D6392, D6214, D4437	77 lb/in.
Peel Strength (@ yield)	D6392, D6214, D4437	15 lb/in.

C. Coefficient Of Soil And Geosynthetic Friction

1. Records and presentation of data shall be as described in the ASTM Standard.

2. The direct shear test shall be performed by an approved laboratory in concurrence with ASTM D5321. The soil shall be prepared in occurrence with ASTM D5321. The soil shall be prepared according to the test method for moisture density relationship of soil ASTM D698 within a range in moisture of 2 to 3 percent wet of optimum. The

prepared soil samples shall be saturated in water for a minimum of 24 hours prior to testing. The geomembrane shall be installed on top of the saturated soil sample.

3. The direct shear test shall be performed for two conditions:

   a. Unconsolidated Undrained Conditions: Apply the shear force to the traveling container at a constant rate of ranging from 1 to 5 mm/minute. Record the shear force for at least 50 mm of total horizontal displacement.

   b. Consolidated Drained Conditions: Apply the shear force using a constant rate not greater than 0.04 mm/minute. Record the shear force for at least 50 mm.

   c. For each of the above conditions a set of three tests shall be performed at confining pressures of 1, 3 and 5 psi.

D. Factory Fabrication

1. 100% of all completed factory seams shall be non-destructively tested using the Air Lance Test Method ASTM D4437. Factory seams will be visually inspected for full seam continuity over their full length. Any areas that do not meet the specified requirements shall be removed and repaired per section.

2. Conformance tests for each panel made will be performed to verify that the seam strength requirements of the specifications are met. The following conformance tests will be performed on each panel in accordance with ASTM D7176 and the requirements of this specification:

   a. Thickness

   b. Bonded seam strength (shear strength)

   c. Peel adhesion

3. The sample shall be cut into ten one-inch wide specimens. Five peel and five bonded seam specimens are removed. Five specimens shall be tested for bonded seam strength and five for peel adhesion. To be acceptable, the average of five test specimens for peel and the

average of five test specimens for bonded seam strength must meet the minimum peak load requirements of factory seams as follows:

a. Bonded Seam Strength: One-inch strips cut with the weld centrally located are tested by stressing the weld in a "shear" configuration. That is, the top sheet is stressed in relation to the bottom sheet in a direction away from the weld. A pass result occurs when the specimen averages meet the minimum peak load requirements stated in the contract (usually 80% of specified sheet strength). A failure occurs when the weld separates or the material breaks at a peak load less than the minimum requirements. The test result to be reported will be the average of the peak loads recorded for each of the five specimens.

b. Peel Adhesion: One-inch strips cut with the weld centrally located are tested by stressing the top sheet in relation to the overlapped edge of the lower sheet in an effort to peel the weld away. Each specimen will be peeled one inch along the seam length. A pass result occurs when the specimen meets the minimum peak load requirements stated in the contract. A failure occurs when the weld peels at a peak load less than the specification without film tearing bond. The test result to be reported is the average of the peak loads recorded for each of the five specimens.

4. Each test will be identified by panel serial number and the manufacturer's roll number. These tests shall be performed in the fabricators laboratory.

5. Prior to installation of the geomembrane at the site, the Fabricator will provide to the Engineer, copies of manufacturer material certifications and a copy of conformance test results for all panels to be supplied, verifying conformance with this specification and the requirements as represented in ASTM D7176 specification. The location of any defects and repairs and all necessary retesting results will also be documented in the report.

6. When a seam sample is removed from the panel being fabricated the resulting hole will be repaired with a

patch with a minimum of a one inch bonded area around the patch, and the patch will be rounded on all corners.

7. Factory fabricated geomembrane panels are packaged accordion folded, rolled on a fiber core, and shrink wrapped.

8. All panels will be packaged with a protective, black stretch wrap or cardboard cover to protect the panel from weather or shipping damage.

E. Geomembrane Penetration Boots

1. The Fabricator shall furnish all geomembrane penetration boots and other materials required for completion of the geomembrane installation. All geomembrane boots required for the project shall be factory prefabricated boots. The geomembrane shall be of the same thickness as the geomembrane panels.

2. Geomembrane penetrations are to be constructed only at the locations shown on the drawings. No deviation in the quantity or configuration of geomembrane penetrations will be accepted without the advance written approval of the Engineer.

3. All penetrations through the geomembrane shall be thoroughly and securely sealed. The seal between the geomembrane and the pipe shall be without any detectable leakage.

4. In attaching the geomembrane penetration boot in the field, no field seams will be allowed in locations or configurations that do not allow for Construction Quality Control testing. Visual observation is not considered a sole acceptable method for in-field quality control.

5. Where clamps, fasteners, gasket seals or sealants are used, the Fabricator shall use only materials that are compatible with the geomembrane.

6. All sealed areas shall be Air Lance tested using ASTM D4437 and verified to be leak free.

PART 3 - EXECUTION

A. Transportation

Transportation is the responsibility of the Contractor.

B. Delivery And On-Site Storage

1. Off-loading and storage is the responsibility of the Contractor.

2. The Contractor shall be responsible for replacing any material damaged during off-loading at no additional cost to the Owner.

3. The material shall be kept free of all debris and solvent compounds that may adversely affect the performance of the cap.

4. The rolls shall be stored on a prepared, firm surface (not wooden pallets) and shall not be stacked more than two rolls high.

5. Vehicle traffic shall be prohibited from traveling on the newly installed geomembrane system.

C. Site Preparation

1. All required grading, grooming and construction quality assurance (CQA) testing on any low permeability soil to be covered by the geomembrane shall be complete and accepted by the Owner’s Representative and Contractor’s, or Subcontractor’s, Liner System Engineer prior to geomembrane placement.

2. The surface to be covered by the geomembrane shall be cleared of sharp objects, angular stones, sticks, or any materials that may contribute to punctures, shearing, rupturing or tearing of the geosynthetic materials. The geomembrane subgrade shall have a smooth, finished surface, free from pockets, holes, ruts, and discontinuities that, in the judgment of the Engineer, will cause bridging of the material. The subgrade shall be inspected for unsuitable areas or soft spots before the geomembrane is placed, and additional surface preparation will be required to eliminate any unsuitable areas as determined by the Engineer.

3. The Installer shall inspect the subgrade surface immediately prior to the deployment of each geomembrane panel. No geomembrane shall be placed on unsuitable subgrade surface. The Installer's Quality Control (QC) inspector shall furnish their signature on a Subgrade Acceptance Log prior to the installation of each panel or series of panels placed on a daily basis.

4. Under no condition shall the geomembrane be placed over standing water on the subgrade.

D. Installation

1. Installation of the PVC geomembrane shall be performed in the presence of the installation supervisor.

2. Geomembrane sheets shall be laid out and installed by qualified technicians in accordance with the approved Panel Layout Plan. Sheets shall be placed in order to result in sheet termination at the storage pond base and the layout shall be designed to minimize the number and length of field joints. Seams shall be orientated parallel to the line of maximum slope i.e. down the slope, not across. No seams shall be closer than 5-feet from the toe of the slope. Seams shall be overlapped in the downstream direction, like roof shingles. Seams shall be aligned to prevent the least possible number of wrinkles and "fishmouths". If a fishmouth or wrinkle is found, it shall be relieved, capped, and vacuum tested. Geomembrane layout and placement shall be consistent with proper methods for geomembrane installation.

3. Field joints shall be made by overlapping adjacent sheets.

E. Seaming Methods

1. A six-inch wide overlap must be cleaned of all dust, dirt or foreign debris no more than 30 minutes prior to welding. Only clean, soft rags will be used for cleaning. If mud has adhered to the sheet surface overlap area, it will be removed with clean water and allowed to dry prior to seaming.

2. During the cleaning operation, the sheet will be inspected for defective areas which must be removed and/or repaired prior to seaming. The seaming operation requires a solid, smooth subsurface. Subsurface voids,

hard nodules, rocks, soft areas or unsuitable conditions will be removed or repaired prior to seaming during subgrade preparation.

3. Seaming cannot be conducted in the presence of standing water. Wet surfaces must be allowed to dry. A slip sheet or seaming board may be used to lift the geomembrane above damp surfaces. If wind conditions contaminate the seaming area or displace the geomembrane sheets, temporary ballast and additional cleaning procedures will be required.

4. The geomembrane panels shall be joined utilizing approved seaming methods. Dual-track fusion welding shall be the required method on all seams where it is feasible. Chemical welds shall be made only where approved by the Engineer.

5. All geomembrane surfaces that are to become a seam interface are to be free of dust, dirt, excess moisture or any other condition that may affect the quality of the seam.

6. Seaming will not be allowed during rain, unless proper precautions are made to allow the seam to be made on dry subgrade and geomembrane materials. If weather conditions are not satisfactory, panels will not be put into place. If panels are placed and pulled out, the installation crew will do what is necessary to finish or secure those individual panels that day.

7. The field seams shall be produced using one of the following methods:

   a. Dual-Track Thermal Fusion Weld – All field seams shall be fused using Dual-Track Thermal Fusion Welding. Each Master Seamer shall complete a trial weld of 5-feet long and each sample shall be tested in accordance with the ASTM D7176. A seam produced by melting the two intimate surfaces by running a hot metal wedge or hot air device between the surfaces, followed immediately by pressure to form a homogeneous bond. This seam has a center air channel for non-destructive testing of the seam. Panels to be seamed shall be overlapped sufficiently to allow proper conformance testing of seams. The Installer shall mark the liner where the Dual-Track Fusion Welding machine settings are adjusted (including

speed, temperature and pressure). Measurable setting values shall be indicated on the liner.

b. Chemical Fusion Weld – Chemical Fusion Welding shall only be used for repairs and detail work. All field seams will be a minimum of 2 inches wide. A sufficient amount of chemical fusion agent will be applied that, upon compressing the seam surfaces together, a thin excess of chemical fusion agent will be forced out. A high durometer rubber, nylon or steel roller will be used to compress the seam surfaces together until a bond is formed. Roller action will be at a parallel direction to the seam's edge so that excessive amounts of chemical fusion agent will be purged from between the sheets. Trapped chemicals should be rolled out of the seaming area. Care will be exerted in applying the chemical fusion agent. A continuous wet layer of chemical fusion agent is necessary to prevent a leak at the tie-in point between the last chemical fusion agent application and the next. If the chemical fusion agent, which is initially shiny when applied, takes on a dull filmy appearance, the interfaces may require a faster closing together or the ambient temperature is too high to continue seaming. The installer will monitor this condition at sheet temperatures over 105°F. At the completion of seaming, all rags, chemical containers, etc., will be properly removed from the geomembrane.

8. Conformance seam samples shall be pulled at intervals as directed by the Owner’s Representative and Contractor’s, or Subcontractor’s, Liner System Engineer or at a minimum of one per 500 lineal feet of thermally welded seam when Air Lance Testing using ASTM D4437 is performed.

9. If conformance sampling is specified, both sides of the weld shall be tested for shear and peel strength sample in accordance with ASTM D6392.

10. Samples shall be tested and evaluated in accordance with the ASTM D7176.

11. Prequalification Test Seams

a. Test seams shall be prepared and tested by the Installer to verify that the seaming parameters are adequate.

b. Test seams shall be made in accordance with ASTM D4437 by each welding technician at the beginning of each seaming period. Test seaming shall be conducted under the same conditions and with the same equipment and operator as production seaming. The test seams shall be approximately 5 feet long for all types of field welds.

c. Samples shall be tested and evaluated in accordance with the ASTM D7176. It should be noted that conditioning of samples and appropriate temperature and humidity requirements must be met to allow for proper testing of the PVC geomembrane.

d. If there is no area on site to provide for these requirements, seam strength can be verified for production using trial welds sent to an independent testing laboratory to verify quality.

e. For peel and shear testing see Conformance Field Seam Testing section of this specification. Field peel and shear strength values should meet the requirements of Part 2.

f. If a test seam fails, an additional test seam shall be immediately completed. If the additional test seam fails, the seaming apparatus shall be rejected and not used until the deficiencies are corrected and a successful full test seam can be produced.

g. Each test seam shall be labeled with date, geomembrane temperature, number of seaming unit, panel identification, seam number or test location, technician performing the test seam and a pass or fail description.

12. Non-Destructive Field Seam Testing:

a. All field seams shall be non-destructively tested by the Installer over the full length of the seams before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of Quality Control person, and

outcome of all non-destructive shall be recorded and submitted to the Owner’s Representative.

b. Testing should be performed as the seaming progresses, not at the completion of all field seaming, unless agreed to in advance by the CM. All defects found should be repaired, re-tested and remarked to indicate acceptable completion of repair.

c. Non-destructive testing shall be performed using either the air lance test method (ASTM D4437) or vacuum box test method (ASTM D4437).

d. Air Lance Testing:

(1) Chemical and solid thermal, i.e., single track, welds can be tested utilizing the Air Lance Test Method ASTM D4437. The Installer shall provide an air compressor, air hose, and air lance wand with a pressure gauge capable of measuring the air flow at the tip. The testing shall be performed by experienced technicians familiar with this testing procedure.

(2) This non-destructive test involves placing the air lance wand 1/4-inch to 1/2-inch, but not more than 2 inch, from the edge of the completed seam and closely monitoring the backside of the sheet for any air penetration through the seam, loose edges, riffles, and/or noise. If air penetrates the seam area, the technician will either see this visibly or hear it audibly.

(3) All seams tested by the air lance method shall be marked with the date tested, name of the technician, length of the seam, and test results. As with all Quality Control work this should be documented on all Quality Control paperwork and preferably witnessed by the Owner’s Representative and Contractor’s, or Subcontractor’s, Liner System Engineer.

e. Vacuum Box Testing: Vacuum Box testing is usually not used on PVC geomembranes because the geomembrane can be pulled up into the vacuum box unless a screen

covers the box opening. The vacuum box test procedure is described in ASTM D4437.

13. Conformance Field Seam Testing:

    a. When Air Lance Testing is performed using ASTM D4437, a minimum of one sample per 500 lineal feet of field seam or at another pre-determined length should be obtained and tested in accordance with ASTM D6392 by the Installer from a location specified by the Owner's Representative and Contractor's, or Subcontractor's, Liner System Engineer. To obtain test results prior to completion of geomembrane installation, samples shall be cut by the Installer as directed by the Owner's Representative and Contractor's, or Subcontractor's, Liner System Engineer as seaming progresses. The Installer shall not be informed in advance of the sample location.

    b. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Installer shall repair all holes in the geomembrane resulting from obtaining the samples. All patches shall be repaired and tested using an air lance test. All tested seam areas shall be patched and tested the same day as the sample.

    c. The sample size shall be 12 inches wide by 36 inches long with the seam centered lengthwise. The sample shall be cut length-wise. The sample shall be cut into three equal sections and distributed as follows; one section given to the Owner's Representative as an archive sample, one section given to the Contractor's, or Subcontractor's, Liner System Engineer for laboratory testing, and one section given to the Installer for field testing.

    d. For field testing of samples, the geomembrane installer shall cut 10 identical 1 inch wide replicate specimens from his sample. The Installer shall test five replicate specimens for seam shear strength and five for peel strength. Peel strength tests will be performed on both the inside and outside of dual track welds. To be acceptable an average of five specimens must pass ASTM D7176 field seam testing requirements.

e. Independent seam testing shall be conducted in accordance with ASTM D6214 for chemical seams and ASTM D6392 for thermal seams by an accredited independent testing laboratory.

f. Reports of the results of examinations and testing shall be prepared and submitted to the Owner's Representative and Contractor's, or Subcontractor's, Liner System Engineer.

g. For field seams, if laboratory tests fail, that shall be considered an indicator of possible inadequacy of the entire seam length corresponding to the test sample. Additional samples of the subject seam shall be taken by the Installer at locations indicated by the Owner's Representative and Contractor's, or Subcontractor's, Liner System Engineer, typically 10-feet on either side of the failed sample and laboratory seam tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of inadequate seams. All sample locations shall be repaired with a cap strip either thermally or chemically welded into place. All cap stripped seams shall be non-destructively tested with an air lance test.

14. Identification of Defects:

    a. Panels and seams shall be inspected by the Installer after panel deployment to identify all defects, including holes, blisters, and undispersed raw materials

    b. Seams shall be inspected by the Installer before, during, and after field seaming to identify all dirty and wrinkled areas and any defects.

15. Evaluation of Defects: Each suspect location (both in geomembrane seam and non-seam areas) shall be non-destructively tested using the air lance test method in ASTM D4437. Each location which fails non-destructive testing shall be marked, numbered, measured, and posted on the daily installation drawings and subsequently repaired.

    a. If a sample fails the field or laboratory tests, the Installer shall repair the seam between the two

nearest passed locations on both sides of the failed sample location.

b. Defective seams, tears, or holes shall be repaired by re-seaming or applying a cap strip.

c. Re-seaming may consist of either:

(1) Removing the defective area and re-welding the parent material using the original welding equipment, or

(2) Re-seaming by cap stripping.

d. Each patch shall extend a minimum of 6 inches in all directions beyond the defect.

e. All repairs shall be measured, located, and recorded.

16. Verification of repairs on seams: Each repair shall be non-destructively tested using the air lance test in ASTM D4437. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be re-seamed and retested until a passing test result is obtained. The number date, location, technician, and test outcome of each patch shall be recorded.

17. Daily field installation reports: At the beginning of each day's work, the Installer shall provide the Owner's Representative with daily reports for all work accomplished the previous work day. Reports shall include the following:

a. Total amount and location of geomembrane placed;

b. Total length and location of seams completed, technician name, and welding unit numbers;

c. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers, and locations of non-destructive and conformance testing;

d. Results of the pre-qualification test seams;

e. Results of non-destructive testing.

f. Results of conformance testing.

(1) Conformance test results shall be reported prior to covering the lining or within 48 hours.

F. U-Trench Anchor Construction and Backfilling

1. Construct and line anchor trench as specified on contract drawings.

2. The anchor trench should be backfilled and compacted by the Contractor. Trench backfill material should be placed in loose lifts and compacted.

3. Care should be taken when backfilling the anchor trench to prevent any damage to the geomembrane or other geosynthetics. At no time will construction equipment come into direct contact with the geomembrane. If damage occurs, it will be repaired, at the backfilling contractor's expense, prior to the completion and backfilling of the anchor trench.

G. Final Walk Over And Acceptance

1. Before placement of any backfill, piping, or geotextiles, the completed geomembrane shall receive a final joint walk over by the Contractor to visually search for any undetected holes, defects, or other faults which may adversely affect the performance of the geomembrane.

2. Contractor to certify in writing upon completion of Final Walk Over as to occurrence and satisfaction of event and any remedial action taken as a result of faults discovered.

H. Covering the Geomembrane

1. The PVC geomembrane must be covered with a minimum of twenty four (24) inches of clean soil, free of sticks, stones larger than 1/2-inch diameter, rubbish, or any other material which may damage the liner. The cover material should be placed over the liner as soon as practical after the liner is installed.

2. Care should be taken when covering the liner to prevent any damage to the geomembrane or other geosynthetics. At no time will construction equipment come into direct contact with the geomembrane. If damage occurs, it will

be repaired, at the contractor's expense, prior to the completion of geomembrane covering.

3. Cover soil shall be only placed over the geomembrane from the base of the slope to the top of the slope. Cover soil should never be pushed down the slope.

4. Cover soil should be “rolled” onto the installed geomembrane and not pushed along the geomembrane which can result in damage and wrinkling of the geomembrane.

5. Contractor's Geomembrane Installation Supervisor shall remain onsite after the final work to advice on procedures and monitor throughout the period of placement of cover soil.

6. Contractor shall not use construction equipment which will result in slope failure. The maximum construction loads that may be imposed shall be determined by the Contractor's independent testing laboratory.

I. Hydrostatic Testing of Geomembrane Liner

1. Prior to final acceptance of geomembrane liner, the lined pond shall be hydrostatically tested by filling the pond to within 2-ft of the top of berm elevation.

2. After the pond is filled, the level of the pond shall be recorded and monitored for a period of seven (7) days. The decrease in level of the pond shall be compared to that of a minimum 5-ft diameter reference pool.

3. The rapid infiltration basins (RIBs) surrounding the reject pond shall be photographed daily and monitored for visible leaks.

J. Contract Closeout

Provide in accordance with Section 01700.

K. Certification

Provide a written certification from the manufacturer and liner system Engineer that the equipment has been properly installed according to the plans, specifications and manufacturer’s specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County.

END OF SECTION

SECTION 02778 CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 - GENERAL

A. Description

This section includes materials and installation of concrete curbs, gutters, and sidewalks.

B. Submittals

Submit six copies of a report from a testing laboratory verifying that crushed rock and aggregate material contains less than 1% asbestos by weight or volume and conforms to the specified gradations or characteristics.

C. Testing for Compaction

The Owner will test for compaction as described in Section 02200.

D. Standard Specifications

Wherever reference is made in this section to the State Specifications, such reference shall be understood to mean the Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

PART 2 - MATERIALS

A. Forms

1. Forms shall conform to the requirements of Section 03100. Provide stakes and bracing materials to hold forms securely in place.

2. Materials for sidewalk forms shall be 2-inch dressed lumber straight and free from defects, or standard metal forms. Where short-radius forms are required, 1-inch dressed lumber or plywood may be used. Provide stakes and bracing materials to hold forms securely in place.

B. Crushed Rock Base

Clean 3/4-inch and smaller crushed rock or crushed gravel, free from foreign material and containing less than 1% asbestos by weight or volume, and conforming to Class 12 per Section 901 of the Florida State Specifications.

C. Expansion Joint Filler

Expansion joint filler shall be 1/2 inch thick for curbs and 1/4 inch thick for sidewalks and shall conform to premolded joint filler in Section 03250.

D. Concrete

Concrete shall be Class I per Section 345 in the Florida State Specifications.

E. Reinforcing Steel

Conform to Section 415 and 931 in the Florida State Specifications.

F. Curing Compound

Curing compound shall be as specified in Section 03345.

G. Excavation and Backfill

Conform to Section 02200.

PART 3 - EXECUTION

A. Preparation of Subgrade

Excavate and shape subgrade to line, grade, and cross-section. Compact subgrade until the top 12 inches are compacted to 90% relative compaction. Remove all soft material disclosed by compacting and replace with crushed rock base. The finished subgrade shall be within a tolerance of ±0.08 of a foot of the grade and cross-section shown and shall be smooth and free from irregularities at the specified relative compaction. The subgrade shall be considered to extend over the full width of the base course.

B. Placing Crushed Rock Base

After the subgrade for curbs, sidewalks, and roadway slabs is compacted and at the proper grade, spread crushed rock base material. Sprinkle with water and compact. Top of the compacted gravel shall be at the proper level to receive the concrete. Compact crushed rock base 4 inches or more of compacted crushed rock base material.

C. Setting Forms

1. Conform to Section 03100.

2. Forms on the face of the curb shall not have any horizontal joints within 7 inches of the top of the curb. Brace forms to prevent change of shape of movement in any direction resulting from the weight of the concrete during placement. Construct short-radius curved forms to exact radius. Tops of forms shall not depart from gradeline more than 1/8 inch when checked with a 10-foot straightedge. Alignment of straight sections shall not vary more than 1/8 inch in 10 feet.

D. Sidewalk Construction

Sidewalk construction shall be in accordance with Section 522 of the FDOT Standard Specifications for Raod and Bridge Construction.

END OF SECTION

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SECTION 02810 SODDING

PART 1 - GENERAL

A. Description

Provide all materials, water, equipment, transportation, tools, and labor, to establish grass plus all items called for or that can be reasonably inferred from the drawings, including sodding, grading, fertilizing, watering, mowing, replacing and maintaining the area for a complete job. Sod all areas disturbed. Seed and mulch not allowed.

B. Applicable Publications

Portions of the publications listed below form a part of this specification only to the extent referenced.

1. Florida Department of Transportation, "Standard Specifications for Road and Bridge Construction" (Fla. DOT SPEC).

2. Turfgrass Producers Association of Florida, "Standards of Sod Quality."

C. Records

Submit written weekly records to the County of all grassed areas for use in determining the beginning and ending of the maintenance period for each area. The records shall indicate the date of grassing, fertilizing and mowing, the type (sod), quantity (sq. ft., sq. yds, or acres) and location of grassing.

D. Submittals

1. Submit Shop Drawings in accordance with the General Conditions, Section 01300 and the following. Submit certificates stating that the materials conform to the requirements of this specification as follows:

   a. Certificate from sod producer stating that sod meets the requirements for "Florida Standard Grade" as defined by the Turfgrass Producers Association of Florida, and set forth in paragraph "SOD" of this specification.

   b. Fertilizer manufacturer's certificate of analysis including Nitrogen, Phosphorus Potash and complete

micro-nutrients in accordance with paragraph "Fertilizer" of this specification.

2. Submit a copy of the certificate(s) with each delivery.

PART 2 - PRODUCTS

A. Sod

1. Argentine Bahia with well matted roots. The sod shall be taken up in commercial-size rectangles, preferably 12-inch by 24-inch or larger, except where 6-inch strip sodding is called for.

2. The sod shall have no visible broadleaf weeds when viewed from a standing position and the turf shall be visibly consistent with no obvious patches of foreign grasses. In no case may the total amount of foreign grasses or weeds exceed 2% of the total canopy. Florida Standard Grade sod shall be neatly mowed and mature enough that when grasped at one end it can be picked up and handled without damage. The sod shall be sufficiently thick to secure a dense stand of live grass. The sod shall be live, fresh and uninjured, at the time of planting. It shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling.

B. Fertilizer

Commercial grade, controlled release, granular fertilizer consisting of blend of coated prilled urea with iron included in a slowly soluble form, free flowing and uniform in composition conforming to Florida DOT Specification 982-1, and bearing the manufacturer's guaranteed statement of analysis by weight of 12 parts nitrogen, 8 parts phosphoric acid and 8 parts potash, plus complete micronutrient including magnesium, sulfur, zinc, manganese, copper and boron.

C. Source Requirements for Sod and Mulch

Comply with all current restrictions for transporting sod and mulch material from or through quarantine areas for the white fringed beetle, witchweed, and West Indian sugar cane borer weevil, as issued by the Division of Plant Industry, Florida Department of Agriculture and the Animal and Plant Health Inspection Service, U.S. Department of Agriculture.

D. Water for Grassing

Water shall be free of acid, alkali, or organic materials and shall have a pH of 7.0 to 8.5. Provide all water needed for grassing. Provide permanent or temporary piping and valves, and temporary trucks to convey water from the source to the point of use. Provide any meters required and pay for water used if the water is taken from a public water system. Water shall be free of petroleum products, pesticides and any other deleterious constituents. Plant reclaimed water is available for watering. Contractor is responsible for pumping of reclaimed water source. Coordinate with Owner's representative for pumping access.

PART 3 - EXECUTION

A. Coordination of Work

Coordinate all work activities to provide for establishment of grass cover at the earliest possible time in the construction schedule to minimize erosion of topsoil.

B. Construction Methods - General

1. Provide and establish grass in all areas designated on the drawings or that are disturbed during construction (except areas to be paved, landscaped or covered with structures).

2. Do not fertilize when wind velocities exceed 15 miles per hour. Sod only when the soil is in proper condition to induce growth.

3. When a length of roadway slopes or adjacent areas have been graded and made ready, commence grassing in accordance with these specifications. Incorporate grass covering into the project at the earliest practical time in the life of the contract to reduce potential erosion.

4. Store fertilizer in dry locations away from contaminants. Sprinkle sod with water and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that heating will not develop.

C. Construction Methods for Grassing

1. The location of grassing will be as called for in the drawings. If the type is not designated, match the type of grass in adjacent areas.

2. Sequence of Operations: The several operations involved in the work shall proceed in the following sequence:

   a. Preparation of the ground.

   b. Sodding.

   c. Watering and maintaining

D. Preparation of Area to be Grassed

1. Prepare the areas to be grassed by disc-harrowing and thoroughly pulverizing them to a depth of at least 6 inches.

2. Bring all areas to be grassed to finished grades, remove weeds, surplus dirt and rock debris over 1 inch in diameter, and rough grade the area.

3. Test the soil for pH. If the soil is below a pH level of 5.5, spread lime to raise the pH level to at least 5.5.

4. Uniformly apply fertilizer at the rate of 400 to 500 pounds per acre. Immediately after the fertilizer and/or lime are spread over the area, mix them into the soil to a depth of approximately 4 inches.

5. Float the area to a smooth uniform grade. Slope all areas to drain. Establish flow lines as shown on the drawings. Finish areas to be grassed approximately 1 inch below top of adjoining curb or pathway.

E. Sodding

1. Incorporate sodding into the project at the earliest practical time in the life of the contract. Do not use sod which has been cut for more than 3 days. Stack any sod which is not planted within 24 hours after cutting and maintain properly moistened.

2. Place the sod on a prepared surface, with abutting joints. Fill any gaps or cracks between sod blocks with sod. Roll with a minimum one-ton roller to obtain an even surface. Bring the sod edge in a neat, clean manner to the edge of all paving and shrub areas and project limits.

3. Where sodding is used in drainage ditches, stagger the setting of the pieces to avoid a continuous seam along the line of flow.

4. On areas where the sod may slide due to height and slope, peg the sod with pegs driven through the sod blocks into firm earth at suitable intervals. Replace any pieces of sod which, after placing, show an appearance of extreme dryness.

F. Mowing

1. Mow first when the grass reaches a height of 3 to 4 inches. Mow a second time when the grass reaches a height of 6 inches and before a seedhead occurs. Subsequent mowings should establish a uniform grass surface of 2-1/2 inches and be made before seedhead occurs. All mowings should be made with a cut height as low as possible to stop shading of the Bahia grass.

2. Mow sod to establish a uniform grass surface of 2-1/2 inches.

3. Provide equipment for mowing that does not rut the soil surface. Fill any ruts that are in excess of two (2) inches deep with native soil free from twigs and rocks larger than 1 inch in diameter. Temporarily suspend mowing operations when the soil is too wet to provide adequate support and traction for equipment.

G. Watering

1. Maintain a balanced watering program until the acceptance of work.

2. Apply water in sufficient quantities and as often as seasonal conditions require keeping the grassed areas moist.

3. Provide supplemental water and irrigate seed areas when the rainfall is not adequate to maintain soil moisture necessary for germination and growth of the grass. It is Contractor's responsibility to determine the quantities of water required and when to irrigate. This obligation shall remain in full force and effect until final acceptance of the work by County and shall be provided at no additional cost to County.

4. County, at his discretion, may relieve Contractor of this obligation at such time as County is able to provide irrigation. This action, however, does not relieve Contractor of the provisions and guarantees set forth in the Contract Documents.

H. Maintenance

1. Maintain all grassed areas for a period of 90 days after the date of substantial completion and guarantee against all defects and faults of material and workmanship.

2. Maintain grass areas by watering, fertilizing, and mowing to establish an even and uniform grass surface of 2-1/2 inches, as specified above.

3. In the event that the grass exhibits iron chlorosis symptoms during the establishment period, apply liquid iron at manufacturer's recommended rates.

I. Guarantee

1. Guarantee all grasses areas to be alive and in satisfactory growth at the end of the maintenance period (90 days).

2. Replace any grass that is dead or not in satisfactory growth, as determined by the County or County's representative. Guarantee new sod or seed for an additional 90 days.

3. The term "Satisfactory Growth" as used in this section is defined as even plant growth in healthy conditions without bare spots larger than one square foot in seeded areas and without bare spots in sodded areas. Bare spots larger than one square foot in seeded areas shall be re-seeded and bare spots in sodded areas resodded. All grassed and sodded areas shall be maintained until satisfactory growth has been demonstrated. In the event that the subsequent stand of grass is found to be contaminated with weeds or other obnoxious or undesirable growth, effectively eliminate such undesirable growth, at the Contractor's expense.

4. Replace sod with the same variety as initially specified.

J. Inspection

1. Request inspection from the County and his representative at least 72 hours in advance of the time inspection is required.

2. Provide an authorized representative to be on-site during inspection.

END OF SECTION

SECTION 02834 STEEL CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

A. Description

This section includes materials and installation of galvanized steel chain link fence and gates, top and bottom tension wires, top rail and bottom tension wire, and anticlimb extension arms with barbed wire.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's descriptive literature and drawings of fence and gate installation.

3. Submit manufacturer's certificate or original shipping tags showing compliance with cited U.S. Federal and ASTM specifications.

PART 2 - MATERIALS

A. Galvanized Chain Link Fabric

1. Fabric height shall be 96 inches unless otherwise shown in the drawings.

2. ASTM A392, Class 1; or U.S. Federal Specification RR-F-191/1D, Type I; 1.2 ounces per square foot zinc coating, hot-dip galvanized after weaving, 2-inch diamond mesh, 11-gauge steel wire for height 60 inches or less, 9 gauge for height over 60 inches.

3. Top selvage knuckled, bottom selvage twisted and barbed.

4. Tie wire shall be same material and gauge as the chain link fabric.

B. Galvanized Posts and Braces

1. Steel Pipe: ASTM F1083. Galvanize 1.8 ounces per square foot.

2. Provide posts and braces in compliance with the over 6-foot classification of U.S. Federal Specification RR-F-191/3D, as follows:

   a. End, Corner, and Pull Posts: 2-1/2-inch steel pipe, 5.79 pounds per linear foot.

   b. Line Posts: 2-inch steel pipe, 3.65 pounds per linear foot.

   c. Gateposts for up to 6-Foot Leaf Width Gate: 2-1/2 inches, 5.79 pounds per linear foot.

   d. Gatepost for 6- to 13-Foot Leaf Width Gate: 3-1/2 inches, 9.1 pounds per linear foot.

3. Alternatively, provide steel pipe, posts, and braces as follows:

   Steel pipe shall conform to ASTM A1011 or A653, cold-formed, electric welded, minimum yield strength of 50,000 psi. Provide posts and braces with Type A galvanized coating in compliance with ASTM F1043 for heavy industrial fence, Group IA pipe or Group II rolled shapes as follows:

   a. End, Corner, and Pull Posts: 2.875-inch (outside diameter) steel pipe, 4.64 pounds per linear foot.

   b. Line Posts: 2.375-inch (outside diameter) steel pipe, 3.12 pounds per linear foot.

   c. Gateposts for up to 6-Foot Leaf Width Gate: 2.875 inches (outside diameter), 4.64 pounds per linear foot.

   d. Gatepost for 6- to 13-Foot Leaf width Gate: 4 inches (outside diameter), 6.56 pounds per linear foot.

4. Post Brace Assembly: At gateposts and end posts and at each side of corner and pull posts, place a horizontal compression brace to the next post at midheight of fabric. Truss the two posts together with a diagonal tension rod. Use 1-1/4-inch minimum pipe for the horizontal brace and 3/8-inch (nominal, 5/16-inch true) diameter adjustable diagonal truss rod.

5. Length of Posts into Footing: At line posts for fabric height of less than 72 inches, provide 24 inches. At

line posts for fabric height of 72 inches and more, provide 36 inches. At end, corner, and pull posts, provide 10 inches more than at line posts. At gateposts, provide 16 inches more than at line posts. In solid rock, the portion of the depth of footing that is in solid rock may be reduced to one-half of the above lengths.

C. Galvanized Hardware

Comply with U.S. Federal Specification RR-F-191/4D or ASTM F626 and the following:

1. Caps: Weathertight caps on exposed ends of tubular members.

2. Tension Wires: 7-gauge galvanized steel coil spring steel.

3. Tension or Stretcher Bars: One piece, 2 inches less than fabric height, 3/16 inch by 3/4 inch. Provide one bar for each gatepost and end post and two for each corner and pull post.

D. Galvanized Barbed Wire

1. Barbed Wire: ASTM A121, Class 3, two twisted 12-1/2-gauge steel wires, 0.80-ounce-per-square-foot zinc coating, 4-point round-shape barbs 5 inches apart.

2. Extension Arms: Post cap and anticlimb 45-degree galvanized steel single extension arm per ASTM F626 for three barbed wires. Top wire: 12 inches above fabric. Provide way for top rail.

E. Galvanized Gates

1. Provide gates in accordance with ASTM F900, except as modified.

2. Tubular Perimeter Members: Provide 2-inch pipe, 3.65 pounds per linear foot. Provide intermediate vertical member for width over 8 feet and intermediate horizontal member for width over 10 feet. Assemble frame by welding or with malleable or pressed steel corner fittings, riveted for rigid connection. Provide fabric and barbed wire as for fence. Use stretcher bars at vertical edges and optional at top and bottom edges. Diagonal cross

bracing of 3/8-inch (nominal, 5/16-inch true) diameter adjustable truss rods. Form anticlimb extension by extending vertical members 12 inches above fabric. Provide hinged gates to swing through 180 degrees from closed to open.

3. Gate Hardware:

   a. Hinges: Provide pressed or forged steel or malleable iron, nonlift-off type, offset for 180-degree opening, one and one-half pairs for each leaf over 6 feet high.

   b. Latch: Provide forked type or plunger-bar type for operation from either side, with padlock eye as integral part.

   c. Cane Bolt: Provide one 24-inch-long cane bolt at each leaf more than 4 feet 0 inches wide.

F. Concrete

Five, 94-pound sacks of portland cement per cubic yard. Do not use accelerating admixtures.

PART 3 - EXECUTION

A. Preparation for Installation

Clear the line of the fence and dispose of resulting material. Grade between post centers, excavate high spots, and fill low spots so bottom of fabric will be between 1 and 2 inches above finished grade.

B. Installation

Install in accordance with ASTM F567, except as modified herein.

C. Setting Posts

1. Space line posts uniformly at maximum intervals of 10 feet between gateposts and corner posts.

2. Excavate postholes so concrete will be 3 inches below and around metal posts, except that minimum diameter of concrete footing for end, corner, pull, and gateposts is

12 inches. In solid rock, diameters may be reduced to post outside diameter plus 3 inches.

3. Set posts plumb to within 1/4 inch of the post vertical centerline.

4. Fill postholes with concrete to 2 inches above finish grade and crown to slope away from post. In solid rock, emplace posts with a grout of one part portland cement to three parts sand, with sufficient water for workability.

D. Installing Fabric

1. Place fabric on security side of fence. Place tension bands on side opposite fabric side and peen bolt ends or score threads.

2. Tie fabric to line posts and clip tension bar to end, corner, pull, and gateposts at 15-inch intervals. Tie fabric to tension wires or weave tension wires through fabric at 24-inch intervals. Gauge of tie wire equal to gauge of fabric. Tie tension wires to line posts with 6-gauge wire. Twist tie wires two full turns and bend back edges to reduce hazard.

3. Join rolls of fabric by weaving a single strand into ends of the rolls to form a continuous mesh.

END OF SECTION

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DIVISION 3 - CONCRETE

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SECTION 03100 CONCRETE FORMWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and design, install and remove formwork for cast-in-place concrete as shown on the Drawings and as specified herein.

B. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts and other items furnished under other Sections and required to be cast into concrete, or approved in advance by the Engineer.

1.02 RELATED WORK

A. Concrete Reinforcement is included in Section 03200.

B. Concrete Joints and Joint Accessories are included in Section 03250.

C. Cast-in-Place Concrete is included in Section 03300.

D. Grout is included in Section 03600.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Form release agent

2. Form ties

B. Samples

1. Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not adversely affect concrete surfaces to be painted, coated or otherwise finished and will not affect the forming materials.

C. Certificates

1. Certify that form release agent is suitable for use in contact with potable water after 30 days (non-toxic and free of taste and odor).

1.04 REFERENCE STANDARDS

A. American Concrete Institute (ACI)

1. ACI 301 - Standard Specification for Structural Concrete

2. ACI 318 - Building Code Requirements for Reinforced Concrete

3. ACI 347 - Formwork for Concrete

B. American Plywood Association (APA)

1. Material grades and designations as specified

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

1.05 SYSTEM DESCRIPTION

A. General: Architectural Concrete is wall, slab, beam or column concrete which will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of walls to 2-ft below the normal water surface in open tanks and basins.

B. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete.

PART 2 PRODUCTS

2.01 GENERAL

A. The usage of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.02 MATERIALS

A. Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the Engineer and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.

B. Wall Forms

1. Forms for all exposed exterior and interior concrete walls shall be "Plyform" exterior grade plywood panels manufactured in compliance with the APA and bearing the trademark of that group, or equal acceptable to the Engineer. Provide B grade or better veneer on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.

2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging.

C. Rustication strips shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.

D. Form Release Agent

1. Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste or odor.

E. Form Ties

1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1-1/2-in of the face of the concrete. The part of the tie to be removed shall be at least 1/2-in diameter or be provided with a wood or metal cone at least 1/2-in diameter and 1-1/2-in long. Form ties in concrete exposed to view shall be the cone-washer type.

2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be of approved wood or plastic.

3. Flat bar ties for panel forms, if used, shall have plastic or rubber inserts having a minimum depth of 1-1/2-in and sufficient dimensions to permit proper patching of the tie hole.

4. Ties for liquid containment structures shall have an integral waterstop that is tightly welded to the tie.

5. Common wire shall not be used for form ties.

6. Alternate form ties consisting of tapered through-bolts at least 1-in in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used at the Contractor's option. Obtain Engineer's acceptance of system and spacing of ties prior to ordering or purchase of forming. Clean, fill and seal form tie hole with non-shrink cement grout. The Contractor shall be responsible for watertightness of the form ties and any repairs needed.

PART 3 EXECUTION

3.01 GENERAL

A. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions and appearance indicated on the Drawings.

B. Forms for walls shall have removable panels at the bottom for cleaning, inspection and joint surface preparation. Forms for walls of considerable height shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, prevent segregation and prevent the accumulation of hardened concrete on the forms above the fresh concrete.

C. Molding, bevels, or other types of chamfer strips shall be placed to produce blockouts, rustications, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 3/4-in chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the Drawings. Sizes of moldings shall conform to the sealants manufacturer's recommendations.

D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms so that the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for the adequacy of the forming system.

E. Before form material is re-used, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like new" condition of the form is maintained.

3.02 FORM TOLERANCES

A. Forms shall be surfaced, designed and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for the specified finishes.

1. Formed Surface Exposed to View: Edges of all form panels in contact with concrete shall be flush within 1/16-in and forms for plane surfaces shall be such that the concrete will be plane within 3/16-in in 4-ft. Forms shall be tight to prevent the passage of mortar, water and grout. The maximum deviation of the finish wall surface at any point shall not exceed 1/4-in from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.

2. Formed surfaces not exposed to view or buried shall meet requirements of Class "C" Surface in ACI 347.

3. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1-in.

3.03 FORM PREPARATION

A. Wood forms in contact with the concrete shall be coated with an effective release agent prior to form installation.

B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms, except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.

3.04 REMOVAL OF FORMS

A. The Contractor shall be responsible for all damage resulting from removal of forms. Forms and shoring for structural slabs or beams shall remain in place in accordance with ACI 301 and ACI 347. Form removal shall conform to the requirements specified in Section 03300 and a curing compound applied.

3.05 INSPECTION

A. The Engineer on site shall be notified when the forms are complete and ready for inspection at least 24 hours prior to the proposed concrete placement.

B. Failure of the forms to comply with the requirements specified herein, or to produce concrete complying with requirements of this Section, shall be grounds for rejection of that portion of the concrete work. Rejected work shall be repaired or replaced as directed by the Engineer at no additional cost to the Owner. Such repair or replacement shall be subject to the requirements of this Section and approval of the Engineer.

END OF SECTION

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SECTION 03200 CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.

B. Furnish only all deformed steel reinforcement required to be entirely built into concrete masonry unit construction.

1.02 RELATED WORK

A. Concrete Formwork is included in Section 03100.

B. Concrete Joint and Joint Accessories are included in Section 03250.

C. Cast-in-place Concrete is included in Section 03300.

D. Grout is included in Section 03600.

E. Reinforced Unit Masonry is included in Division 4.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Reinforcing steel. Placement drawings shall conform to the recommendations of ACI 315. All reinforcement in a concrete placement shall be included on a single placement drawing or cross referenced to the pertinent main placement drawing. The main drawing shall include the additional reinforcement (around openings, at corners, etc) shown on the standard detail sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.

2. Bar bending details. The bars shall be referenced to the same identification marks shown on the placement drawings.

3. Schedule of all placements to contain synthetic reinforcing fibers. The amount of fibers per cubic yard to be used for each of the placements shall be noted on the schedule. The name of the manufacturer of the fibers and the product data shall be included with the submittal.

B. Submit Test Reports, in accordance with Section 01340, of each of the following items.

1. Certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.

2. Welder's certification. The certification shall be in accordance with AWS D1.4 when welding of reinforcement required.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

2. ASTM A184 - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.

3. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

4. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement

5. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement

6. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

7. ASTM A616 - Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement

8. ASTM A617 - Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement

9. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

10. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

11. ASTM A775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

12. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.

13. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.

B. American Concrete Institute (ACI)

1. ACI 301 - Standard Specification for Structural Concrete

2. ACI 315 - Details and Detailing of Concrete Reinforcement.

3. ACI 318 - Building Code Requirements for Structural Concrete

4. ACI SP-66 - ACI Detailing Manual

C. Concrete Reinforcing Steel Institute (CRSI)

1. Manual of Standard Practice

D. American Welding Society (AWS)

1. AWS D1.4 - Structural Welding Code Reinforcing Steel

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

1.05 QUALITY ASSURANCE

A. Provide services of a manufacturer's representative, with at least 2 years experience in the use of the reinforcing fibers for a preconstruction meeting and assistance during the first placement of the material.

1.06 DELIVERY, HANDLING AND STORAGE

A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.

B. Reinforcing steel shall be shipped and stored with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted Placing Drawings.

C. Reinforcing steel shall be stored off the ground and kept free from dirt, oil, or other injurious contaminants.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials shall be new, of domestic manufacture and shall comply with the following material specifications.

B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.

C. Concrete Reinforcing Bars required on the Drawings to be Welded: ASTM A706.

D. Welded Steel Wire Fabric: ASTM A185. Provide in flat sheets.

E. Welded Deformed Steel Wire Fabric: ASTM A497.

F. Welded Plain Bar Mats: ASTM A704 and ASTM A615 Grade 60 plain bars.

G. Fabricated Deformed Steel Bar Mats: ASTM A184 and ASTM A615 Grade 60 deformed bars.

H. The following alternate materials are allowed:

1. ASTM A615 Grade 60 may be used for ASTM A706 provided the following requirements are satisfied:

a. The actual yield strength of the reinforcing steel based on mill tests shall not exceed the specified yield strength by more than 18,000 psi. Retests shall not exceed this value by more than an additional 3000 psi.

b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement shall not be less than 1.25.

c. The carbon equivalency (CE) of bars shall be

0.55 or less.

I. Reinforcing Steel Accessories

1. Plastic Protected Bar Supports: CRSI Bar Support Specifications, Class 1 - Maximum Protection.

2. Stainless Steel Protected Bar Supports: CRSI Bar Support Specifications, Class 2 - Moderate Protection.

3. Precast Concrete Block Bar Supports: CRSI Bar Support Specifications, Precast Blocks. Blocks shall have equal or greater strength than the surrounding concrete.

4. Steel Protected Bar Supports: #4 Steel Chairs with plastic or rubber tips.

J. Tie Wire

1. Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire or stranded wire.

K. Mechanical reinforcing steel butt splices shall be positive connecting taper threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products Inc., Solon, OH or equal. They shall meet all ACI 318 Building Code requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Bar couplers shall be torqued to manufacturer's recommended value.

1. Unless otherwise noted on the Drawings, mechanical tension splices shall be designed to produce a splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the rebar.

2. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar and shall be capable of developing the ultimate strength of the rebar in compression.

L. Fiber Reinforcement

1. Synthetic reinforcing fiber for concrete shall be 100 percent polypropylene collated, fibrillated fibers as manufactured by Propex Concrete Systems

Chattanooga, TN - Propex or equal. Fiber length and quantity for the concrete mix shall be in strict compliance with the manufacturer's recommendations as approved by the Engineer.

2.02 FABRICATION

A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice.

B. Bars shall be cold bent. Bars shall not be straightened or rebent.

C. Bars shall be bent around a revolving collar having a diameter of not less than that recommended by the ACI 318.

D. Bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded, shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3 EXECUTION

3.01 INSTALLATION

A. Surface condition, bending, spacing and tolerances of placement of reinforcement shall comply with the CRSI Manual of Standard Practice. The Contractor shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.

B. Except as otherwise indicated on the Drawings, the minimum concrete cover of reinforcement shall be as follows:

1. Concrete cast against and permanently exposed to earth: 3-in

2. Concrete exposed to soil, water, sewage, sludge and/or weather: 2-in (including bottom cover of slabs over water or sewage)

3. Concrete not exposed to soil, water, sewage, sludge and/or weather:

a. Slabs (top and bottom cover), walls, joists,

shells and folded plate members - 1-in

b. Beams and columns (principal reinforcement, ties, spirals and stirrups) - 1-1/2-in

C. Reinforcement which will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.

D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall comply with AWS D1.4.

E. Reinforcing steel interfering with the location of other reinforcing steel, conduits or embedded items, may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacement of bars to avoid interference, shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.

F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.

G. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold-bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld or otherwise repair as directed by the Engineer. Do not bend reinforcement after it is embedded in concrete unless specifically shown otherwise on the Drawings.

3.02 REINFORCEMENT AROUND OPENINGS

A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by an opening. The bars shall have sufficient length to develop bond at each end beyond the opening or

penetration.

3.03 SPLICING OF REINFORCEMENT

A. Splices designated as compression splices on the Drawings, unless otherwise noted, shall be 30 bar diameters, but not less than 12-in. The lap splice length for column vertical bars shall be based on the bar size in the column above.

B. Tension lap splices shall be provided at all laps in compliance with ACI 318. Splices in adjacent bars shall be staggered. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.

C. Splicing of reinforcing steel in concrete elements noted to be "tension members" on the Drawings shall be avoided whenever possible. However, if required for constructability, splices in the reinforcement subject to direct tension shall be welded to develop, in tension, at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be offset the distance of a Class B splice.

D. Install wire fabric in as long lengths as practicable. Wire fabric from rolls shall be rolled flat and firmly held in place. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI-318 but not less than 12-in. The spliced fabrics shall be tied together with wire ties spaced not more than 24-in on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.

E. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30 bar diameters. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the Engineer.

3.04 ACCESSORIES

A. Determine, provide and install accessories such as chairs, chair bars and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the

reinforcement and the placement of concrete.

B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.

C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use of galvanized or plastic tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.

D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

3.05 INSPECTION

A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished his/her observations of the reinforcing steel.

END OF SECTION

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SECTION 03250 CONCRETE JOINTS AND JOINT ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Concrete Formwork is included in Section 03100.

B. Concrete Reinforcement is included in Section 03200.

C. Cast-In-Place Concrete is included in Section 03300.

D. Concrete Finishes are included in Section 03350.

E. Grout is included in Section 03600.

F. Miscellaneous Metals are included in Section 05500.

G. Sealants and Caulking are included in Section 07920.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data. Submittals shall include at least the following:

1. Standard Waterstops: Product data including catalogue cut, technical data, storage requirements, splicing methods and conformity to ASTM standards.

2. Special Waterstops: Product data including catalogue cut, technical data, location of use, storage requirements, splicing methods, installation instructions and conformity to ASTM standards.

3. Premolded joint fillers: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

4. Bond breaker: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

5. Expansion joint dowels: Product data on the complete assembly including dowels, coatings, lubricants, spacers, sleeves, expansion caps, installation requirements and conformity to ASTM standards.

6. Compressible joint filler: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.

7. Bonding agents: Product data including catalogue cut, technical data, storage requirements, product life, application requirements and conformity to ASTM standards.

B. Certifications

1. Certification that all materials used within the joint system are compatible with each other.

2. Certification that materials used in the construction of joints are suitable for use in contact with potable water 30 days after installation.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A675 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.

2. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

3. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

4. ASTM D1751 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).

5. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

B. U.S. Army Corps of Engineers (CRD).

1. CRD C572 - Specification for Polyvinylchloride Waterstops.

C. Federal Specifications

1. FS SS-S-210A - Sealing Compound for Expansion Joints.

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

PART 2 PRODUCTS

2.01 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.

C. All chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used on similar structures for more than five years.

2.02 MATERIALS

A. Standard Waterstops

1. PVC Waterstops - The waterstop shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. The waterstop shall be Greenstreak Group, Inc. model No. 732 or approved equal for construction joints and Greenstreak Group Inc. Model No. 738 for expansion joints. Provide grommets or pre-punched holes spaced at 12 inches on center along length of waterstop.

2. Factory Fabrications: Provide factory made waterstop fabrications for all changes of direction, transitions, and intersections, leaving only straight butt joints of sufficient length for splicing in the field.

B. Special Waterstops

1. Base Seal PVC Waterstop - The waterstop shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. Waterstops shall be style 925 for expansion joints, style 928 for control joints, and style 927 for construction joints by Greenstreak Plastic Products, St. Louis, MO or equal.

2. Preformed adhesive waterstops - The waterstop shall be a rope type preformed plastic waterstop meeting the requirements of Federal Specification SS-S-210A. The rope shall have a cross-section of approximately one square inch unless otherwise specified or shown on the Drawings. The waterstop shall be Synko-Flex waterstop as manufactured by Synko-Flex Products of Houston, TX, Lockstop by Greenstreak Group Inc., or equal. Primer for the material shall be as recommended by the waterstop manufacturer.

C. Premolded Joint Filler

1. Premolded joint filler - structures. Self-expanding cork, premolded joint filler shall conform to ASTM D1752, Type III. The thickness shall be 3/4-in unless shown otherwise on the Drawings.

2. Premolded joint filler - sidewalk and roadway concrete pavements or where fiber joint filler is specifically noted on the Drawings. The joint filler shall be asphalt-impregnated fiber board conforming to ASTM D1751. Thickness shall be 3/4-in unless otherwise shown on the Drawings.

D. Bond Breaker

1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint.

2. Except where tape is specifically called for on the drawings, bond breaker for concrete shall be either bond breaker tape or a nonstaining type bond prevention coating such as Williams Tilt-up Compound by Williams Distributors Inc.; Silcoseal 77, by SCA Construction Supply Division, Superior Concrete Accessories or equal.

E. Expansion Joint Dowels

1. Dowels shall be smooth steel conforming to ASTM A675, Grade 70. Dowels must be straight and clean, free of loose flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04-in on the diameter of the dowel and extends no more than 0.04-in from the end. Bars shall be coated with a bond breaker on the expansion end of the dowel. Expansion caps shall be provided on the expansion end. Caps shall allow for at least 1-1/2-in of expansion.

F. Bonding Agent

1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation of Lyndhurst, N.J.; Concresive Liquid (LPL) by Master Builders of Cleveland, OH or equal. Acrylic may be used if approved by the Engineer.

G. Compressible Joint Filler

1. The joint filler shall be a non-extruded watertight strip material use to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 68 degrees F and subsequently recovering at least 20 percent of its original thickness in the first 1/2 hour after unloading. Compressible Joint filler shall be Evasote 380 E.S.P, by E-Poxy Industries, Inc., Ravena, NY , Sikaflex 1a by Sika or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Standard Waterstops

1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Provide factory made waterstop fabrications for all changes in direction, intersections and transitions leaving only straight butt joints splices for the field.

2. Horizontal waterstops in slabs shall be clamped in position by the bulkhead (unless previously set in concrete).

3. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete.

4. Waterstops shall be terminated 3-in below the exposed top of walls. Expansion joint waterstop center bulbs shall be plugged with foam rubber, 1-in deep, at point of termination.

B. Special Waterstops

1. Install special waterstops at joints where specifically noted on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided.

2. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of connections or splices. Connections and splices shall conform to the manufacturer’s recommendations and as specified herein.

3. Waterstops shall be terminated 3-in below the exposed top of walls.

C. Construction Joints

1. Make construction joints only at locations shown on the Drawings or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor, must be submitted to the Engineer for written approval.

2. Additional or relocated joints should be located where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. However, if a beam intersects a girder at the joint, offset the joint a

distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.

3. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings. When joints in beams are allowed, provide a shear key and inclined dowels as approved by the Engineer.

4. Provide sealant grooves for joint sealant where indicated on the Drawings.

5. At all construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 1/4-in to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding.

6. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.

7. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the Engineer.

D. Expansion Joints

1. Do not extend through expansion joints, reinforcement or other embedded metal items that are continuously bonded to concrete on each side of joint.

2. Position premolded joint filler material accurately. Secure the joint filler against displacement during concrete placement and compaction. Place joint filler over the face of the joint, allowing for sealant grooves as detailed on the Drawings. Tape all joint filler splices to prevent intrusion of mortar. Seal expansion joints as shown on the Drawings.

3. Expansion joints shall be 3/4-in in width unless otherwise noted on the Drawings.

4. Where indicated on Drawings, install smooth dowels at right angles to expansion joints. Align dowels accurately with finished surface. Rigidly hold in place and support during concrete placement. Unless otherwise shown on the Drawings, apply oil or grease to one end of all dowels through expansion joints. Provide plastic expansion caps on the lubricated ends of expansion dowels.

5. Provide center bulb type waterstops in all wall and slab expansion joints in liquid containment structures and at other locations shown on the Drawings.

E. Control Joints

1. Provide sealant grooves, sealants and waterstops at control joints in slabs on grade or walls as detailed. Provide waterstops at all wall and slab control joints in water containment structures and at other locations shown on the Drawings.

2. Control joints may be sawed if specifically approved by the Engineer. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during sawcutting.

3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Where specifically noted on the Drawings, coat the concrete surface with a bond breaker prior to placing new concrete against it. Avoid coating reinforcement or waterstops with bond breaker at these locations.

END OF SECTION

SECTION 03300 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide cast-in-place concrete as indicated and in compliance with Contract Documents.

1.02 REFERENCES

A. American Concrete Institute (ACI):

1. 117: Specifications for Tolerances for Concrete Construction and Materials and Commentary.

2. 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

3. 214R: Recommended Practice for Evaluation of Strength Test Results of Concrete

4. 301: Standard Specifications for Structural Concrete

5. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete

6. 304.2R: Placing Concrete by Pumping Methods

7. 305R: Hot Weather Concreting

8. 306R: Cold Weather Concreting

9. 308: Standard Practice for Curing Concrete

10. 309R: Guide for Consolidation of Concrete

11. 311.4R: Guide for Concrete Inspection

12. 318: Building Code Requirements for Structural Concrete

13. 350: Code Requirements For Environmental Engineering Concrete Structures

B. American Society for Testing and Materials International (ASTM):

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field

4. C33: Standard Specification for Concrete Aggregates

5. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

6. C40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete

7. C42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

8. C87: Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar

9. C88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

10. C94: Standard Specification for Ready-Mixed Concrete

11. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or Cube Specimens)

12. C123: Standard Test Method for Lightweight Particles in Aggregate

13. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

14. C138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete

15. C143: Standard Test Method for Slump of Hydraulic Cement Concrete

16. C150: Standard Specification for Portland Cement

17. C157: Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete

18. C171: Standard Specification for Sheet Materials for Curing Concrete

19. C172: Standard Practice for Sampling Freshly Mixed Concrete

20. C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

21. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

22. C260: Standard Specification for Air-Entraining Admixtures for Concrete

23. C289: Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)

24. C295: Standard Guide for Petrographic Examination of Aggregates for Concrete

25. C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

26. C311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete

27. C494: Standard Specification for Chemical Admixtures for Concrete

28. C595: Standard Specification for Blended Hydraulic Cements

29. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

30. C881: Standard Test Method for Epoxy Resin Base Bonding Systems for Concrete

31. C882: Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear

32. C989: Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

33. C1017: Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

34. C1064: Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete

35. C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

36. C1116: Standard Specification for Fiber Reinforced Concrete

37. C1240: Standard Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout

38. D75: Standard Practice for Sampling Aggregates

39. E154: Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

40. E1745: Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

41. E329: Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

C. American Association of State Highway and Transportation Officials (AASHTO):

1. M182: Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

1.03 TOLERANCES

A. Conform to ACI 117.

B. Concrete slabs for buildings shall be within 1/8 inch of 10 ft straightedge in each direction except where slabs are dished for drains. Deviations from elevation indicated shall not exceed 3/4 in.

C. Pitch floor to floor drains minimum of 1/8 inch/ft or as shown on Drawings. Minimum thickness of slabs and depth of beams shall be as dimensioned on Drawings. Pitch bottom of slab or beam to match top slope of slab or beam to maintain thickness or depth noted. As an alternate, bottom of slab or beam may be poured level provided that minimum thickness or depth is maintained.

1.04 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01300.

B. Product Data:

1. Manufacturer's specifications and instructions including Material safety Data Sheets (MSDS) for admixtures and curing materials. Manufacturer’s certification of compatibility of all admixtures.

C. Proposed mix designs including complete details of product additives and certification that all additives are compatible with all other additives. In addition, submit drawing which indicates the portions of each structure which is to receive the concrete waterproofing additive.

D. Submit prequalification test results to the Engineer for each Ready Mix Concrete Mix proposed, showing adequate performance for:

1. Compressive strength

2. The standard deviation for the concrete compressive strength tests shall be in conformance with ACI 214.3R 88(97) “Recommended Practice for Evaluation of Compression Test Results of Concrete.”

3. Air entrainment

E. Shop Drawings:

1. Provide certificate that cement used complies with ASTM C150 and these specifications.

2. Provide certificates that aggregates comply with ASTM C33. Submit gradation analysis with concrete mix designs.

3. Provide certificate of compliance with these specifications from the manufacturer of the concrete admixtures.

4. For each formulation of concrete proposed, provide concrete mix designs and laboratory 7-day and 28-day compressive tests, or submit test results of 7- and 28-day compressive tests of the mix where the same mix has been used on two previous projects in the past twelve months.

5. Proposed special procedures for protection of concrete under wet weather placement conditions.

6. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.

F. Manufacturers' Instructions

1. Provide epoxy bonding compound manufacturer's specific instructions for use. Provide manufacturer's data sheets as to suitability of product to meet job requirements with regard to surface, pot life, set time, vertical or horizontal application, and forming restrictions.

G. Field Quality Control Submittals

1. Provide delivery tickets for ready-mix concrete or weighmasters certificate per ASTM C94, including weights of cement and each size aggregate and amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant

shall account for moisture in both coarse and fine aggregate.

1.05 QUALITY ASSURANCE

A. Plant Certification: Plant or concrete supplier shall comply with requirements of National Ready Mixed Concrete Association (NRMCA) certification plan as regards material storage and handling, batching equipment, central mixer, truck mixers with counters, agitators, nonagitating units, and ticketing system.

B. Testing of Ready Mix Concrete

1. Testing will be performed by an independent testing agency arranged by the Owner.

2. Testing of Ready Mix Concrete trucks on delivery will include:

a. Slump

b. Air content

c. Wet density

d. Concrete temperature

3. Samples will be cast for laboratory testing for:

a. Compressive strength

4. Initially 3, 7, 14, and 2-28 day compression samples will be taken and tested. However, upon achieving acceptable results the testing will be reduced to 7 and 2-28 day tests.

5. Samples may be taken for other testing as determined by the Engineer.

6. Copies of the results of all concrete testing carried out by the independent testing agency will be made available to the Engineer upon request.

7. The provision of the test results from the independent testing agency does not relieve the Contractor of the responsibility to furnish

materials and construction in compliance with the performance requirements of the contract documents and to carry out their own testing program.

8. The Contractor shall take samples and carry out testing as part of their quality control procedures to verify that the concrete satisfies the performance requirements set out in these specifications. Where possible, these tests shall be carried out on the same batches as tested by the independent testing agency.

9. Copies of the test results for all tests carried out by the Contractor must be made available to the Engineer for review and records.

C. Unless otherwise indicated, materials, workmanship, and practices shall conform to the following standards:

1. Local building codes.

2. ACI 301, "Structural Concrete for Buildings."

3. ACI 318, "Building Code Requirements for Reinforced Concrete."

4. ACI 350, "Code Requirements For Environmental Engineering Concrete Structures."

D. Where provisions of pertinent codes and standards conflict with this specification, the more stringent provisions govern.

E. Concrete not meeting the minimum specified 28-day design strength shall be cause for rejection and removal from the work.

F. Perform concrete work in conformance with ACI 301 unless otherwise specified.

G. Do not use admixtures, including calcium chloride, which will cause accelerated setting of cement in concrete.

H. Do not place concrete until design mix and material test results are accepted by the Engineer.

I. Employ an independent testing laboratory, acceptable to the Engineer, to develop concrete mix designs and testing. Concrete testing shall be performed by an ACI Concrete Field Technician, Grade I or equivalent.

J. Methods of Sampling and Testing:

1. Fresh Concrete Sampling: ASTM C172

2. Specimen Preparation: ASTM C31

3. Compressive Strength: ASTM C39

4. Air Content: ASTM C231

5. Slump: ASTM C143

6. Temperature: ASTM C1064

7. Unit Weight: ASTM C138

8. Obtaining Drilled Cores: ASTM C42

K. Acceptance of Structure: Acceptance of completed concrete work requires conformance with dimensional tolerances, appearance and strength as indicated or specified.

L. Hot weather concrete to conform to ACI 305R and as specified herein.

M. Cold weather concrete to conform to ACI 306R and as specified herein.

N. Reject concrete delivered to job site that exceeds the time limit or temperature limitations specified.

O. Do not place concrete in water or on frozen or uncompacted ground.

P. Workability

1. Concrete shall be of such consistency and composition that it can be worked readily into the forms and around the reinforcement without excessive vibrating and without permitting the

materials to segregate or free water to collect on the surface.

2. Adjust the proportions to secure a plastic, cohesive mixture, and one that is within the specified slump range.

3. To avoid unnecessary changes in consistency, obtain the aggregate from a source with uniform quality, moisture content, and grading. Handle materials to minimize variations in moisture content that would interfere with production of concrete of the established degree of uniformity and slump.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Deliver concrete to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

B. Reject concrete not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket.

1.07 SITE CONDITIONS:

A. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C 31 and as specified herein.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:

1. Portland Cement, ASTM C150, Type I/II or Type II.

2. Shall be one brand form one source. Use no cement that has become damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Use no salvaged or reclaimed cement.

3. Maximum tricalcium aluminate shall not exceed 8 percent. The maximum percent alkalies shall not exceed 0.6 percent.

B. Fly Ash:

1. Provide fly ash conforming to the following requirements:

a. Class F fly ash conforming to ASTM C 618 for chemical and physical properties.

b. Supplemental requirements in percent:

(1) Maximum carbon content: 3 percent

(2) Maximum sulfur trioxide (SO3) content: 4 percent

(3) Maximum loss on ignition: 3 percent

(4) Maximum water requirement (as a percent of control): 100 percent

(5) Fineness, maximum retained on No. 325 sieve: 25 percent

C. Fine Aggregates:

1. Clean, sharp, natural sand conforming to requirements of ASTM C33 with a fineness modulus between 2.50 and 3.0.

D. Coarse Aggregate:

1. Well graded crushed stone, natural rock conforming to requirements of ASTM C33.

E. Water and Ice:

1. Use water and ice free from injurious amounts of oil, acid, alkali, salt, organic matter or other deleterious substances and conforms to requirements of ASTM C94.

2. Water shall not contain more than 500 mg/L of chlorides nor more than 500 mg/L of sulfate.

3. Heat or cool water to obtain concrete temperatures specified, and in conformance with ACI 305R and ACI 306R.

F. Color Additive for Exterior Electrical Duct Encasement:

1. For exterior electrical duct concrete encasements, use a color additive for identification purposes.

G. Concrete Admixtures:

1. Maintain compressive strength and maximum water-cement ratios specified in Table 03300-1 when using admixtures. Include admixtures in solution form in the water-cement ratio calculations.

2. Do not use any admixture that contains chlorides or other corrosive elements in any concrete. Admixtures shall be nontoxic after 30 days.

3. Use admixtures in compliance with the manufacturer’s printed instructions. The manufacturer shall certify the compatibility of multiple admixtures used in the same mix.

4. Do not use admixtures in greater dosages than recommended by manufacturer.

5. Water Reducing:

a. Water-reducing admixture shall conform to ASTM C494, Type A. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

b. Products:

(1) BASF Corporation; Polyheed Series

(2) Sika Corporation, Plastocrete 161

(3) WR Grace & Co.;Darex II-AEA

(4) Euclid Chemical Company; Eucon NW

6. Water Reducing and Retarding:

a. Water-reducing and retarding admixture shall conform to ASTM C494, Type D. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

b. Products:

(1) BASF Corporation; Pozzolith Series

(2) Sika Corporation; Plastiment

(3) Euclid Chemical company; Eucon WR-91

7. High-Range Water-Reducing Admixture (Superplasticizer):

a. High-Range water-reducing admixture shall conform to ASTM C494, Type F or ASTM C1017, Type I.

b. Products:

(1) BASF Corporation; Glenium Series

(2) WR Grace & Co.; Daracem 100

(3) Euclid Chemical company; Eucon SPC

8. Crystalline Waterproofing additive:

a. Concrete waterproofing system shall be of the crystalline type, defined by the ACI 212.3R – 10 Report on Chemical Admixtures for Concrete as a "PRAH" type hydrophilic admixture. It shall react such that it chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the concrete. The system shall cause the concrete to become sealed against the penetration of liquids from any direction, and shall protect the concrete from deterioration due to harsh environmental conditions. The additive shall be used in all concrete that is in contact with water

which includes slabs-on-grade, elevated slabs, beams, columns and walls.

b. Acceptable admixture is Xypex Admix C-1000 manufactured by Xypex Chemical Corporation, 13731 Mayfield Place, Richmond, B.C. The admixture shall be added to the concrete mix at a rate of 2% - 3% by weight of Portland cement content.

H. Fiber Reinforcement:

1. Concrete noted as fiber reinforced concrete on Drawings shall be fiber reinforced in accordance with the following:

a. Fiber reinforcing shall conform to ASTM C 1116, Type III.

b. Fibers shall be macro fibers. Micro fibers are prohibited.

c. Fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement.

d. Volume of fibers shall be a minimum of 1-1/2 pounds per cubic yard.

e. Fiber length: 1/2-inch to 3/4-inch.

I. Epoxy Bonding Agent:

1. Epoxy bonding agent shall conform to ASTM C881 Type I, II, IV or V; Grade 2 for epoxy resin adhesives. The class of epoxy bonding agent shall be suitable for ambient and substrate temperatures.

2. Products:

a. Sika Corp.; Sikadur 32

b. Euclid Chemical Company; Duralcrete

c. BASF Corporation, Concresive Liquid LPL

J. Vapor Retarder: 10 mil polyethylene sheet conforming to ASTM E1745.

K. Curing Compound:

1. Liquid form, which will form impervious membrane over, exposed surface of concrete when applied to fresh concrete by means of spray gun. Compound shall not inhibit future bond of floor covering or concrete floor treatment. Use Type I-D compound with fugitive dye, Class B, having 18 percent minimum solids conforming to ASTM C309.

2. Products:

a. BASF Construction Chemicals: Kure-N-Seal

b. Euclid Chemical Company: Rez-Seal

L. Burlap Mats:

1. Conform to AASHTO M182.

M. Sisal-Kraft Paper and Polyethylene Sheets for Curing:

1. Conform to ASTM C171.

2.02 MIXES

A. Conform to ASTM C94, except as modified by these specifications.

B. Air content as determined by ASTM C231: 2 +/- 1 percent

C. Provide concrete with the following compressive strengths at 28 days and proportion it for strength and quality requirements in accordance with ACI 318. The resulting mix shall not conflict with limiting values specified in Table 03300-1.

Table 03300-1				
Class	Type of Work	28-Day Minimum Compressive Strength (psi)	Minimum Cementitous Content (lbs per C.Y.)	Maximum Water/ Cement Ratio
A	Concrete for all structures and concrete not otherwise specified.	4,000	560	0.44
B	Pavement, concrete topping, pipe encasement	3,000	500	0.54
C	Miscellaneous unreinforced concrete, mud slab	2,000	376	0.60
E	Precast concrete	5,000	630	0.40

D. Measure slump in accordance with ASTM C143:

1. Proportion and produce the concrete to have a maximum slump of 4±1 inches.

2. Mixes containing water reducers shall have a maximum slump of 6 inches after the addition of a mid-range water reducer and maximum slump of 8 inches after the addition of a high range water reducer.

E. Pozzolan Content:

1. Water to cementitious ratio shall not exceed water to cement ratio given on table.

2. Fly Ash: Use of is optional. Combine fly ash with cement at rate of 1.0 lb fly ash/lb reduction of cement. Fly ash shall not be less than 15 percent nor more than 20 percent of the total cementitous content given in table.

F. Aggregate Size:

1. Aggregate size shall be 3/4-inch maximum for slabs and sections 8 inches thick and less. Aggregate

size shall be 1 inch maximum for sections greater than 8 inches and less than 17 inches. Aggregate size shall be 1-1/2 inches maximum for all thicker slabs and sections. Aggregate size for floor topping shall be maximum 3/8-inch.

2. Combined aggregate grading shall be as shown in the following table:

Table 03300-2				
Maximum Aggregate Size	1-1/2 inch	1 inch	3/4-inch	3/8-inch
Aggregate Grade per ASTM C33	467	57	67	8

PART 3 EXECUTION

3.01 SUBGRADE INSPECTION:

A. Examine the subgrade and the conditions under which work is to be performed and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions are corrected to comply with specified subgrade conditions in a manner acceptable to the Engineer.

3.02 MIXING AND TRANSPORTING CONCRETE:

A. General: Conform to concreting procedures set forth in ASTM C94, ACI 304R and as specified herein.

B. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

C. Discharge concrete into forms within 1-1/2 hours after cement has entered mixing drum or before the drum has revolved 300 revolutions after the addition of water, whichever occurs first.

D. Do not add water at the jobsite.

E. Keep a record showing time and place of each pour of concrete, together with transit-mix delivery slips certifying the contents of the pour.

F. Discharge of concrete shall be completed within the limits set out in Table 03300-3.

Table 03300-3	
Maximum Time to Concrete Discharge	
Concrete Temperature	Limit
Over 90 Degree F	Remove concrete from jobsite and discard concrete
86 to 90 Degree F	45 minutes
81 to 85 Degree F	60 minutes
70 to 80 Degree F	75 minutes
Below 70 Degree F	90 minutes

3.03 CONCRETE ACCEPTANCE

A. Accept or reject each batch of concrete delivered to the point of agitator or mixer truck discharge. Sign delivery batch tickets to indicate concrete acceptance.

B. Reject concrete delivered without a complete concrete delivery batch ticket as specified herein. The concrete supplier will furnish copies of the signed batch ticket to the Contractor and Engineer.

C. The testing agency shall perform field tests at the point of agitator or mixer truck discharge. Accept or reject concrete on the basis of conformity with slump, air content and temperature specified. Slump and air content of pumped concrete will be tested at pipe discharge.

D. The testing agency shall inspect concrete transit truck's barrel revolution counter and gauge for measuring water added to the concrete. Reject concrete that exceeds the maximum barrel revolution of 300, the limits in Table 03300-3 or concrete that has water content exceeding the specified water-cement ratio.

E. Reject concrete not conforming to specification before discharging into the forms.

3.04 PREPARATION AND COORDINATION

A. Contractor shall notify the Engineer of readiness to place concrete in any portion of the work a minimum of 5 working days prior to concrete placement. Failure to provide this notification could be cause for delay in placing concrete.

B. Reinforcement, positioning of embedded items, and condition of formwork will be observed by the Engineer prior to concrete placement.

C. Coordinate the sequence of placement such that construction joints will occur only as designed.

D. Schedule sufficient equipment for continuous concrete placing. Provide for backup equipment and procedures to be taken in case of an interruption in placing. Provide backup concrete vibrators at the project site. Test concrete vibrators the day before placing concrete.

E. Compact the subgrade and/or bedding. Saturate the subgrade approximately eight hours before placement and sprinkle ahead of the placement of concrete in areas where vapor retarder is not used. Remove standing water, mud, and foreign matter before concrete is deposited.

F. Where shown on contract drawings, intentionally roughen surfaces of set concrete in a manner to expose bonded aggregate uniformly at joints.

G. When shown on contract drawings, install a granular base beneath slabs on ground. Place granular material on a compacted subgrade and compact granular base.

H. Place vapor retarder under slabs on grade and where shown on contract drawings. Install material with 6 inch lap at joints and seal joints with tape as recommended by the vapor retarder manufacturer. Tape material cut for slab penetrations to the pipe, conduit or other items passing through the slab. Use tape recommended by the vapor retarder manufacturer.

I. Install vapor retarder without punctures or tears and protect against punctures and breaks.

J. Where concrete is required to be placed and bonded to existing concrete, coat the contact surfaces with epoxy bonding agent. The method of preparation and application of the bonding agent shall conform to the manufacturer's recommendations.

3.05 CONCRETE PLACEMENT

A. Placement shall conform to ACI 304R as modified by these specifications.

B. Alternate sections of concrete walls and slabs may be cast simultaneously. Do not place adjacent sections of walls until seven days after placement of first placed concrete.

C. Do not place concrete until free water has been removed or has been diverted by pipes or other means and carried out of the forms, clear of the work. Do not deposit concrete underwater, and do not allow free water to rise on any concrete until the concrete has attained its initial set. Do not permit free or storm water to flow over surfaces of concrete so as to injure the quality or surface finish.

D. Do not place concrete during inclement weather. Protect concrete placed from inclement weather. Keep sufficient protective covering ready at all times for this purpose.

E. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing. Do not deposit concrete in large quantities in one place to be worked along the forms with a vibrator.

F. Deposit concrete continuously and in level layers. Place in lifts not exceeding 24 inches. Avoid inclined layers and cold joints. Place concrete at lower portion of slope first on sloping surfaces.

G. Do not deposit partially hardened concrete in forms. Retempering of partially hardened concrete is not permitted. Remove partially hardened concrete from site at no additional compensation.

H. Do not allow concrete to fall freely in forms to cause segregation (separation of coarse aggregate from

mortar). Limit maximum free fall of concrete to 4 feet. Do not move concrete horizontally more than four feet from point of discharge. Space points of deposit not more than eight feet apart.

I. At least two hours shall elapse after depositing concrete in the columns or walls before depositing in beams or slabs supported thereon. Place beams monolithically as part of the floor or roof system, unless otherwise shown on contract drawings.

J. Consolidate concrete using mechanical vibrators operated within the mass of concrete and/or on the forms conforming to procedures set forth in ACI 309R and as specified herein.

K. Conduct vibration to produce concrete of uniform texture and appearance, free of honeycombing, streaking, cold joints or visible lift lines.

L. Conduct vibration in a systematic manner with regularly maintained vibrators. Furnish sufficient backup units at job site. Use vibrators having minimum frequency of 8,000 vibrations per minute and of sufficient amplitude to consolidate concrete.

M. Insert and withdraw vibrator vertically at a uniform spacing over the entire area of placement. Space distances between insertions such that spheres of influence of each insertion overlap.

N. Use additional vibration with pencil vibrators on vertical surfaces and on exposed concrete to bring full surface of mortar against the forms so as to eliminate air voids, bug holes and other surface defects. Employ the following additional procedures for vibrating concrete as necessary to maintain proper consolidation of concrete:

1. Reduce distance between internal vibration insertions and increase time for each insertion.

2. Insert vibrator as close to face of form as possible without contacting form or reinforcement.

3. Use spading as a supplement to vibration where particularly difficult conditions exist.

O. Pumping Concrete:

1. Conform to the recommendations of ACI 304.2R except as modified herein.

2. Base pump size on rate of concrete placement, length of delivery pipe or hose, aggregate size, mix proportions, vertical lift, and slump of concrete.

3. Use pipe with inside diameter of at least three times the maximum coarse aggregate size, but not less than 2 inches.

4. Do not use aluminum pipes for delivery of concrete to the forms.

3.06 CURING AND PROTECTION

A. General:

1. Protect concrete from premature drying, hot or cold temperatures, and mechanical injury, beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.

2. Comply with curing procedures set forth in ACI 301, ACI 308 and as specified herein.

3. Perform hot weather concreting in conformance with ACI 305R and as specified herein when the ambient atmospheric temperature is 80 degrees F or above.

4. Perform cold weather concreting in conformance with ACI 306R.

5. Concrete required to be moist cured shall remain moist for the entire duration of the cure. Repeated wetting and drying cycles of the curing process will not be allowed.

B. Curing Duration:

1. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared

from unformed concrete surfaces. Initial curing starts as soon as concrete achieves final set. Forms left tightly in place are considered as part of the curing system, provided that wooden forms are kept continuously moist. Keep continuously moist for not less than 72 hours.

2. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least 10 days.

3. Avoid rapid drying at the end of the final curing period.

C. Curing Requirements:

1. Unformed Surfaces: Cover and cure entire surface of newly placed concrete immediately after completing finishing operations and water film has evaporated from surface or as soon as marring of concrete will not occur. Protect finished slabs from direct rays of the sun to prevent checking, crazing and plastic shrinkage.

2. Formed Surfaces: Minimize moisture loss for formed surfaces exposed to heating by the sun by keeping forms wet until safely removed. Keep surface continuously wet by warm water spray or warm water saturated fabric immediately following form removal.

3. Below grade structures: Moist cure by the application of water to maintain the surface in a continually wet condition.

4. Other concrete: Moist cure by moisture-retaining cover curing, or by the use of curing compound.

D. Curing Methods:

1. Water Curing: Use water curing for unformed surfaces. Continuously water cure all exposed concrete for the entire curing period. Provide moisture curing by any of the following methods:

a. Keeping the surface of the concrete continuously wet by ponding or immersion.

b. Continuous water-fog spray or sprinkling.

c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4 inch lap over adjacent mats. Weight down the curing cover to maintain contact with the concrete surface.

2. Sealing Materials:

a. Use common sealing materials such as plastic film or waterproofing (kraft) paper.

b. Lap adjacent sheets a minimum of 12 inches. Seal edges with waterproof tape or adhesive. Use sheets of sufficient length to cover sides of concrete member.

c. Place sheet materials only on moist concrete surfaces. Wet concrete surface with fine water spray if the surface appears dry before placing sheet material.

d. The presence of moisture on concrete surfaces at all times during the prescribed curing period is proof of acceptable curing using sheet material.

3. Membrane Curing Compound:

a. Apply membrane-curing compound uniformly over concrete surface by means of roller or spray at a rate recommended by the curing compound manufacturer, but not less than 1 gallon per 150 sq. ft. of surface area. Agitate curing material in supply container immediately before transfer to distributor and thoroughly agitate it during application for uniform consistency and dispersion of pigment.

b. Do not use curing compounds on construction joints or on surfaces to receive dustproofer/sealer, concrete paint, concrete fills and toppings or other applications requiring positive bond.

c. Reapply membrane-curing compound to concrete surfaces that have been subjected to wetting within 3 hours after curing compound has been applied by method for initial application.

E. Protection from environmental conditions: Maintain the concrete temperature above 50 degrees F continuously throughout the curing period. Make arrangements before concrete placing for heating, covering, insulation or housing to maintain the specified temperature and moisture conditions continuously for the curing period.

1. When the atmospheric temperature is 80 degrees F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering.

2. Protect the concrete continuously for the entire curing period.

3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes.

4. Avoid temperature changes in concrete that exceed 5 degrees F in any one hour and 50 degrees F in any 24-hour period.

F. Protection from physical injury: Protect concrete from physical disturbances such as shock and vibration during curing period. Protect finished concrete surfaces from damage by construction equipment, materials, curing procedures and rain or running water. Do not load concrete in such a manner as to overstress concrete.

3.07 FIELD QUALITY CONTROL:

A. Hot Weather Requirements

1. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation in accordance with ACI 305R and the following.

2. When the weather is such that the temperature of the concrete as placed would exceed 90 degrees F, use ice or other means of cooling the concrete during mixing and transportation so that the temperature of the concrete as placed will not exceed 90 degrees F .

3. Take precautions when placing concrete during hot, dry weather to eliminate early setting of concrete. This includes protection of reinforcing from direct sunlight to prevent heating of reinforcing, placing concrete during cooler hours of the day, and the proper and timely application of specified curing methods.

4. There will be no additional reimbursement to the Contractor for costs incurred for placing concrete in hot weather.

B. Cold Weather Requirements

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306R and the following.

2. When the temperature of the surrounding atmosphere is 40 degrees F or is likely to fall below this temperature, use heated mixing water not to exceed 140 degrees F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.

3. When placed in the forms during cold weather, maintain concrete temperature at not less than 55

degrees F. Materials shall be free from ice and frozen lumps before entering the mixer.

4. Maintain the air and the forms in contact with the concrete at temperatures above 40 degrees F for the first five days after placing, and above 35 degrees F for the remainder of the curing period. Provide thermometers to indicate the ambient temperature and the temperature 2 inches inside the concrete surface.

5. There will be no additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

C. Backfill Against Walls

1. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.

D. Concrete Testing

1. Concrete quality testing shall be performed on the concrete by independent testing agency retained by the Owner.

2. The testing agency will use concrete samples provided by the Contractor to perform slump (per ASTM C143), air content (per ASTM C231), and temperature tests (per ASTM C1064) and for field control test specimens.

3. The testing agency will submit test reports of concrete field measurements specified above to the Contractor and to the Engineer.

4. Provide and maintain facilities for safe storage and proper curing of concrete test specimens on the project site, as required by ASTM C31.

5. Concrete Quality Test Specimen:

a. Perform sampling and curing of test specimen in accordance with ASTM C31.

b. Testing agency personnel will record truck and load number from the delivery batch ticket, the concrete placement location of each specimen, the date, concrete strength, slump, air content and temperature.

c. The testing agency will cast a minimum of one set of 8 test specimens, each 4 inch diameter by 8 inch long cylinders, for each 50 cubic yard of each mix design of concrete but not less than once a day.

d. Test cylinders in accordance with ASTM C39. Test two cylinder at 7 days for information; test three cylinders at 28 days for acceptance; and hold three reserve cylinders for verification. Strength acceptance will be based on the average of the strengths of the three cylinders tested at 28 days. If one cylinder of a 28-day test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use a reserve cylinder for the test result.

6. The Contractor may take field control test specimens for small quantities of concrete.

7. Concrete acceptance shall be based on the requirements of ACI 318 and ACI 350.

8. Field cured cylinders conforming to ASTM C31 will be required to determine field compressive strength of concrete. Laboratory cured cylinders for concrete quality testing shall not be used for determining field compressive strength.

9. Concrete Coring:

a. When the concrete quality test specimen compression tests fail to be in compliance with the Contract Documents or when the Engineer detects deficiencies in the concrete, the Contractor will take concrete cores at least 2 inches in diameter from the structure

in conformance with ASTM C 42 at locations determined by the Engineer.

b. Obtain at least three representative cores from each member or area of concrete that is considered potentially deficient.

c. Obtain additional cores to replace cores that show evidence of having been damaged subsequent to or during removal from the structure.

d. The testing agency shall compression test the cores taken from the structure in conformance with ASTM C39 and submit test strength test results of cores specified above to the Contractor and to the Engineer.

e. All costs associated with coring and testing of cores will be borne by the Contractor at no additional cost to the Owner.

E. Crystalline Waterproofing Admixture Testing

1. Crystalline waterproofing system shall be tested in accordance with the following standards and conditions, and the testing results shall meet or exceed the performance requirements as specified herein. Independent tests verifying these results shall be submitted prior to approval.

2. Independent Laboratory: Testing shall be performed by an independent laboratory meeting the requirements of the recognized specifying body of the country in which the testing is performed. Testing laboratory shall obtain all concrete samples and waterproofing product samples.

3. Crystalline Formation: Crystallizing capability of waterproofing system shall be evidenced by independent SEM (Scanning Electron Microscope) photographs showing crystalline formations within the concrete matrix at a magnification no greater than 2000 times.

d. Water Permeability: Independent testing shall be performed according to U.S. Army

Corps of Engineers CRD-C48 - Mod " Permeability of Concrete" and the European Standard EN-12390-8. Under CRD-C48 treated concrete samples shall be pressure tested to 150 psi (350 foot head of water) or 1.05 MPa (106 m head of water). The treated samples shall exhibit no measurable leakage against control samples which shall exhibit full saturation and measurable leakage. EN-12390-8 testing shall show at least a 75% reduction in depth of water penetration for Admixture treated concrete as compared to the control concrete.

e. Petroleum Product Permeability: Independent testing shall be performed according the European EN – 12390-8. Treated samples shall show a more than an 80% reduction in depth of penetration for both diesel and unleaded gasoline as compared to a control concrete.

f. Acid Resistance: Independent testing shall be performed to determine "Sulfuric Acid Resistance of Concrete Specimens". Treated concrete samples (dosage rates of 3%) shall be and tested against untreated control samples after 40 days of curing. All samples shall be immersed in 7% sulfuric acid and weighed daily until a control sample reaches a weight loss of 50%. At this time on final weighing the percentage weight loss of the 3% treated samples shall be 40% or lower.

g. Sulfate Resistance: Independent testing shall be performed against Australian Standard AS 1141.24, US Bureau of Reclamation - Procedure for Length Change of Hardened Concrete Exposed to Alkali Sulfates or another recognized international standard for weight loss and length change. Samples exposed to Ammonium Sulfate solution for 25 weeks shall show a weight loss of at least 25% less than the control concrete and a length change of - 0.01% or less than the control.

h. Freeze Thaw Resistance Testing: Independent testing against JUS U.M1.016, ASTM – C-666 or other recognized international standard for durability of air entrained treated samples shall show at least a 60% improvement for treated concrete versus that of a control concrete when subjected to 250 freeze thaw cycles.

i. Salt Scaling Resistance: Independent testing against JUS U.M1.055, ASTM C667 or other recognized international standard for salt scaling resistance shall show no visible scaling for treated sample versus a control sample which shall show showing scaling to a depth of at least 0.5 mm when samples are subjected to 25 freeze thaw cycles.

j. Compressive Strength: Independent testing shall be performed according to ASTM C39 "Compressive Strength of Cylindrical Concrete Specimens". Concrete samples containing the crystalline waterproofing additive shall be tested against untreated control sample. At 28 days, the treated samples shall exhibit an increase in compressive strength over the control sample.

k. Concrete Shrinkage: Independent testing against Australian Standard AS 1012.13, ASTM C-157 or other recognized international standard for concrete shrinkage shall show neutral to reduced shrinkage for admixture modified concrete as compared to a control sample.

l. Fire Testing: Independent testing against a recognized international standard for fire testing shall show negligible difference between admixture treated concrete versus control concrete when slabs are exposed to a hydrocarbon fire.

END OF SECTION

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SECTION 03350 CONCRETE FINISHES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and finish cast-in-place concrete surfaces as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Concrete Formwork is included in Section 03100.

B. Cast-In-Place Concrete is included in Section 03300.

C. Grout is included in Section 03600.

D. Moisture Protection is included in Division 7.

E. Painting, toppings and special surfaces are included in Division 9.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Concrete sealer. Confirmation that the sealer is compatible with additionally applied coatings shall also be submitted.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Standard Specification for Concrete Aggregates.

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

1.05 QUALITY ASSURANCE

A. Finishes

1. For concrete which will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finishes are required and provide the proper finishes to receive these products.

2. Changes in finishes made to accommodate products different from those specified shall be performed at no additional cost to the Owner. Submit the proposed new finishes and their construction methods to the Engineer for approval.

B. Services of Manufacturer's Representative

1. Make available at no extra cost to the Owner, upon 72 hours notification, the services of a qualified field representative of the manufacturer of curing compound, sealer or hardener to instruct the user on the proper application of the product under prevailing job conditions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Chemical hardener shall be Lapidolith by Sonneborn; Hornolith by A.C. Horn; Penalith by W.R. Meadows or equal fluosilicate base material.

B. Concrete sealer shall be "Kure-N-Seal", by Sonneborn, Minneapolis, MN or equal.

PART 3 EXECUTION

3.01 FORMED SURFACES

A. Forms shall not be removed before the requirements of Section 03300, have been satisfied.

B. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications or corners when removing the forms or performing any other work adjacent thereto.

C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

D. Rough-Form Finish

1. Immediately after stripping forms and before concrete has changed color, carefully remove all fins and projections.

2. Promptly fill holes left by tie cones and defects as specified in Section 03300.

E. Rubbed Finish

1. Immediately upon stripping forms and before concrete has changed color, carefully remove all fins. While the wall is still damp apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within all pits, air holes or blemishes in the parent concrete. Avoid coating large areas with the slurry at one time.

2. Before the slurry has dried or changed color, apply a dry (almost crumbly) grout proportioned by volume and consisting of 1 part cement to 1-1/2 parts of clean masonry sand having a fineness modulus of approximately 2.3 and complying with the gradation requirements of ASTM C33 for such a material. Grout shall be uniformly applied by means of damp pads of coarse burlap approximately 6-in square used as a float. Scrub grout into the pits and air holes to provide a dense mortar in all imperfections.

3. Allow the mortar to partially harden for 1 or 2 hours depending upon the weather. If the air is hot and dry, keep the wall damp during this period using a fine, fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel. (Note: Grout allowed to remain on the wall too long will harden and will be difficult to remove.)

4. Allow the surface to dry thoroughly and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cutoff with the trowel so it can

be wiped off clean with the burlap.

5. On the day following the repair of pits, air holes and blemishes, the walls shall again be wiped off clean with dry, used pieces of burlap containing old hardened mortar which will act as a mild abrasive. After this treatment, there shall be no built-up film remaining on the parent surface. If, however, such a film is present, a fine abrasive stone shall be used to remove all such material without breaking through the surface film of the original concrete. Such scrubbing shall be light and sufficient only to remove excess material without changing the texture of the concrete.

6. A thorough wash-down with stiff bristle brushes shall follow the final bagging or stoning operation. No extraneous materials shall remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after the application of the repair grout.

F. Abrasive Blast Finish

1. Coordinate with Rubbed Finish application. Do not begin until Rubbed Finish operation is complete or before concrete has reached minimum 7-day strength. The Rubbed Finish application may be deleted by the Engineer if the unfinished concrete surface is of superior quality. Apply the abrasive blast finish only where indicated on Drawings.

2. Prepare a sample area of minimum 4-ft high by 16-ft wide Blast Finish as directed by Engineer on a portion of new wall construction which will not be exposed in the final work. Sample area shall contain a variety of finishes obtained with different nozzles, nozzle pressures, grit materials and blasting techniques for selection by Engineer. Final accepted sample shall remain exposed until completion of all Blast Finish operations.

3. Blast finish operation shall meet all regulatory agency requirements. Blast Finish contractor shall be responsible for obtaining all required permits and/or licenses.

4. Perform abrasive blast finishing in as continuous an operation as possible, utilizing the same work crew

to maintain continuity of finish on each surface or area of work. Maintain patterns or variances in depths of blast as present on the accepted sample.

5. Use an abrasive grit of proper type and gradation as well as equipment and technique to expose aggregate and surrounding matrix surfaces as follows:

   a. Medium: Generally expose coarse aggregate - 1/4-in to 3/8-in reveal.

6. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure and blasting techniques required to match Architect's samples.

7. Upon completion of the Blast Finish operation, thoroughly flush finished surfaces with clean clear water to remove residual dust and grit. Allow to air dry until curing of concrete is complete.

8. After the concrete has cured for a minimum of 28 days, apply a clear acrylic sealer as directed by manufacturer.

3.02 FLOORS AND SLABS

A. Floated Finish

1. Machine Floating

   a. Screed floors and slabs with straightedges to the established grades shown on the Drawings. Immediately after final screeding, a dry cement/sand shake in the proportion of two sacks of portland cement to 350 lbs of coarse natural concrete sand shall be sprinkled evenly over the surface at the rate of approximately 500 lbs /1,000 sq ft of floor. Do not sprinkle neat, dry cement on the surface.

   b. The application of the cement/sand shake may be eliminated at the discretion of the Engineer if the base slab concrete exhibits adequate fattiness and homogeneity and the need is not indicated. When the concrete has hardened sufficiently to support the weight of a power float without its digging into or disrupting the level surface, thoroughly float the shake

into the surface with a heavy revolving disc type power compacting machine capable of providing a 200 lb compaction force distributed over a 24-in diameter disc.

c. Start floating along walls and around columns and then move systematically across the surface leaving a matte finish.

d. The compacting machine shall be the "Kelly Power Float with Compaction Control" as manufactured by Kelley Industries of SSP Construction Equipment Inc., Pomona, CA or equal. Troweling machines equipped with float (shoe) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades will not be permitted. The use of any floating or troweling machine which has a water attachment for wetting the concrete surface during finishing will not be permitted.

2. Hand Floating

a. In lieu of power floating, small areas may be compacted by hand floating. The dry cement/sand shake previously specified shall be used unless specifically eliminated by the Engineer. Screed the floors and slabs with straightedges to the established grades shown on the Drawings. While the concrete is still green, but sufficiently hardened to support a finisher and kneeboards with no more than 1/4-in indentation, wood float to a true, even plane with no coarse aggregate visible. Use sufficient pressure on the wood floats to bring moisture to the surface.

3. Finishing Tolerances

a. Level floors and slabs to a tolerance of plus or minus 1/8-in when checked with a 10-ft straightedge placed anywhere on the slab in any direction. Where drains occur, pitch floors to drains such that there are no low spots left undrained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other correction as directed by the Engineer.

B. Broom Finish

1. Screed slabs with straightedges to the established grades indicated on the Drawings. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a stiff bristle broom lightly across the surface in the direction of drainage, or, in the case of walks and stairs, perpendicular to the direction of traffic to provide a non-slip surface.

C. Steel Trowel Finish

1. Finish concrete as specified in Paragraph 3.04. Then, hand steel trowel to a perfectly smooth hard even finish free from high or low spots or other defects.

D. Concrete Sealer

1. Prepare and seal surfaces indicated on the room finish schedule to receive a sealer as follows:

a. Finish concrete as specified in the preceding paragraphs and in accordance with the Schedule in Paragraph 3.05 below.

b. Newly Placed Concrete: Surface must be sound and properly finished. Surface is application-ready when it is damp but not wet and can no longer be marred by walking workmen.

c. Newly-Cured Bare Concrete: Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that surface is no more than damp, and not wet.

d. Aged Concrete: Restore surface soundness by patching, grouting, filling cracks and holes, etc. Surface must also be free of any dust, dirt and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required, following the procedure indicated under cured concrete.

e. Methods: Apply sealer so as to form a continuous, uniform film by spray, soft-bristle

pushbroom, long-nap roller or lambswool applicator. Ordinary garden-type sprayers, using neoprene hose, are recommended for best results.

f. Applications: For curing only, apply first coat evenly and uniformly as soon as possible after final finishing at the rate of 200 to 400 sq ft per gallon. Apply second coat when all trades are completed and structure is ready for occupancy at the rate of 400 to 600 sq ft per gallon.

g. To meet guarantee and to seal and dustproof, two coats are required. For sealing new concrete, both coats shall be applied full-strength. On aged concrete, when renovating, dustproofing and sealing, the first coat should be thinned 10 to 15 percent with reducer per manufacturer's directions.

3.03 CONCRETE RECEIVING CHEMICAL HARDENER

A. After 28 days, minimum, concrete cure, apply chemical hardener in three applications to a minimum total coverage of the undiluted chemical of 100 sq ft per gallon and in accordance with manufacturer's recommendations as reviewed.

3.04 APPROVAL OF FINISHES

A. All concrete surfaces, when finished, will be inspected by the Engineer.

B. Surfaces which, in the opinion of the Engineer, are unsatisfactory shall be refinished or reworked.

C. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03300 unless otherwise directed by the Engineer.

3.05 SCHEDULE OF FINISHES

A. Concrete shall be finished as specified either to remain as natural concrete to receive an additional applied finish or material under another section.

B. Concrete for the following conditions shall be finished as noted on the Drawings and as further specified herein:

1. Concrete to Receive Dampproofing: Rough-form finish. See Paragraph 3.01D above.

2. Concrete Not Exposed to View and Not Scheduled to Receive an Additional Applied Finish or Material: Rough-form finish. See Paragraph 3.01D above.

3. Exterior Vertical Concrete Above Grade Exposed to View: Rubbed finish. See Paragraph 3.01E above.

4. Interior Vertical Concrete Exposed to View Except in Water Containment Areas: Rubbed finish. See Paragraph 3.01E above.

5. Vertical Concrete in Water Containment Areas. Rubbed finish on exposed surfaces and extending to two feet below normal operating water level: Rough-form finish on remainder of submerged areas. See Paragraphs 3.01E and 3.01D above.

6. Interior and Exterior Underside of Concrete Exposed to View: Rubbed finish. See Paragraph 3.01E above.

7. Exterior surfaces exposed to view and indicated to have an abrasive blast finish. See Paragraph 3.01F above.

8. Interior or Exterior Horizontal Concrete not Requiring Floor Hardener or Sealer: Floated finish. See Paragraph 3.02A above.

9. Concrete for Exterior Walks, Interior and Exterior Stairs: Broomed finish perpendicular to direction of traffic. See Paragraph 3.02B above.

10. Concrete Slabs On Which Process Liquids Flow or In Contact with Sludge: Steel trowel finish. See Paragraph 3.02C above.

11. Concrete to Receive Hardener: See Paragraph 3.02D above.

12. Concrete to Receive Floor Sealer: See Paragraph 3.02E above.

13. Concrete tank bottoms to be covered with grout: See Section 03600.

END OF SECTION

SECTION 03420 PRECAST, PRESTRESSED CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install the precast, prestressed roof slabs and accessories as shown on the Drawings and as specified herein.

B. The work of this Section includes but is not necessarily limited to:

1. Precast, prestressed roof slabs.

2. All inserts, weld plates, strand anchors, bolts, anchor bolt, slip angles, bearing plates, pipe sleeves and reinforcing bars which are cast into the prestressed concrete members as indicated on Drawings.

3. Furnish and place all anchors, weld plates, inserts, reinforcing bars and other accessories in cast-in-place concrete as required for installation of the work under this Section.

4. Erection including all necessary shimming and welding and removal of lifting hooks.

5. Grouting between all roof slabs.

1.02 RELATED WORK

A. Concrete reinforcing is included in Section 03200.

B. Cast-in-place concrete is included in Section 03300.

C. Roofing is included in Division 7.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, complete shop drawings and calculations for all members. The shop drawings and calculations shall be prepared and stamped by a State of Florida registered professional engineer. Fabrication of members shall not proceed until shop drawings are approved by the Engineer. Submit

installation and handling literature and requirements for drilling and cutting openings in the field.

B. All inserts, hangers, openings, pipe sleeves, blockouts, etc, required by various trades or as indicated, located and detailed on the final approved drawings will be cast as such and any omission or changes in location or details or various trades shall be done at the expense of the Contractor.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A36 – Standard Specification for Carbon Structural Steel.

2. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

3. ASTM A416 – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

4. ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

5. ASTM C33 – Standard Specification for Concrete Aggregates.

6. ASTM C150 – Standard Specification for Portland Cement.

B. American Concrete Institute (ACI)

1. ACI 318 – Building Code Requirements for Structural Concrete.

C. American Association of State Highway and Transportation Officials (AASTHO).

1. AASTHO HB-13 – Standard Specifications for Highway Bridges.

D. American Welding Society (AWS)

1. AWS D1.1 – Structural Welding Code-Steel.

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

1.05 QUALITY ASSURANCE

A. All prestressed structural concrete elements shall be manufactured at an existing plant and satisfactory evidence shall be given the Engineer to substantiate that the fabricator is capable of and has the organization and plant for, performing the work and of maintaining the schedule required. The manufacturer of these elements must also submit a record of his\her work for the 5 years to substantiate that he\she has been manufacturing prestressed members.

1.06 DESIGN CRITERIA

A. The design and construction of prestressed members shall conform to the ACI 318.

B. Furnish two copies of design calculations to the Engineer for approval. Calculations shall indicate all assumptions and cover all phases of design. All elements shall be designed to support their own weight, plus the superimposed loads shown on the Drawings. Calculations shall also include the amount of camber produced, together with the dead and live load deflections. Fabrication shall not be started until written approval of the design calculations has been received.

C. The thickness of the elements has been established and is indicated on the Drawings. All steel, mild or strand, shall have a minimum of 2-in of concrete cover. All concrete elements shall have shear keyways on the sides of the members which will be placed adjacent to other elements.

D. The precast prestressed members shall be designed for the following superimposed loads:

1. Concrete topping at a density of 150 pcf to the thickness indicated on the Drawings.

2. Dead load and live load as indicated on the Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

A. All cement, sand and gravel used in this Section of work including patching of members shall be obtained from one single source to ensure as uniform a texture as possible.

B. Cement shall be portland cement conforming to ASTM C150, Type III.

C. Aggregates shall consist of sand and gravel conforming to ASTM C33. Size of coarse aggregate shall meet spacing requirements of prestressing steel and/or reinforcing steel. The maximum size of aggregate shall be no larger than 1-in.

D. Reinforcing steel shall be intermediate grade, new billet steel and deformed in accordance with ASTM A615, Grade 60. Cast-in anchor plates, weld plates and angle headers with clips shall conform with ASTM A36. Prestressing strand shall conform to the ASTM A416, Grade 250K.

E. Non-shrink grout shall be Masterflow 713 by Master Builders Company; Euco N-S by Euclid; Five Star Grout by US Grout Corp or equal.

PART 3 EXECUTION

3.01 CONCRETE STRENGTH

A. All prestressed concrete members shall have a minimum 28-day compressive strength of 5,000 psi using Type III cement.

B. Unless otherwise specified by the Engineer, concrete shall have a minimum compressive strength of 3,500 psi at transfer of prestressing force, as determined by test.

3.02 FABRICATION

A. All exposed surfaces shall be steel formed and tops of roof members shall have a wood float finish. All members shall be steam cured at 130 to 160 degrees F. All corners shall have minimum 1/2-in chamfer.

B. Sizes of all members shall conform to those shown on the Drawings with the following dimensional tolerances:

1. Cross sectional tolerance for all members shall be plus 1/4-in minus zero-in.

2. Length of members shall be plus or minus 3/8-in.

3. Ends of members out of square shall be plus or minus 1/4-in plus.

   a. Deviation from straight line shall be not greater than 1/8-in per 10-ft of length measured by a light line stretched from end to end of unit.

   b. Difference in camber between two adjacent slabs in place after welding shall not be more then 1/2-in.

3.03 HANDLING AND ERECTION

A. All prestressed units shall be carefully loaded and hauled on trucks and erected to prevent damage. They shall be erected by experienced workmen, true to line and grade in proper sequence, welded and/or anchored as indicated on Drawings. All members superficially damaged during shipment or erection shall be rejected until they are repaired by experienced workmen. Units badly damaged shall be rejected until they are replaced. The Engineer shall be the sole judge of this damage. No holes shall be cut or drilled in the field without written approval of the Engineer.

B. Connections between roof slabs shall be as required on the Drawings. Seal all longitudinal joints prior to placing grout. All welding shall be in accordance with AWS D1.1. Bolts shall be low carbon steel conforming to ASTM A307.

3.04 TESTS

A. At least three standard test specimens for each production line shall be prepared in accordance with Section 4.7 of ACI 318, at the time the concrete is deposited to determine the concrete strength at different ages.

B. All testing of products or concrete strength tests to be done by the outside testing laboratory selected by the Engineer will be done at the expense of the Owner; except test of specimens for strength at transfer of

prestressing force (see Paragraph 3.01 above) shall be made and observed by the laboratory if so desired.

END OF SECTION

SECTION 03461 PRECAST CIRCULAR CONCRETE MANHOLES

PART 1 - GENERAL

A. Description

This section includes design, materials, testing, and installation of precast circular concrete manholes.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's catalog data on precast concrete manholes, frames, and covers. Show dimensions and materials of construction by ASTM reference and grade. Show lettering on manhole covers.

PART 2 - MATERIALS

A. Precast Circular Concrete Manholes

1. Precast circular concrete manholes shall comply with ASTM C478, except that the wall thickness shall be 5 inches minimum. Precast circular manholes are to be compliant with the Orange County Utilities Standards and Construction Specifications Manual. Minimum manhole diameter shall be 48 inches. Design manholes for the depths shown in the drawings, assuming a soil density of 110 pounds per cubic foot.

2. Minimum allowable steel shall be hoops of No. 4 wire cast into each unit.

3. Precast top sections shall be eccentric cone, except in specific instances where approved by the Resident Project Representative (RPR) for utility conflict resolution.

4. Design joints using a butyl rubber sealant per ASTM C990.

5. Precast circular concrete manholes shall be batched with concrete dyed crystalline waterproofing admixture with corrosion protection. Reference the Orange County

Utilities Standards and Construction Specifications Manual's Approved Product List included in Attachment A.

B. Manhole Frames and Covers

1. Manhole frames and covers shall be made of cast iron conforming to ASTM A48, Class 30. Castings shall be smooth, clean, and free from blisters, blowholes, and shrinkage. Frames and covers shall be designed for H20-44 traffic loads. The cover shall seat firmly into the frame without rocking.

2. Grind or otherwise finish each cover so that it will fit in its frame without rocking. Frames and covers shall be matchmarked in sets before shipping to the site.

3. Sewer manhole covers shall have the word "SANITARY" and the letters as indicated in the drawings cast thereon. Do not apply any other lettering.

4. Before leaving the foundry, clean castings and subject them to a hammer inspection.

C. Pipe Connections for Sewer Manholes

Provide resilient watertight connectors between the manhole and piping in accordance with ASTM C923 and OCU standards. Connections shall consist of a chemically resistant neoprene EPDM flexible boot, locking ring, and pipe clamp(s). The locking ring shall be stainless steel and shall lock the boot into the preformed opening in the manhole. The pipe clamp shall be stainless steel. Alternatively, cast the flexible boot in the manhole and eliminate the locking ring. Pipe connections shall be Kor-N-Seal (Dukor Corporation), Z-Lok-XP (A-Lok Products, Inc.), or equal.

D. Concrete

1. Cement for manholes and precast bases shall conform to ASTM C150 and C595, Type IP (MS) or, in lieu of Type IP (MS), provide a mixture of 85% Type II portland cement and 15% pozzolan fly ash.

2. Concrete used in pouring the manhole base shall be Class A per Section 03300.

3. Concrete shall be batched with concrete dyed crystalline waterproofing admixture with corrosion protection.

Reference the Orange County Utilities Standards and Construction Specifications Manual's Approved Product List included in Attachment A.

E. Sealing Compound and Mortar

Butyl rubber sealing compound shall comply with ASTM C990. Mortar shall comply with ASTM C387, Type S, or use grout complying with Section 03300.

F. Crushed Rock for Manhole Base

Crushed rock shall comply with Section 02223. Crushed rock shall be the same material as the pipe bedding. If rock is not used for the pipe bedding, use 3/4-inch crushed rock for the manhole base.

PART 3 - EXECUTION

A. Manhole Base

1. Excavate for the manhole and install a crushed rock base, 9 inches thick, per Section 02223. Crushed rock base material shall extend 9 inches beyond the outside edge of the concrete manhole base. Compact to 90% relative density.

2. Form and pour concrete bases as one monolithic pour. For sewer manholes, form the portion above the invert elevation of the sewer pipe to provide a smooth channel section. Channels shall vary uniformly in size and shape from inlet to outlet.

B. Sealing and Grouting of Manhole Sections

Clean ends of precast sections of foreign materials. Place two wraps of butyl rubber sealing compound around the groove of the lower section. Set next section in place. Fill remaining interior and exterior joint cavity completely with mortar of the proper consistency. Trowel interior and exterior surfaces smooth on tongue-and-groove joints. Wipe off any excess grout from the interior and exterior of the joints. Prevent mortar from drying out by applying curing compound or comparable method. Chip out and replace cracked or defective mortar. Completed manhole shall be rigid and watertight.

C. Installing Manholes

1. Set each precast concrete manhole unit plumb on a bed of sealant or mortar to make a watertight joint at least 1/2 inch thick with the concrete base or with the preceding unit. Point the inside joint and wipe off the excess sealant or mortar. Secure the manhole frame to the grade ring with grout and cement mortar fillet. Backfill, compact, and replace pavement.

2. Assemble units so that the cover conforms to the elevation determined by the manhole location as follows:

   a. In Paved Areas: Top of cover shall be flush with the paving surface.

   b. In Shoulder Areas: Top of cover shall be flush with existing surface where it is in traveled way of shoulder and 0.1 foot above existing surface where outside limits of traveled way but not in the existing roadside ditch.

   c. In Roadside Ditch or Unpaved Open Areas: Top of cover shall be 18 inches above the ground surface.

D. Leakage Testing of Sewer Manholes

Test manholes for leakage in accordance with specification section 02530.

E. Backfill Around Manholes

Backfill and compact around the manholes using native material, per Section 02223 and the pipe specification.

F. Coating Manhole Exteriors (Other Than Electrical Utility Manholes)

Coat interior and exterior of manholes per the Orange County Utilities Standards and Construction Specifications Manual's Approved Product List included in Attachment A.

END OF SECTION

SECTION 03600 GROUT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Formwork is included in Section 03100.

B. Concrete Reinforcement is included in Section 03200.

C. Concrete Joints and Joint Accessories are included in Section 03250.

D. Cast-in-Place Concrete is included in Section 03300.

E. Grout for reinforced masonry is included in Division 3.

F. Miscellaneous Metals are included in Section 05500.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Commercially manufactured nonshrink cementitous grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.

2. Commercially manufactured nonshrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.

3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine

aggregate, product data on any proposed admixtures and the proposed mix of the grout.

4. Concrete grout. The submittal shall include data as required for concrete as delineated in Section 03300 and for fiber reinforcement as delineated in Section 03200. This includes the mix design, constituent quantities per cubic yard and the water/cement ratio.

B. Laboratory Test Reports

1. Submit laboratory test data as required under Section 03300 for concrete to be used as concrete grout.

C. Certifications

1. Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with potable water after 30 days curing.

D. Qualifications

1. Grout manufacturers shall submit documentation that they have at least 10 years experience in the production and use of the proposed grouts which they will supply.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes

2. ASTM C579 - Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes

3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

4. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

B. U.S. Army Corps of Engineers Standard (CRD)

1. CRD C-621 - Corps of Engineers Specification for Nonshrink Grout

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

1.05 QUALITY ASSURANCE

A. Qualifications

1. Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.

B. Pre-installation Conference

1. Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.

C. Services of Manufacturer's Representative

1. A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend the pre-installation conference and shall be present for the initial installation of each type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems.

D. Field Testing

1. All field testing and inspection services required shall be provided by the Owner. The Contractor shall assist in the sampling of materials and shall provide any ladders, platforms, etc, for access to the work. The methods of testing shall comply in detail with the applicable ASTM Standards.

2. The field testing of Concrete Grout shall be as specified for concrete in Section 03300.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.

B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.

C. Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the Owner.

D. Nonshrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.

E. Nonshrink epoxy grouts shall be delivered as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.07 DEFINITIONS

A. Nonshrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.

B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

A. Nonshrink Cementitious Grout

1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD C-621. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.

    a. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Set Grout by Master Builders, Inc.; Gilco Construction Grout by Gifford Hill & Co.; Euco NS by The Euclid Chemical Co.; NBEC Grout by U. S. Grout Corp. or equal.

    b. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders, Inc.; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Supreme Grout by Gifford Hill & Co.; Five Star Grout by U. S. Grout Corp. or equal.

B. Nonshrink Epoxy Grout

1. Nonshrink epoxy-based grout shall be a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30×10^{-6} when tested in conformity with ASTM C531. The grout shall be Ceilcote 648 CP by Master Builders Inc.; Five Star Epoxy Grout by U.S. Grout Corp.; Sikadur 42 Grout-Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co. or equal.

C. Cement Grout

1. Cement grouts shall be a mixture of one part portland cement conforming to ASTM C150, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout

1. Concrete grout shall conform to the requirements of Section 03300 except as specified herein. It shall be proportioned with cement, coarse and fine aggregates, water, water reducer and air entraining agent to produce a mix having an average strength of 2900 psi at 28 days, or 2500 psi nominal strength. Coarse aggregate size shall be 1/2-in maximum. Slump should not exceed 5-in and should be as low as practical yet still retain sufficient workability.

2. Synthetic reinforcing fibers as specified in Section 03200 shall be added to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

E. Water

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

A. Grout shall be placed over cured concrete which has attained its full design strength unless otherwise approved by the Engineer.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may effect the bond or performance of the grout.

C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.

D. Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of baseplates prior to the installation of the grout.

E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24 hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the Engineer for each specific location of grout installation.

F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.

G. Construct grout forms or other leakproof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.

1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.

H. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.

I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.02 INSTALLATION - GENERAL

A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.

B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.

C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours thereafter or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.

D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.

E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

F. Reflect all existing underlying expansion, control and construction joints through the grout.

3.03 INSTALLATION - CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.

B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

C. Placements greater than 3-in in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.

D. Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.

F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.

G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION - NONSHRINK EPOXY GROUTS

A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.

B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.

C. Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

F. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.05 INSTALLATION - CONCRETE GROUT

A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of concrete grout.

B. Remove the debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.

C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use or soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste. (A bonding grout composed of 1 part portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)

D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.

E. Provide grout control joints as indicated on the Drawings.

F. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.06 SCHEDULE

A. The following list indicates where the particular types of grout are to be used:

1. General purpose nonshrink cementitious grout: Use at all locations where non shrink grout is called for on the plans except for base plates greater in area than 3-ft wide by 3-ft long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.

2. Flowable nonshrink cementitious grout: Use under all base plates greater in area than 3-ft by 3-ft. Use at all locations indicated to receive flowable nonshrink grout by the Drawings. The Contractor, at his/her option and convenience, may also substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.

3. Nonshrink epoxy grout: Use for the setting of anchor rods, anchor bolts and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.

4. Cement grout: Cement grout may be used for grouting of incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.

5. Concrete grout: Use for overlaying the base concrete under scraper mechanisms of clarifiers to allow more control in placing the surface grade.

END OF SECTION

SECTION 03740 MODIFICATIONS AND REPAIR TO CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide concrete repair as indicated and in compliance with Contract Documents.

B. Complete repair work in accordance with this specification and the product manufacturer's instructions regarding surface preparation and application.

C. The areas of concrete repair shall be determined by the Contractor and the Engineer and shall include any location where concrete deterioration has reached a depth of 1/2-inch or deeper and at any air voids, bugholes or poorly consolidated concrete areas where the specified filler/surfacer materials cannot be used for filling or surfacing of the concrete.

D. If repair work is required for an area indicated to receive protective lining or coating, provide such repair in accordance with the requirements of this specification and the related product manufacturer's written instructions.

E. The repair work specified herein is intended to cover the requirements for repair of concrete only, to a maximum depth of approximately 1-1/2-inch. If after blasting and cleaning, an area is discovered that requires a repair greater than 1-1/2-inch deep, or an area is discovered that requires repair or replacement of reinforcing steel notify the Engineer so that details may be provided to the Contractor to complete the repair.

1.02 REFERENCES

A. American Concrete Institute (ACI):

1. 503.4: Standard Specification for Repairing Concrete with Epoxy Mortars

B. American Society for Testing and Materials International (ASTM):

1. C33: Standard Specifications for Concrete Aggregates

2. C150: Standard Specification for Portland Cement

3. C321: Standard Test Method for Bond Strength of Chemical-Resistant Mortars

4. C882: Test Method for Bond Strength of Epoxy Resin Systems

5. D570: Test Method for Water Absorption of Plastics

6. D638: Test Method for Tensile Properties of Plastics

7. D695: Test Method for Compressive Properties of Rigid Plastics

8. D790: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

9. D4262: L.R. Standard Test Method for pH of Chemically Cleaned or Acid Etched Concrete Surfaces

10. E337: L.R. Standard Practice Test Method for Measuring Humidity with a Psychrometer.

C. National Association of Corrosion Engineers (NACE):

1. 6D-173: "A Manual for Painter Safety"

2. 6F-163: "Surface Preparation of Steel or Concrete Tank Interiors"

3. TPC2: "Coatings and Linings for Immersion Service"

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01300.

1. Procedures proposed for the accomplishment of repair work. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations to be coordinated with other works in progress.

2. Manufacturer's recommendations and product data sheets for all repair materials including performance criteria, surface preparation, ambient condition requirements and applications, curing requirements, volatile organic compound (VOC) data, and safety requirements.

3. Material Safety Data Sheets (MSDS) for any materials brought on-site including all repair system materials, solvents and abrasive blast media.

4. Qualifications of foreman and epoxy gun operators and demonstration of meeting the minimum requirements specified.

5. Design Mixes: Provide concrete and cement mortar in conformance with Section 03300 and as specified herein.

1.04 QUALITY ASSURANCE

A. Furnish the names of all subcontractors proposed for use for this work including necessary evidence and/or experience records to ascertain their qualifications in the application of epoxy, polyurethane, polymer-modified and cement-based compounds.

B. Include in accepted applicator qualifications:

1. A minimum of five years experience in applying epoxy polyurethane and polymer-modified and cement-based compounds similar to those specified in this Section.

2. A letter from the manufacturer of the specified materials, on the manufacturer's letterhead, signed by an officer of the company, stating that the subcontractor/applicator has been trained in the proper techniques for the preparation of the surface, and proper methods for mixing, placing, curing, and caring of the manufacturer's products. This letter shall further state that the subcontractor/applicator is on the manufacturer's approved list of contractors.

C. Adhere strictly to the manufacturer’s recommendations regarding temperature at time of application for all work. Do not use epoxy materials when either the temperature of the concrete to be repaired or the ambient temperature is below 50 degrees F . 24 hours before, during, or for a period of 48 hours after the completion of the repair. Temporary heat may be used to meet the specified requirements.

D. Use new repair materials and use within the shelf life limitations set forth by the manufacturer.

E. The Contractor is ultimately responsible for the concrete repair work. Inspections by the Engineer or others do not limit the Contractor’s responsibility.

F. Make all parts of the work accessible for inspections by the Engineer. Correct any conditions not in conformance with the specifications at no additional cost to the Owner.

G. Submit any changes in the specified repair work methods to the Engineer for review.

H. Provide technical field support or training services required by the accepted material manufacturers at no additional cost to the Owner.

I. Provide materials from a single manufacturer for all components of a single repair.

1.05 SERVICES OF MANUFACTURERS REPRESENTATIVES

A. Provide the services of a qualified manufacturer's technical representative to instruct the Contractor's personnel in the mixing, proper use and application of the epoxy, polyurethane polymer-modified and cement-based compounds.

B. Provide written certification from the manufacturers' representative that materials have been mixed and applied properly and surfaces to receive these products have been prepared properly, all in conformance with manufacturer's requirements.

C. Provide on-site time required for the manufacturer's representative to achieve a successful installation at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide shelter to store materials in area or areas designated by the Owner solely for this purpose. Confine mixing, thinning, clean-up and associated operations and storage of repair mortar materials debris before authorized disposal, to these areas.

B. Mix all specified materials in the sheltered mixing operation and materials from direct sunlight and inclement weather. Protect facilities from staining and damage.

C. Do not dispose of waste materials on-site.

D. Store waste temporarily in closed, nonflammable containers until final disposal. Keep no rubbish in Contractor's area longer than 24 hours.

E. Deliver all materials to the job site in new, unopened containers. Each container shall bear the manufacturer's name and label. Labels on all material containers shall contain the following information:

1. Name of product.

2. Federal Specification Number if applicable.

3. Manufacturer's batch number.

4. Manufacturer's name.

5. Generic type of material.

6. Hazardous material identification label.

7. Shelf life date.

F. Clearly mark all containers indicating any safety hazards associated with the use of or exposure to the materials.

G. Handle and store materials to prevent damage or loss of label. Protection of materials is the Contractor's responsibility.

1.07 PROJECT/SITE CONDITIONS

A. Environmental Requirements:

1. Comply with the repair material manufacturer's recommendations as to environmental conditions under which materials can be applied and cured.

2. Do not apply materials when dust is being generated.

B. Protection:

1. Cover or otherwise protect finish work or other surfaces not being repaired.

C. Ventilation:

1. Provide ventilation to meet product requirements prior to, during, and after application.

PART 2 PRODUCTS

2.01 WATER

A. The water used for mixing concrete repair products shall be clear, potable and free of deleterious substances.

2.02 AGGREGATE

A. All aggregates shall conform to ASTM C33 and Section 03300.

2.03 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to ASTM C881 Type I, II, IV or V; Grade 2 for epoxy resin adhesives, depending on the application. The class of epoxy bonding agent shall be suitable for all ambient and substrate temperatures.

B. Products:

1. Sika Corp.; Sikdur 32

2. Euclid Chemical Company; Duralcrete

2.04 ANTI-CORROSION COATING

A. Anti-corrosion coating shall be a three-component, epoxy-modified cementitious material.

B. Products:

1. Sika Corp.; Sika Armatec 110

2. Sto Concrete Restoration Division; CR 246

3. Euclid Chemical Company; Duralprep

2.05 EPOXY CRACK REPAIR BINDER

A. Epoxy crack repair binder shall be a two-component, 100 percent solids, high-modulus, low viscosity epoxy adhesive suitable for crack grouting by injection.

B. Products:

1. Sika Corp.; Sikadur 52

2. Euclid Chemical Company; Duralcrete LV

3. BASF Chemical Company; SBC Concresive 1380

2.06 FLEXIBLE POLYURETHANE CRACK REPAIR MATERIAL

A. Flexible polyurethane crack repair material shall be a one-component, water-activated polyurethane hydrophilic injection grout capable of 700 percent expansion. Polyurethane grout shall form a tough flexible foam seal that is impenetrable to water.

B. Products:

1. Prime Resins; Prime Flex 900 XLV

2. Avanti International; Scotch Seal 5600 Chemical Grout

2.07 EPOXY REPAIR MORTAR

A. Epoxy Repair Mortar shall be two-component, 100 percent solids, 100 percent reactive epoxy resin system.

B. Spall repair mortar for use in horizontal applications.

1. Products:

a. BASF Building Systems; Concresive Paste LPL

b. Sika Chemical Corp.; Sikadur 22 Lo-Mod

C. Spall repair mortar for use in vertical and overhead applications.

1. Products:

a. Sika Chemical Corp.; Sikadur 23 Lo-Mod Gel

2.08 SPALL REPAIRS USING NON-SHRINK CEMENTITOUS MORTAR

A. Products:

1. BASF Building Systems; EMACO S88 CI

2. BASF Building Systems; Thorite

3. Sauereisen, Inc.; Underlayment F-120

2.09 SPALL REPAIRS USING POLYMER MODIFIED CEMENTITOUS MORTAR

A. Repair spalls repair not requiring formwork using a two-component, polymer-modified cementitious mortar having a minimum 28-day compressive strength of 7,000 psi.

B. Spall repair mortar for use in horizontal applications.

1. Products:

a. Sika Corp.; Sikatop 122 Plus

b. Euclid Chemical Company; Duraltop Fast Set

C. Spall repair mortar for use in vertical applications.

1. Products:

a. Sika Corp; Sikatop 123 Plus

b. Euclid Chemical Company; Duraltop Gel

2.10 SPALL REPAIRS REQUIRING FORMWORK

A. Repair spalls repair requiring formwork using a two-component, polymer-modified cementitious mortar/pea gravel mixture and shall have a minimum 28-day compressive strength of 6,000 psi. Mix each unit of mortar with Saturated Surface Dry (SSD) pea gravel to form the repair material following the manufacturer's recommendations.

B. Products:

1. Sika Corp.; Sikatop 111 Plus

2. Euclid Chemical Company; Duraltop Flowable Mortar

2.11 SEALANT

A. Sealant shall be a two-component polyurethane sealant as specified in Section 03250. Primers and bond breakers shall conform to the sealant manufacturer's recommendations.

2.12 EXPANSION JOINT FILLER

A. Expansion joint filler shall be as specified in Section 03250.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform exterior work during dry weather and appropriate temperature conditions in accordance with the manufacturer's recommendations. Protect unfinished work during inclement weather with tarpaulins or heavy gage polyethylene sheeting.

B. Perform work in spaces within structures at temperature and conditions suitable for proper curing in accordance with the manufacturer's recommendations.

C. Coordinate concrete rehabilitation work with other work being performed.

D. Remove scaling, broken, loose and disintegrating materials by use of hand tools or power driven saws, down to solid unyielding material.

E. Clean surfaces thoroughly of efflorescence, oils, grease and other objectionable material in area to be repaired in accordance with the manufacturer's recommendations.

3.02 EPOXY BONDING AGENT

A. Use epoxy bonding agent to adhere fresh mortar to existing concrete. Roughen existing concrete surfaces prior to application of bonding agent. Concrete surface shall be clean and sound, free of all foreign particles and laitance. Place repair material while bonding agent is still tacky or per the written instructions of the manufacturer. Reapply bonding agent if bonding agent cures prior to placement of repair material.

B. Conform to all the requirements of ACI 503.4, and as specified herein.

3.03 ANTI-CORROSION COATING

A. Sandblast clean and coat reinforcing steel that is cut or exposed during alteration and/or repair operations with an anti-corrosive coating.

B. Cover all exposed parts of the steel with the coating and apply according to manufacturer's recommendations.

3.04 EPOXY CRACK REPAIR

A. Cracks on horizontal surfaces: When permitted by the Engineer, repair existing structural cracks by gravity feeding an epoxy crack repair binder into the prepared crack.

1. Rout concrete surface at the crack to form a minimum 1/4-inch wide by 1/4-inch deep V-notch and clean to remove all loose and foreign particles. Fill crack with clean, dry sand and pour epoxy crack repair binder into V-notch, completely filling crack.

2. As binder penetrates into crack, apply additional binder to the V-notch.

B. Cracks on vertical or horizontal surfaces: Repair existing structural cracks by pressure injecting an epoxy crack repair binder into the prepared crack. Seal cracked surfaces and install injection ports per manufacturer's recommendations.

1. Do not cut reinforcement steel when drilling holes injection ports. If rebar is encountered during drilling, abandon the hole and relocate. Patch the abandoned hole immediately with epoxy mortar flush with the surface of the existing concrete.

2. Once the surface sealing material has cured, inject crack with epoxy crack repair binder as directed by the manufacturer.

3. Remove injection ports upon satisfactory completion of crack injection and patch with epoxy mortar.

3.05 RIGID AND FLEXIBLE POLYURETHANE CRACK REPAIR

A. Repair leaking cracks by pressure injecting with a waterproof hydrophilic or hydrophobic injection grout seal crack surfaces and install injection ports per manufacturer's recommendations.

B. Do not cut rebar when drilling holes for injection ports. If rebar is encountered during drilling, abandon the hole and patch immediately with epoxy mortar flush with the surface of the existing concrete.

C. Once the surface sealing material has cured, inject crack with waterproof hydrophilic or hydrophobic injection grout as directed by the manufacturer.

3.06 SPALL REPAIR

A. Saw cut the perimeter of the repair area to a minimum depth of 1/2-inch below the surface of the concrete.

B. Chip all loose concrete in the repair area to remove loose and degraded concrete to a minimum of 1/2-inch or until a sound substrate is reached.

C. Clean the area and repair to the original dimensions with spall repair patching material according to the manufacturer's recommendations.

D. Make final finished surface of patches flat, level and even with the existing concrete surface. Do not feather repair mortar to meet existing concrete surface.

E. Finish final patches on horizontal surfaces consistent with the finish on the existing structure.

3.07 JOINT REPAIR

A. Remove sealant, bond breaker and joint filler.

B. Remove unsound concrete on the joint faces.

C. Remove laitance and provide a clean dry surface.

D. Prepare an epoxy mortar by combining epoxy crack repair binder with aggregate following the manufacturer's instructions.

E. Restore surface to original dimensions by trowelling epoxy mortar onto the existing substrate in a manner to ensure bonding following the manufacturer's instructions.

F. Cure repair in accordance with the manufacturer's instructions.

G. Install new joint filler, bond breaker and sealant.

3.08 CURING

A. Cure repair materials in accordance with manufacturer recommendations.

3.09 CLEANING

A. Mechanically remove excess material from walls, floors, etc. after material has cured.

B. Clean excess materials caused by work under this Section from existing surfaces by the use of power sanders. Vacuum surfaces to receive final cleaning and finishing specified under other sections of the specifications. Sand cracks flush to adjacent surfaces.

C. Remove misplaced sealants using methods and materials recommended by the manufacturers. Leave finished work and work area in a neat and clean condition.

3.10 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 03800 LEAKAGE TESTING OF HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Water tightness testing of reinforced concrete water retaining structures.

1.02 REFERENCE STANDARDS

A. American Concrete Institute (ACI)

1. ACI 350.1-01 – Tightness Testing of Environmental Engineering Concrete Structures.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide potable water, piping, and equipment required to test concrete structures for leakage.

PART 3 EXECUTION

3.01 GENERAL

A. Hydrostatically test reinforced concrete structures which will contain water to requirements specified below, and are free of detectable leaks.

B. Do not start leak testing or cleaning of surfaces until concrete is cured and joint sealants have set and cured a minimum of 14 days.

C. Conduct testing before backfill is placed against walls.

D. Prior to testing, clean exposed surfaces by thorough hosing, and remove surface laitance and loose matter from walls and slabs. Remove wash water and debris by means other than washing through plant piping.

3.02 TEST PROCEDURE

A. Fill structure to be tested to the normal operating liquid level. Filling rate shall not exceed 4 feet of water per hour, and shall be at continuous uniform rate with continuous monitoring.

B. The exterior surface of the tank shall be monitored for flowing leaks. Repair any flowing leaks which occur before continuing filling.

C. The water shall be kept at the test level for at least three days prior to the actual test.

D. Measure the vertical distance to the water surface from a fixed point on the tank above the water surface. Record measurements at 24-hour intervals.

E. A drop of the water surface exceeding 1/10 of 1% of the normal volume of contained liquid will be considered failing.

F. The structure will have also been considered to have failed the test if flowing or seeping water is observed, or if moisture can be transferred to a dry hand from the exterior surface.

G. Independently measure change in water volume due to evaporation and precipitation using a 24 inch deep white, watertight container not less than 10 square feet of surface area. Position the container to experience environmental conditions similar to the structure being tested. The volume change of the structure shall be corrected based on the water volume change in the sample container.

H. Failing tanks which exhibit no visible signs of leaking or seepage may be permitted to be immediately retested.

I. Failing tanks will be drained, repaired, and retested until the tank has met the test requirements at no additional cost to the owner.

3.03 REPAIR METHODS

A. Methods for repairing concrete are described in section 03740.

END OF SECTION

DIVISION 4 - MASONRY

04230 Reinforced Unit Masonry

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SECTION 04230 REINFORCED UNIT MASONRY

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide all materials, equipment, and labor required to construct the reinforced unit masonry construction in accordance with the Drawings and Specifications.

1. Provide and install masonry units, grout, mortar, precast lintels, sills, reinforcement and connectors.
2. Provide, erect and maintain all bracing, shoring and scaffolding required to complete masonry construction.
3. Coordinate all work with that of other trades.

1.02 SUBMITTALS

A. Submit shop drawings, product data, and mix designs in accordance with Section 01300.

B. Mortar: Submit mix designs indicating type and proportions of ingredients in compliance the proportion specification of ASTM C 270.

C. Grout: Submit mix designs indicating type and proportions of the ingredients according to the proportion requirements of ASTM C 476.

D. Reinforcement: Submit complete shop drawings, including bar lists and placement drawings.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Do not use damaged masonry units.

B. Protect concrete masonry units and cementitious materials from rain and ground water.

C. Protect reinforcement, ties and metal accessories from damage and store off the ground.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete Masonry Units: ASTM C 90, Type II normal weight units with minimum compressive strength of 1900 psi on net area.

B. Premix Mortar: ASTM C 270, Type S.

C. Grout: ASTM C-476 course grout, 2500 psi compressive strength at 28 days.

D. Aggregate:

E. 1. Sand: ASTM C-144

F. 2. Pearock for grout: ASTM C-404, number 89

G. Mixing water shall be potable.

2.02 REINFORCEMENT

A. Reinforcing steel bars: ASTM A-615, Grade 60.

B. Horizontal Joint Reinforcement: ASTM A 951 Galvanized steel wire, 9 gauge, ladder type.

2.03 TIES AND ANCHORS

A. Provide ties and anchors as shown on the drawings, hot dip galvanized in compliance with ASTM A 153.

2.04 PRECAST CONCRETE LINTELS

A. U-lintel units, minimum compressive strength: 3500 psi at 28 days.

B. All units shall have a sand block finish.

C. Manufacture and tolerances shall be in compliance with PCI MNL-116, “Manual for Quality control for Precast Concrete.”

D. Manufacturer shall rate U-lintel units for gravity, uplift, and lateral loads in units of pounds per lineal foot, and provide load vs. deflection data.

E. Lintels shall be of length sufficient to bear 8 inches on either side of opening.

2.05 MIXING

A. Mortar

1. Mortar shall be thoroughly machine mixed for 3 to 5 minutes in a machine designed for this purpose.

2. Mortar shall be used and placed in final position within 1-1/2 hours after mixing.

3. Mortar that has stiffened within the usable time may be retempered not more than one time by adding water as needed to maintain workability.

B. Grout:

1. Proportion and mix grout in accordance with the requirements of ASTM C 476.

2. Mix grout to a consistency with a slump between 8 and 11 inches.

2.06 FABRICATION OF REINFORCEMENT

A. Fabricate bars used in masonry reinforcement in accordance with the fabricating tolerances of ACI 315.

B. Bend all bars cold

C. The minimum inside bend diameter is 6 bar diameters.

D. Provide standard hooks with a 90 degree bend plus an extension of 12 bar diameters.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that all reinforcing dowels are positioned in accordance with the Drawings.

B. Remove laitance, loose aggregate, of anything that would prevent mortar from bonding to the foundation.

C. Provide cleanouts in the bottom course of masonry for each grout pour at each filled cell. Use units with one face shell removed and provide temporary support for units above, or use header units with concrete brick supports, or cut openings in one face shell. Openings shall have a minimum area of 12 square inches and a minimum opening dimension of 3 inches.

3.02 LAYING CONCRETE BLOCK

A. Do not wet concrete masonry units. (CMU)

B. Place CMU with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross webs of starting courses in mortar. Maintain head and bed joint widths of 3/8 inch.

C. Pattern Bond: Lay block in ½ running bond. Vertical joints in each course shall be centered on units in courses above and below.

D. Maintain vertical continuity of core or cell cavities, which are to be reinforced and grouted, to provide minimum clear dimensions indicated and to provide minimum

E. clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.

F. Install all frames required to be set in masonry. Set block tightly against frames, build in all frame anchors, and fill frames with grout.

G. Joints of all exposed masonry shall be tooled as follows: 3/8″ concave joint.

H. Wait until mortar is thumb-print hard until tooling joint. The required personnel employed by the contractor shall be kept on the jobs after hours, if necessary, to properly tool joints.

I. Both vertical and horizontal joints shall be maintained uniform in spacing.

J. Joints shall be rubbed with a sponge to provide a flush, neat, rubbed joint.

K. Block work shall be laid plumb, level, and true to line and grade. Lay block within the following tolerances:

L. Mortar joint thickness: Bed: ±1/8 inch; Head: -1/4 inch, + 3/8 inch.

M. Variation from plumb, level, and line: ¼ inch in 10 feet, 3/8 inch total.

N. Mortar boards and boxes shall be cleaned at the end of each day’s work, and all tools shall be kept clean

3.03 PLACING REINFORCEMENT

A. Clean reinforcement of loose rust, mill scale, earth or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on Drawings or final shop drawings, or bars with reduced cross-section due to rusting or other causes.

B. Place reinforcement straight, centered in cells, and tied at laps and intersection of bars. Horizontal reinforcement may be placed as the masonry work progresses. Where vertical bars are shown in close

proximity, provide distance between bars of not less than the nominal bar diameter or 1 inch, whichever is greater.

C. Splice reinforcement bars only as shown. Do not splice at other points unless approved by the Engineer. Provide lapped splices, unless otherwise shown. In splicing vertical bars or attaching to dowels, tie spices with wire.

D. Provide not less than the minimum lap shown, or if not shown, as required by governing code.

E. Place joint reinforcement so that longitudinal wires are embedded in mortar with a minimum cover of 5/8 inch.

F. Place vertical reinforcement centered in the cell to a tolerance of ± 1/2 inch.

3.04 GROUTING

A. Use fine grout for filling spaces less than 4 inches in both horizontal directions.

B. Use course grout for filling 4 inch spaces or larger in both horizontal directions.

C. Place grout within 1.5 hours from introducing water in the mixture and prior to initial set.

D. Grouting Technique: At the Contractor's option, use either low-lift or high-lift grouting techniques subject to the requirements which follow.

E. Consolidate grout by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.

F. Low-Lift Grouting:

1. Provide a minimum clear dimension of 2 inches and clear area of 8 sq. in. in vertical cores to be grouted.

2. Place vertical reinforcement prior to laying of CMU. Extend vertical reinforcement above elevation of maximum pour height as required to allow for splicing and support it in position at vertical intervals not exceeding 192 bar diameters nor 10 feet.

3. Lay CMU to maximum pour height. Limit pour height to 5 feet. If bond beam occurs below the 5 feet height stop, pour at course below bond beam.

4. Preparation of Grout Spaces: Prior to grouting, inspect and clean out the grout spaces. Remove dust, dirt, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcement and adjust to proper position. Clean top surface of structural members supporting masonry to ensure bond.

5. Pour grout using container with spout or by chute and rod or vibrate during placing. Place grout continuously. Do not interrupt pouring of grout for more than one hour. Terminate grout pours 1 1/2-inches below top course of pour.

6. Bond Beams: Terminate grout in vertical cells 1 1/2-inches below bond beam course. Place horizontal reinforcement in bond beams with corners and intersections lapped as shown. Place grout in bond beam course before filling vertical cores above bond beam.

G. High-Lift Grouting:

1. Do not use high-lift grouting technique for grouting of CMU unless minimum cavity dimension and area is 3 inches and ten sq. in., respectively.

2. Construct masonry to full height of maximum pour specified, prior to placing grout.

3. Limit grout lifts to a maximum height of 4 feet and grout pours to a maximum height of 24 feet.

4. Place vertical reinforcement before grouting. Tie vertical reinforcement to dowels at base of masonry where shown and thread CMU over or around reinforcement. Support vertical reinforcement at intervals not exceeding 192 bar diameters, nor 10 feet.

5. Place horizontal beam reinforcement as the masonry units are laid.

6. Embed lateral tie reinforcement in mortar joints where shown as masonry units are laid.

7. Preparation of grout spaces: Prior to grouting, inspect and clean out the grout spaces. Remove rust, dirt, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcement and adjust to proper position. Clean top surface of structural members supporting masonry to ensure bond. After final cleaning and inspection, close cleanout holes and brace closures to resist grout pressures.

8. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist displacement of masonry units and breaking of mortar bond. Install shores and bracing, if required, before starting grouting operations.

9. Place grout by pumping into grout spaces unless alternate methods are acceptable to the Engineer.

10. Limit grout pours to sections which can be completed in one working day with not more than one hour interruption of pouring operation. Place grout in lifts which do not exceed 4 feet. Allow not less than 30 minutes, nor more than one hour between lifts of a given pour. Vibrate each grout lift during pouring operation.

11. Place grout in lintels or beams over openings in one continuous pour.

12. When more than one pour is required to complete a given section of masonry, extend reinforcement beyond masonry as required for splicing. Pour grout to within 1 ½ inches of top course of first pour. After grouted masonry is cured, lay masonry units and place reinforcement for second pour section before grouting. Repeat sequences if more pours are required.

3.05 CLEANUP

A. Clean exposed masonry surfaces of all mortar or grout droppings and debris.

END OF SECTION

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DIVISION 5 – METALS

05500	Miscellaneous Metal
05500A	Metal Fabrications

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SECTION 05500 MISCELLANEOUS METAL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all miscellaneous metal complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Concrete joint accessories are included in Section 03250.

B. Masonry reinforcement, ties and accessories are included in Division 4.

C. Metal doors and frames are included in Section 08100.

D. Painting is included in Division 9.

F. Sluice gates, slide gates, operators and appurtenances, including wall thimbles, are included in Division 11.

G. Pipe hangers and sleeves are included in Division 15.

H. Equipment anchor bolts are included in the respective Sections of Divisions 11, 14 and 15.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Shop drawings, showing sizes of members, method of assembly, anchorage and connection to other members.

B. Samples

1. Submit samples as requested by the Engineer during the course of construction.

C. Design Data

1. Submit calculations or test data demonstrating that the railings will resist the loads specified in the 2010 Florida Building Code at the post spacing provided.

2. Submit manufacturer's load and deflection tables for grating.

D. Test Reports

1. Certified copy of mill test reports on each aluminum proposed for use showing the physical properties and chemical analysis.

E. Certificates

1. Submit certification that the railing system is in compliance with OSHA requirements and the 2010 Florida Building Code.

2. Certify that welders have been qualified under AWS, within the previous 12 months, to perform the welds required under this Section.

1.04 REFERENCE STANDARDS

A. Aluminum Association (AA)

1. AA M31C22A41

a. M31: Mechanical Finish, Fine Satin

b. C22: Finish, Medium Matte

c. A41: Clear Anodic Coating, Class I

B. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A48 - Standard Specification for Gray Iron Castings.

3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

4. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.

5. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

6. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

8. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength.

10. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

11. ASTM A366 - Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.

12. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

13. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

14. ASTM A536 - Standard Specification for Ductile Iron Castings.

15. ASTM A570 - Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

16. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

17. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

18. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

C. American Iron and Steel Institute (AISI).

1. Specification for Structural Steel Buildings.

D. American Welding Society (AWS)

1. AWS D1.1 - Structural Welding Code Steel.

2. AWS D1.2 - Structural Welding Code Aluminum.

E. Federal Specifications

1. FS-FF-B-575C - Bolts, Hexagonal and Square

F. Occupational Safety and Health Administration (OSHA)

G. 2010 Florida Building Code. (FBC)

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

1.05 QUALITY ASSURANCE

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

B. Repair items which have become damage or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

1.07 PROJECT/SITE REQUIREMENTS

A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.02 MATERIALS

A. Unless otherwise noted, materials for miscellaneous metals shall conform to the following standards:

1. Structural Steel	
a. W Shapes:	ASTM A992, Gr.50
b. M Shapes:	ASTM A36
c. S,C and MC Shapes:	ASTM A36
d. L Shapes:	ASTM A36
e. Plates and Bars:	ASTM A36
2. Structural Steel Tubing	ASTM A500, Grade B
3. Welded and Seamless Steel Pipe	ASTM A501 or ASTM A53, Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work
4. Steel Sheets	ASTM A366

5. Gray Iron Castings — ASTM A48, Class 35

6. Ductile Iron Castings — ASTM A536,Grade 65-45-12

7. Aluminum Extruded Pipe — ASTM B429, Alloy 6063 T6

8. Aluminum Extruded Shapes — ASTM B221, Alloy 6061 T6

9. Aluminum Sheet and Plate — ASTM B209, Alloy 6061 T6

10. Stainless Steel Plates, Sheets, and Structural Shapes

    a. Exterior, Submerged or Industrial Use — ASTM A167, Type 316 (Type 316L for welded)

    b. Interior and Architectural Use — ASTM A167, Type 304

11. Stainless Steel Bolts, Nuts, and Washers — ASTM A276, Type 316

12. Carbon Steel Bolts and Studs — ASTM A307, Grade A (hot dip galvanized nuts and washers where noted)

13. High Strength Steel Bolts, Nuts and washers — ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted)

    a. Elevated Temperature Exposure — Type I

    b. General Application — Type I or Type II

14. Galvanizing — ASTM A123, Zn w/0.5 percent minimum Ni

15. Galvanizing, hardware — ASTM A153, Zn w/0.5 percent minimum Ni

2.03 ANCHORS, BOLTS AND FASTENING DEVICES

A. Anchor bolt material shall be ASTM F1154, Grade 36 standard headed bolts with heavy hex nuts, Grade A washers, hot-dipped galvanized, unless otherwise noted otherwise.

B. Unless otherwise noted, bolts for the connection of carbon steel or iron shall be steel machine bolts; bolts for the connection of galvanized steel or iron shall be galvanized steel or stainless steel machine bolts; and bolts for the connection of aluminum or stainless steel shall be stainless steel machine bolts.

C. Unless otherwise noted, expansion anchors shall be zinc plated carbon steel wedge type anchors complete with nuts and washers. Type 316 stainless steel, wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are required. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-in behind the concrete reinforcing steel. Expansion anchors shall be Hilti, Kwick-bolt III; ITW Ramset; Redhead trubolt, or equal.

E. Adhesive capsule anchors shall be a two-part stud and capsule chemical resin anchoring system. Capsules shall contain premeasured amounts of polyester or vinyl ester resin, aggregate and a hardener contained in a separate vial within the capsule. Stud assemblies shall consist of an all-thread stainless steel type 316 anchor rod with nut and washer. Adhesive capsule anchors shall be Hilti, HIT-RE 500; Simpson Strong Tie, SET-XP.

F. Adhesive anchors, for fastening to hollow concrete block or brick, shall be a three-part stud, screen and chemical dispenser anchoring system. Adhesive cartridges shall contain premeasured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Stud assemblies shall consist of an stainless steel type 316 all-thread anchor rod with nut and washer. Anchors shall be Hilti, HIT-HY 20 System or equal.

G. Automatic end welded headed anchor studs shall be flux ended studs made from cold drawn steel, ASTM A108 Grades C-1010 through C-1020. Headed anchor studs shall be Nelson, H4L Headed Concrete Anchors or equal.

H. Machine bolts and nuts shall conform to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.

I. Toggle bolts shall be Hilti, Toggler Bolt or equal.

2.04 METAL GRATING

A. Grating shall have rectangular, 3/16-in thick, bearing bars spaced 1-3/16-in on center with cross bars spaced at 4-in on center. All grating panels shall be banded with a bar the same size as the bearing bars.

1. Grating shall not exceed the fabricator's maximum recommended span, and meet or exceed the following load and deflection criteria for the maximum span length at the opening being covered by the grating.

a. The grating shall produce a deflection of 1/360 of the span or less under a uniform live load of 100 lbs/sq ft on the maximum span.

b. The grating shall produce a deflection of 1/360 of the span or less under a concentrated live load of 300 lbs applied at the midpoint of the maximum span.

2. Openings 2-in or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing bars or cross bars shall be welded to the banding bar.

3. Provide trench grating with symmetrical cross bar arrangement.

4. Grating clamps, nuts, bolts, washers and other fastening devices for grating and grating supports shall be Type 316 stainless steel. All grating shall be anchored to the supporting system using saddle clips.

B. Aluminum grating material shall be aluminum alloy 6063-T6 with an anodized finish. Cross bars shall be attached to the bearing bars with interlocked swaged joints. The grating shall be Type BS by IKG Borden, Houston, TX; Type 19 SG-4 by Ohio Gratings, Inc., Canton, OH; Type 19S4 by Seidelhuber Metal Products, San Carlos, CA or equal.

C. Aluminum plank grating shall be aluminum alloy 6063-T6 with an anodized finish. The planks shall be unpunched and a minimum of 1-3/4″ deep. All planks shall be properly secured with hold-down clips per manufacturer. All planks shall be sized to provide a maximum gap of 1/2″ between the

end of the plank and the embedded bearing angle. All planks shall be within 1/4″ of each other in terms of overall length. Where plank grating is placed near a gate frame a neoprene pad shall be attached to the top of the plank with stainless steel self-tapping screws to cover the gap as necessary. If this cannot be achieved then additional aluminum plates shall be fabricated to properly cover all openings. See notes on the drawings for additional requirements at penetrations in the grating.

D. Metal frames and supports for grating shall be of the same material as the grating unless otherwise shown on the Drawings. Where aluminum supports are used, they shall be fabricated from aluminum alloy 6061-T6.

2.05 RAILINGS

A. Guardrail and railing systems shall comply with the requirements of OSHA and FBC.

B. Aluminum railing and handrail shall be a welded or mechanically fastened, seamless, extruded aluminum pipe system. Rails and posts shall be 6061-T6, 6063-T6 or 6105-T5. Splice and reinforcing sleeves, brackets, end caps, toeboards, etc, shall be aluminum alloy 6061-T6, 6063-T6 or 6105-T5 alloy. Cast fittings shall be aluminum alloy No. 214. Railing system fastening hardware shall be Type 304 stainless steel. Aluminum shall have a mill finish. After welding, aluminum shall be anodized. All railing, posts, toeboards and exposed aluminum shall be anodized with an architectural Class I satin finish providing a minimum coating thickness of 0.7 mils and a minimum coating weight of 32 milligrams per square inch in compliance with AA M10C22A41.

C. Railings shall be 2 rail railing systems, as shown on the Drawings, fabricated with 1-1/2-in nominal diameter pipe. Posts shall be Schedule 40 pipe, minimum and rails and guardrail shall be Schedule 40 pipe, minimum. Posts and top rails shall be continuous. Spacing of posts shall not exceed 5-ft on center and shall be uniformly spaced except as otherwise shown on the Drawings. Posts will be required on each side of structure expansion joints. All railing posts shall be vertical.

D. Railing shall be assembled in sections as long as practical but shall not be greater than 24-ft in length. A field splice shall be used when an assembled section is to be attached to another section. Field splices shall be used in all railing panels that cross over structure expansion joints.

1. Field splices shall use internal splice sleeves located within 8-in of railing posts. The sleeve shall be welded to the rail on one side and fastened with a set screw to the rail on other side. The field splice shall be detailed to take the differential expansion between the railing system and the supporting structure.

2. When the field splice occurs in a railing panel crossing a structure expansion joint, the sleeve shall be welded to the rail on one side and be free to slide in the rail on other side. The field splice shall be detailed to take the same movement as the structure expansion joint.

E. The bases or supports for railing posts and guardrail shall be the types indicated on the Drawings.

1. Where non-removable railing is set in concrete, the posts shall be placed in 2-1/2-in diameter formed concrete openings and firmly caulked with a nonsulphur compound, hydraulic cement equal to Por-Rok by Minwax Construction Products Division Sterling Drug, Montvale, NJ. Collars shall be placed around the post bases and fastened in place with set screws on the side of the post away from the walkway. Posts shall be placed with the centerline 4-in from the edge of the concrete except that posts shall be set at the centerline of concrete curbs.

2. Stainless steel and aluminum railing posts, which may collect condensation, shall have a 3/16-in drain hole drilled immediately above the concrete encased area, the base flange, or supporting socket on the side away from the walking area. The bottom of the rail post between the drain hole and the bottom of the post shall be filled with an inert material such as a compressed closed cell neoprene rod.

3. Where handrail is to be fastened to walls, the rails shall be provided with screwed wall flanges fastened to the walls with three 3/8-in stainless steel flat head machine screws.

F. Safety gates, for railing openings, shall be fabricated of matching pipe and rail material and configuration. The gates shall be self-closing gates with approved stop, latch and stainless steel closure spring and hinges.

G. Barrier chains, for railing openings, shall be fabricated of stainless steel chains. Chain shall be 1/4-in stainless steel links, with eleven links per foot as manufactured by Eastern Chain Works, Inc., NY; Lawrence Metal Products, Inc. or equal. Chains shall be fastened to the guardrail posts at the elevation of each rail. One end of each chain shall be connected to one post with a 1/4-in diameter stainless steel eye bolt and the other end shall be connected to the other post by means of a heavy chromium plated bronze swivel eye slide harness snap and a similar eye bolt.

H. Toeboards shall be provided on all railing adjacent to a drop in elevation of 4-ft or more. Toeboards are not required on the inclined portion of stairway railings or where concrete or steel curbs, 4-in or more in height, are present. Toeboards shall be 4-in high channels of the same material as the railing. The channels shall have a minimum thickness of 1/8-in and have flanges of not less than 3/4-in nor more than 1-1/2-in in width. Toeboards shall be positioned with a maximum clearance of 3/16-in from the floor and fastened to railing posts with 1/4-in stainless steel U-bolts, with J-bolts at corner posts and with clip angles and two 1/4-in stainless steel expansion bolts at walls.

I. All railings shall be properly protected by paper, or by an approved coating or by both against scratching, splashes or mortar, paint, or other defacements during transportation and erection and until adjacent work by other trades has been completed. After protective materials are removed, the surfaces shall be made clean and free from stains, marks, or defects of any kind.

2.06 ACCESS HATCHES

A. Access hatches shall have single or double leaf doors as indicated by the Drawings. The doors shall be 1/4-in aluminum diamond pattern plate with welded stiffeners, as necessary, to withstand a live load of 300 lbs/sq ft with a maximum deflection of 1/150th of the span. Hatches shall have a 1/4-in aluminum channel frame with a perimeter anchor flange or strap anchors for concrete embedment around the perimeter. Unless otherwise noted on the Drawings, use pivot torsion bars for counterbalance or spring operators for easy operation along with automatic door hold open. Hardware shall be durable and corrosion resistant with Type 316 stainless steel hardware used throughout. Provide removable lock handle. Finish shall be the factory mill finish for aluminum doors and frames with bituminous coating on the exterior of the frames in contact with concrete. Hatches shall be watertight and have a 1-1/2-in drainage coupling to the channel frame. Access hatches shall be Types as indicated on the Drawings by Bilco Company, New Haven, CT or equal.

2.07 MISCELLANEOUS ALUMINUM

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosings, and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.

D. Angle frames for hatches, beams, grates, etc, shall be complete with welded strap anchors attached.

E. Aluminum diamond plate and floor plate shall have a minimum thickness of 3/8-in. Frames and supports shall be of aluminum construction. Fastening devices and hardware shall be Type 304 stainless steel. Plates shall have a mill finish.

F. Stair treads for aluminum stairs shall have abrasive non-slip nosing as approved.

G. Aluminum nosing at concrete stairs shall be Wooster Products, Inc.; Alumogrit Treads, Type 116; similar by Barry Pattern and Foundry Co.; Andco or equal. Furnish with wing type anchors and flat head stainless steel machine screws, 12-in on center. Nosing shall also be used at concrete ladder openings. Nosing shall a single piece for each step extending to within 3-in at each side of stair or full ladder width. Set nosing flush with stair tread finish at concrete stairs. Furnish treads with heavy duty protective tape cover.

H. Miscellaneous aluminum items shall have a cleaned and degreased mill finish.

2.08 MISCELLANEOUS STEEL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded

connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, holddown straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.

D. Structural steel angle and channel door frames shall be shop coated with primer. Frames shall be fabricated with not less than three anchors on each jamb.

E. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.

F. Lintels, relief angles or other steel supporting masonry or embedded in masonry shall be shop coated with primer.

G. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.

H. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface.

2.09 MISCELLANEOUS STAINLESS STEEL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without

burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.

B. Abrasions in the shop primer shall be touched up immediately after erection. Areas left unprimed for welding shall be painted with primer after welding.

C. Zinc coating which has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damage area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

D. Specialty products shall be installed in accordance with the manufacturer's recommendations.

E. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.

F. Install adhesive capsule anchors using manufacture's recommended drive units and adapters and in compliance with the manufacturer's recommendations.

G. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.

H. All railings shall be erected to line and plumb. Fit all exposed connection together to form tight hairline joints.

I. All steel surfaces that come into contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.

J. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

K. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.

L. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

M. Between aluminum grating, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-in thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

END OF SECTION

SECTION 05500A METAL FABRICATIONS

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Steel framing and supports for overhead doors.

b. Steel framing and supports for applications where framing and supports are not specified in other Sections.

2. Products furnished, but not installed, under this Section include the following:

a. Loose steel lintels.

b. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

3. Related Requirements:

a. Section 03300 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.

b. Section 04810 "Unit Masonry Assemblies" for installing loose lintels, anchor bolts, and other items built into unit masonry.

4. COORDINATION

a. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

5. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

6. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

   a. Steel framing and supports for overhead doors.

   b. Steel framing and supports for applications where framing and supports are not specified in other Sections.

C. INFORMATIONAL SUBMITTALS

1. Qualification Data: For professional engineer.

D. FIELD CONDITIONS

1. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

A. PERFORMANCE REQUIREMENTS

1. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

   a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. METALS

1. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work,

provide materials without seam marks, roller marks, rolled trade names, or blemishes.

a. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

b. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

c. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

d. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

C. FASTENERS

1. Usually retain Type 304 in "General" Paragraph below; retain Type 316 if required for corrosive environments.

2. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

a. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

3. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

4. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

D. MISCELLANEOUS MATERIALS

1. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

2. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

3. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

4. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

5. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

6. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

E. FABRICATION, GENERAL

1. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

2. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

3. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

4. Form exposed work with accurate angles and surfaces and straight edges.

5. Weld corners and seams continuously to comply with the following:

   a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

   b. Obtain fusion without undercut or overlap.

   c. Remove welding flux immediately.

d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

6. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

7. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

8. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

9. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

10. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

F. MISCELLANEOUS FRAMING AND SUPPORTS

1. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

2. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

   a. Fabricate units from slotted channel framing where indicated.

   b. Furnish inserts for units installed after concrete is placed.

G. MISCELLANEOUS STEEL TRIM

1. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

2. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

   a. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

3. Galvanize and prime miscellaneous steel trim.

4. Prime miscellaneous steel trim with zinc-rich primer.

H. STEEL WELD PLATES AND ANGLES

1. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

I. FINISHES, GENERAL

1. Finish metal fabrications after assembly.

2. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

J. STEEL AND IRON FINISHES

1. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

   a. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

2. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

3. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete,

sprayed-on fireproofing, or masonry, or unless otherwise indicated.

4. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

5. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

    a. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

A. INSTALLATION, GENERAL

1. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

2. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

3. Field Welding: Comply with the following requirements:

    a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

    b. Obtain fusion without undercut or overlap.

    c. Remove welding flux immediately.

    d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

4. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

5. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

6. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

   a. Cast Aluminum: Heavy coat of bituminous paint.

   b. Extruded Aluminum: Two coats of clear lacquer.

B. INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

1. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

C. ADJUSTING AND CLEANING

1. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   a. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION

DIVISION 6 – WOOD AND PLASTICS

06105 Miscellaneous Carpentry

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SECTION 06105 MISCELLANEOUS CARPENTRY

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. SUMMARY

1. This Section includes the following:

   a. Rooftop equipment bases and support curbs.

   b. Wood blocking, cants, and nailers.

   c. Wood furring and grounds.

   d. Plywood backing panels.

2. Related Sections include the following:

3. Division 6 Section "Interior Architectural Woodwork" for interior woodwork not specified in this Section.

C. DEFINITIONS

1. Lumber grading agencies, and the abbreviations used to reference them, include the following:

   a. NELMA - Northeastern Lumber Manufacturers Association.

   b. NLGA - National Lumber Grades Authority.

   c. SPIB - Southern Pine Inspection Bureau.

   d. WCLIB - West Coast Lumber Inspection Bureau.

   e. WWPA - Western Wood Products Association.

D. SUBMITTALS

1. Product Data: For each type of process and factory-fabricated product. Indicate component materials and

dimensions and include construction and application details.

a. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.

c. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

d. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

2. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

a. Preservative-treated wood.

b. Fire-retardant-treated wood.

c. Power-driven fasteners.

d. Powder-actuated fasteners.

e. Expansion anchors.

f. Metal framing anchors.

E. DELIVERY, STORAGE, AND HANDLING

1. Stack lumber, plywood, and other panels; place spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

A. WOOD PRODUCTS, GENERAL

1. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

   a. Factory mark each piece of lumber with grade stamp of grading agency.

   b. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

   c. Provide dressed lumber, S4S, unless otherwise indicated.

   d. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

2. Wood Structural Panels:

   a. Plywood: Either DOC PS 1 or DOC PS 2, unless otherwise indicated.

   b. Thickness: As needed to comply with requirements specified but not less than thickness indicated.

   c. Comply with "Code Plus" provisions in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial."

   d. Factory mark panels according to indicated standard.

B. WOOD-PRESERVATIVE-TREATED MATERIALS

1. Preservative Treatment by Pressure Process: AWPA C2 (lumber) and AWPA C9 (plywood), except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).

   a. Preservative Chemicals: Acceptable to authorities having jurisdiction and one of the following:

(1) Chromated copper arsenate (CCA).

(2) Ammoniacal copper zinc arsenate (ACZA).

(3) Ammoniacal, or amine, copper quat (ACQ).

(4) Copper bis (dimethyldithiocarbamate) (CDDC).

(5) Ammoniacal copper citrate (CC).

(6) Copper azole, Type A (CBA-A).

(7) Oxine copper (copper-8-quinolinolate) in a light petroleum solvent.

2. Mark each treated item with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

3. Application: Treat items indicated on Drawings, and the following:

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.

b. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

c. Wood framing members less than 18 inches above grade.

C. FIRE-RETARDANT-TREATED MATERIALS

1. General: Where fire-retardant-treated materials are indicated, provide materials that comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

a. Use treatment for which chemical manufacturer publishes physical properties of treated wood after exposure to elevated temperatures, when tested by a qualified independent testing agency according to

ASTM D 5664, for lumber and ASTM D 5516, for plywood.

b. Use treatment that does not promote corrosion of metal fasteners.

c. Use Exterior type for exterior locations and where indicated.

D. MISCELLANEOUS LUMBER

1. General: Provide lumber for support or attachment of other construction, including the following:

a. Rooftop equipment bases and support curbs.

b. Blocking.

c. Cants.

d. Nailers.

e. Furring.

f. Grounds.

E. PANEL PRODUCTS

1. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 5/8 inch thick.

F. FASTENERS

1. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

a. Where carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M or of Type 304 stainless steel.

2. Nails, Wire, Brads, and Staples: FS FF-N-105.

3. Power-Driven Fasteners: CABO NER-272.

4. Wood Screws: ASME B18.6.1.

5. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

6. Lag Bolts: ASME B18.2.1..

7. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

8. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

   a. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

   b. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 - EXECUTION

A. INSTALLATION, GENERAL

1. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

2. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

3. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

4. Securely attach carpentry work as indicated and according to applicable codes and recognized standards.

5. Countersink fastener heads on exposed carpentry work and fill holes with wood filler.

6. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

B. WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

1. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

C. PANEL PRODUCT INSTALLATION

1. Wood Structural Panels: Comply with applicable recommendations contained in APA Form No. E30K, "APA Design/Construction Guide: Residential & Commercial," for types of structural-use panels and applications indicated.

   a. Comply with "Code Plus" provisions in above-referenced guide.

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DIVISION 7 – THERMAL AND MOISTURE PROTECTION

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SECTION 07552 STYRENE-BUTADIENE-STYRENE (SBS)
MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing.

b. Vapor retarder.

c. Roof insulation.

2. Related Sections:

a. Section 07920 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

b. Section 07710 "Manufactured Roof Specialties" for roof drains.

C. DEFINITIONS

1. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

D. PERFORMANCE REQUIREMENTS

1. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

2. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

3. Roofing System Design: Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.

   a. See Structural drawings for wind loads.

4. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.

   a. Fire/Windstorm Classification: Class 1A-120.

   b. Hail Resistance Rating: SH.

5. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

E. ACTION SUBMITTALS

1. Product Data: For each type of product indicated.

2. Sustainability Submittals:

   a. Product Test Reports: For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.

   b. Product Data: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

3. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.

a. Base flashings and membrane terminations.

b. Tapered insulation, including slopes.

c. Crickets, saddles, and tapered edge strips, including slopes.

d. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

4. Samples for Verification: For the following products:

a. Sheet roofing materials, including base-ply sheet, roofing membrane sheet and flashing sheet, of color specified.

b. Roof insulation.

c. Six insulation fasteners of each type, length, and finish.

F. INFORMATIONAL SUBMITTALS

1. Qualification Data: For qualified Installer, manufacturer and testing agency.

2. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

a. Submit evidence of complying with performance requirements.

3. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

4. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.

5. Warranties: Sample of special warranties.

G. CLOSEOUT SUBMITTALS

1. Maintenance Data: For roofing system to include in maintenance manuals.

H. QUALITY ASSURANCE

1. Manufacturer Qualifications: A qualified manufacturer that is FM Approvals approved for membrane roofing system identical to that used for this Project.

2. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

   a. Installer must have installed at least five roofs of the same materials and methods specified for this project that have been warranted for the same number of years as required under this specification by the manufacturer of the product that will be used in the Work.

3. Source Limitations: Obtain components including roof insulation, fasteners, for membrane roofing system from same manufacturer as membrane roofing or approved by membrane roofing manufacturer

4. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

I. DELIVERY, STORAGE, AND HANDLING

1. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

2. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

   a. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

3. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

4. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

J. PROJECT CONDITIONS

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

2. Surfaces on which the roofing membrane system is to be applied shall be clean, smooth, dry, and free of fins, sharp edges, loose and foreign materials, oil and grease.

   a. Before beginning work, a representative of the manufacturer shall examine the roof surfaces in order to ensure that the substrate is acceptable.

   b. Do not begin installation until all defective conditions have been corrected.

K. WARRANTY

1. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period.

   a. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.

   b. Warranty Period: 20 years from date of Substantial Completion.

2. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section,

including all components of membrane roofing system such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, and walkway products, for the following warranty period:

a. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

A. SBS-MODIFIED ASPHALT-SHEET MATERIALS

1. SBS-Modified Bituminous Membrane Roofing:

a. Basis-of-Design Product: Subject to compliance with requirements, provide by Soprema Inc., or comparable product by one of the following:

(1) CertainTeed Corp.

(2) GAF Materials Corporation

(3) Johns Manville.

(4) MBTechnology.

(5) Siplast, Inc.

2. Roofing Membrane Sheet: SOPRASTAR SANDED

a. Description: Soprastar Sanded membrane reinforced with a 180 gram polyester mat and composed of selected SBS modified bitumen with a polypropylene film and a polyester film highly reflective white top surface. The field and flashing base membrane plies are adhered to a property prepared clean, dry and/or primed (where required) substrate by using the specified method. A Soprastar Sanded cold applied cap sheet is installed over a high brush sanded base membrane. Membrane surface is a smooth surface highly reflective top.

(1) Color: White

(2) SRI: = 96 (Reflectivity .78/Emissivity .89)

B. BASE-PLY SHEET MATERIALS

1. Membrane Base Ply: ELASTOPHENE SANDED

a. Description: Waterproofing membrane shall have a glass mat reinforcement and thermofusible elastomeric asphalt. Both sides shall be lightly sanded. This membrane is to be applied by Cold Applied.

b. Components: Reinforcement shall be 1.9 Ibs/sq. fiberglass. Elastomeric asphalt shall be a mix of selected bitumen and SBS thermoplastic polymer.

c. Physical properties:

(1) Tensile strength:
Longitudinal - 82 Ibs./in.
Transversal- 67 Ibs./in.

(2) Ultimate elongation:
Longitudinal - 4%
Transversal - 4%

(3) Static puncture strength - 18 Ibs.

(4) Low temperature flexibility, no cracking at -22 degrees F.

(5) SBS elongation - 1500%

(6) Load strain product:
Longitudinal - 328
Transversal - 268

(7) Approximate roll weight - 91 Ibs (41.3 kgs)

(8) Approximate thickness - 90 mils (2.2 mm)

C. BASE FLASHING SHEET MATERIALS

1. Base Ply Flashing: ELASTOPHENE 180 SANDED

a. Description: Flashing membrane shall have thermofusible elastomeric asphalt membrane is to be applied by non-woven polyester reinforcement and both sides to have a sanded surface by mopping only.

b. Components: Reinforcement shall be 3.68 Ibs/sq. non-woven polyester. Elastomeric asphalt shall be a mix of selected bitumen and SBS thermoplastic polymer.

c. Physical Properties:

(1) Tensile strength:
Longitudinal - 119 Ibs./in.
Transversal - 88 Ibs./in.

(2) Ultimate elongation,
Longitudinal, 58%
Transversal, 64%

(3) Static puncture strength - 67 Ibs.

(4) Low temperature flexibility, no cracking at -22 degrees F.

(5) SBS elongation - 1500%

(6) Load strain product:
Longitudinal - 6902
Transversal - 5632

(7) Approximate roll weight - 84 Ibs (38.1 kgs)

(8) Approximate thickness - 90 mils (2.2 mm)

2. Cap Flashing: ELASTOPHENE 180 PS Flashing membrane: ASTM D 6164, Grade S, Type SBS-modified asphalt sheet (reinforced with polyester fibers); suitable for application method specified. .

D. AUXILIARY ROOFING MEMBRANE MATERIALS

1. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

a. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

b. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

(1) Plastic Foam Adhesives: 50 g/L.

(2) Gypsum Board and Panel Adhesives: 50 g/L.

(3) Multipurpose Construction Adhesives: 70 g/L.

(4) Fiberglass Adhesives: 80 g/L.

(5) Contact Adhesive: 80 g/L.

(6) Other Adhesives: 250 g/L.

(7) Non-membrane Roof Sealants: 300 g/L.

(8) Sealant Primers for Nonporous Substrates: 250 g/L.

(9) Sealant Primers for Porous Substrates: 775 g/L.

2. Primer: ELASTOCOL 500.

   a. ASTM D 41.

   b. Primer shall be applied on all dissimilar materials except insulation.

   c. Description: Black bituminous varnish.

   d. Composition: Asphalt modified bitumen with thermoplastic polymers and volatile solvents.

3. Cold-Applied Adhesive: . FM Adhesive is a ready to use bitumen based cole adhesive that contains a bituminous binder with sticking agents and low solvent percents (complies with California VOC regulations) It is used for membrane adhesion in lieu of hot asphalt to acceptable and properly prepared low slope and horizontal substrates. This adhesive is applied by squeegee or with specific type equipment. FM Adhesive Squeegee Grade meets ASTM D 4479 criteria

4. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing membrane components to substrate; tested by manufacturer for required pullout strength, and acceptable to roofing system manufacturer.

5. Metal Flashing Sheet: As specified in Section 076200 "Sheet Metal Flashing and Trim."

6. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

   a. Water Cut-Off: Sopracolle or Sopramastic.

   b. Sopralene Flam 180 for gusset material.

E. SUBSTRATE BOARDS

1. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch (16 mm) thick, factory primed.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      (1) Georgia-Pacific Corporation; Dens Deck Prime.

2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

F. VAPOR RETARDER

1. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

   a. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil- (1.0-mm-) thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

3. Glass-Fiber Felt: ASTM D 2178, Type IV, asphalt impregnated.

G. ROOF INSULATION

1. General: Preformed roof insulation boards manufactured or approved by roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation.

2. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

   a. Standard board size to be 4 x 8 with an aged R-value

   b. The insulation manufacturer shall substantiate in writing its recommendations for the use of their product under the asphalt based waterproofing membrane bonded with hot asphalt.

   c. Minimum average aged R - value is to be 25.

3. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

4. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

H. INSULATION ACCESSORIES

1. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.

2. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

3. Wood Nailer Strips: Comply with requirements in “Section 061053 "Miscellaneous Rough Carpentry."

4. Tapered Edge Strips: ASTM C 728, perlite insulation board.

5. Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

   a. Verify that roof openings and penetrations are in place and curbs are set and braced and that roof drain bodies are securely clamped in place.

   b. Verify that wood cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

   c. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 05310 "Steel Decking."

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

2. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. VAPOR-RETARDER INSTALLATION

1. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively.

   a. Continuously seal side and end laps with tape.

2. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

D. INSULATION INSTALLATION

1. Comply with roofing system manufacturer's written instructions for installing roof insulation.

2. Install one lapped base-sheet course and mechanically fasten to substrate according to roofing system manufacturer's written instructions.

3. Insulation Cant Strips: Install and secure preformed 45-degree insulation cant strips at junctures of roofing membrane system with vertical surfaces or angle changes more than 45 degrees.

4. Install tapered insulation under area of roofing to conform to slopes indicated.

5. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

   a. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

6. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or more, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

   a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

7. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

8. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.

9. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:

10. Mechanically Fastened and Adhered Insulation: Install first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

    a. Fasten first layer of insulation according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.

    b. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.

    c. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

11. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints a minimum of 6 inches (150 mm) in each direction from joints of insulation below. Loosely butt cover boards together and fasten to roof deck. Tape joints if required by roofing system manufacturer.

    a. Fasten cover boards according to requirements in FM Approvals' "RoofNav" for specified Windstorm Resistance Classification.

E. ROOFING MEMBRANE INSTALLATION, GENERAL

1. Install roofing membrane system according to roofing system manufacturer's written instructions and applicable recommendations in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing" and as follows:

    a. Deck Type: I (insulated).

    b. Adhering Method: L (cold-applied adhesive).

    c. Squeegee grade adhesives are intended for horizontal applications of the field membrane, except end laps. For the best results, trowel grade FM adhesive should be used in the end laps

    d. Temperature range: The membrane, substrate and ambient temperatures must all be 50 degrees F (10C) ambient temperature.

e. Allow a minimum of 3 days after a membrane is installed for the adhesive to sufficiently cure before allowing foot or equipment traffic on the installed membrane and/or before successive plies are installed. When walking on the cold adhered membrane, a sunken footprint should not be visible nor should the adhesive be capable of sustaining a flame.

f. When the adhesive is used to seal side and end laps, a continuous bleed out of one eighth inch to one quarter inch is required; bleed out6 of cap membranes must be dressed with granules to the point of refusal.

g. All membranes must be allowed to relax prior to their installation in FM Adhesive.

h. Apply the adhesive with a three-sixteenth inch or one quarter inch notched squeegee or spray apply, for a uniform application of one and one-half gallons per square. Do not apply more this amount unless it is specified; do not allow the adhesive to puddle. Porous substrates typically require more adhesive than nonporous substrates.

i. Apply the adhesive in an area slightly larger than the width of the sheet; allow 5 to 15 minutes for the solvents to flash off before embedding the membrane. Flash off time will vary depending on available sunlight, relative humidity, wind flow and ambient temperature

j. At the three inch side laps and six inch end laps, bleed out of one-eighth inch to one quarter inch is required; bleed out of cap membranes should be dressed with granules to the point of refusal.

k. Laps may be sealed with FM Adhesive or heat welded. Trowel grade adhesive is recommended on end laps.

l. Adhesive sealed laps are not considered watertight until the adhesive sets, approximately 24 hours.

2. Cooperate with testing agencies engaged or required to perform services for installing roofing system.

3. Coordinate installation of roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

   a. At end of each day's work, provide tie-offs to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt, with joints and edges sealed.

   b. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.

   c. Remove and discard temporary seals before beginning work on adjoining roofing.

F. BASE-PLY SHEET INSTALLATION

1. Prior to application, the vertical surface receiving the base ply flashing shall receive a coat of primer at the rate of 1SD-200 sq. ft./gallon. This primer coaling must be dry before application of the base sheet flashing.

2. Lay base ply flashing in strips three (3) feet wide to the vertical surfaces, extending onto the flat surface of the roof a minimum of four (4) inches. Side laps shall be three (3) inches and shall be staggered a minimum of four (4) inches with the laps of the base ply.

3. Cold apply base ply flashing directly on its support from bottom to top followed by the torching of the roof tie-in.

4. After installation of base ply flashing, check all lap seams on the flashing by running a heated trowel along the edge of the seams.

   a. Thoroughly seal all voids in the corners and seams.

G. TOP PLY INSTALLATION

1. Once the base ply is applied and does not show any defects, install the top ply.

2. Completely unroll membranes and allow the unrolled membrane to completely relax (typically 20 minutes minimum in warm, sunny conditions) Relaxed membranes appear limp wilted or flaccid. When installed, The Soprastar relaxed membranes should be at or very near the same temperature as the base membrane to which it is being applied.

3. Once completely relaxed, Soprastar membranes are ready to install

4. Set membrane in place over the base ply as specified(starting at the lowest point on the roof, so as to offset head lap-s a minimum of two feet and side laps a minimum of twelve inches from those occurring in the base ply membrane. Subsequent rolls should be aligned with six and one half inches end laps and three inch side laps

5. Back roll Soprastar membranes loosely and gently from each end while standing on the rolls, walking backwards, creating two equivalent sub-rolls with 3 feet left flat in the center of the sheet. Care should be taken to keep rolls aligned.

6. Pulling, not pushing, each sub roll with a roll puller, cold apply the membrane

7. Top ply shall have side laps of three (3) inches and end laps of six (6) inches. Prior to installation of following ply surface granules on laps shall be embedded by torch healing the membrane surface and pressing the granules into the melted asphalt with a hot trowel.

8. Application shall provide a smooth surface, free of air pockets, wrinkles, fishmouths or tears.

9. Run membrane tight up against any vertical surfaces such as curbs, parapets, and vents.

10. After installation of the top ply, check all lap seams on the top ply using the edge of a hot trowel. Correct defect.

H. TOP PLY FLASHING INSTALLATION

1. Once the base ply is applied and does not show any defects, install the top ply.

2. Completely unroll membranes and allow the unrolled membrane to completely relax (typically 20 minutes minimum in warm, sunny conditions) Relaxed membranes appear limp wilted or flaccid. When installed, The Soprastar relaxed membranes should be at or very near the same temperature as the base membrane to which it is being applied.

3. Once completely relaxed, Soprastar membranes are ready to install.

4. Set membrane in place over the base ply as specified starting at the lowest point on the roof, so as to offset head lap-s a minimum of two feet and side laps a minimum of twelve inches from those occurring in the base ply membrane. Subsequent rolls should be aligned with six and one half inches end laps and three inch side laps.

5. Back roll Soprastar membranes loosely and gently from each end while standing on the rolls, walking backwards, creating two equivalent sub-rolls with 3 feet left flat in the center of the sheet. Care should be taken to keep rolls aligned.

6. Pulling, not pushing, each sub roll with a roll puller, cold apply the membrane.

7. Top ply shall have side laps of three (3) inches and end laps of six (6) inches. Prior to installation of following ply surface granules on laps shall be embedded by torch heating the membrane surface and pressing the granules into the melted asphalt with a hot trowel.

8. Application shall provide a smooth surface, free of air pockets, wrinkles, fishmouths or tears.

9. Run membrane tight up against any vertical surfaces such as curbs, parapets, and vents.

10. After installation of the top ply, check all lap seams on the top ply using the edge of a hot trowel. Correct defect.

I. VENT (STACK)

1. Inspect base ply installation and ensure tight seal around pipe.

2. Construct and install sheet metal vent sleeve as per details over base ply.

    a. Provide a minimum 5-inch base flange.

    b. Prime all metal surfaces.

    c. Heat metal flange with torch prior to setting in place and firmly pressing on flange to ensure even contact with roof surface.

3. Mop into place a reinforcing sheet of base ply material three feet square over the vent.

    a. Seal all seams and edges with a heated trowel.

4. Install top ply as specified.

    a. Cut membrane to fit tight against stack sleeve and seal by running a heated trowel around vent base.

5. Install metal vent cap.

J. CORNER FLASHING

1. Inside Comer:

    a. Pre-cut all flashing pieces and prime all surfaces prior to installation.

    b. Fabricate gusset 4-inch wide by 8-inch long with a 2-inch triangular tip.

        (1) Install gusset into comer using a torch and firmly pressing with a hot trowel.

        (2) Set gusset with triangular tip on base ply and wrapping the comer a minimum 2-inches on each side.

    c. Pre-cut base flashing membranes to provide a 4-inch tie-in to roof surface and 3-inch return at corner.

    d. Cold Apply first base flashing sheet into comer over gusset pressing overlap and tie-in firmly into position with a hot trowel.

    e. Cold apply second base flashing sheet into position with edge tight into corner.

(1) Cut off base tie-in selvage at 45-degree from vertical.

(2) Seal all edges with a hot trowel.

f. Pre-cut top flashing membranes to provide a 6-inch tie-in to roof surface and 3-inch return at comer.

g. Cold apply first top flashing sheet into corner over second base ply pressing overlap and tie-in firmly into position with a damp sponge.

h. Cold apply second top flashing sheet into position with edge tight into comer.

(1) Cut off base tie-in selvage at 45-degree from vertical.

(2) Press flashing firmly into position with a damp sponge.

(3) Seal all edges with hot trowel and sprinkle granules to cover seeping asphalt.

2. Outside Comers:

a. Pre-cut all flashing pieces and prime all surfaces prior to installation.

b. Fabricate gusset 4-inch wide by 8-inch long with a 2-inch triangular tip.

(1) Install gusset into corner using a torch and firmly pressing with a hot trowel.

(2) Set gusset with triangular tip on base ply and wrapping the corner a minimum of 2-inches on each side.

c. Pre-cut base flashing membranes to provide a 4-inch tie-in to roof surface and 3-inch return at comer.

d. Cold apply first base flashing sheet into comer over gusset pressing overlap and tie-in firmly into position with a hot trowel.

e. Cold second base flashing sheet into position with returns wrapped around corners.

(1) Cut off base tie-in selvage at 45-degree from vertical.

(2) Seal all edges with a hot trowel.

f. Pre-cut top flashing membranes to provide a 6-inch tie-in to roof surface and 3-inch return at corner.

g. Cold apply first top flashing sheet into comer over second base ply pressing overlap and tie-in firmly into position with a damp sponge.

h. Cold apply second top flashing sheet into position with edge tight into comer.

(1) Cut off base tie-in selvage at 45-degree from vertical.

(2) Press flashing firmly into position with a damp sponge.

(3) Seal all edges with hot trowel and sprinkle granules to cover seeping asphalt.

K. CURBS

1. Inspect and verify that all curbs are properly secured to deck, are level, a minimum 6-inches above finished roof, primed and ready to receive flashings.

2. Base ply membrane is to run horizontally tight up against the vertical curb or cant as required.

a. When base ply membrane is to act as temporary seal for an extended length of time, carry membrane up vertical surface a minimum of 1-inch.

3. Gusset to be fabricated 4-inch wide by 8-inch long with a 2-inch triangular tip.

a. Install gusset onto comer using a torch and firmly pressing with a hot trowel.

b. Set gusset with triangular tip on base ply and wrapping the corner a minimum 2-inches on each side.

4. Install base ply flashing as specified.

a. Pre-cut flashing to the total sum of curb height, thickness plus 1-inch for inside curb securement and 4-inch tie-in along base with width to match that of curb plus 3-inch overlap on each end.

b. Secure along inside of curb with roofing nails.

c. Cut back comer base selvage at 45-degree angle from vertical.

5. Install top ply as specified.

a. Pre-cut flashing to the total sum of curb height plus 6-inches for base tie-in with width to match that of curb plus 3-inch overlap at each end.

b. Cut flashing flush with the top of curb and seal edges with heated trowel.

c. Cut back comer base selvage at 45-degree angle from vertical.

d. Firmly press flashing into position using a damp sponge.

6. Provide metal counter flashing.

L. ROOF EDGE

1. Install base ply membrane as specified. Carry membrane over roof edge a minimum of 3-inches and temporarily fasten using galvanized roofing nails.

2. Install a continuous metal cleat (material) and edge as detailed.

a. Prime all dissimilar surfaces prior to membrane or flashing installation.

b. Flange on edge to be 4-inch minimum.

c. Nail flange to decking or wood blocking at 4-inch center - staggered.

3. Cover edge with a reinforcing strip of base membrane mopped into place. Membrane is to carry beyond the metal flange onto base ply a minimum of 4-inches.

a. Hold the reinforcing strip back from outside edge of metal by 3/4-inch.

b. Seal all edges with a hot trowel.

4. Install top ply of membrane according to 3.11 of this section with the edge tight against the metal and sealed with a hot trowel.

M. COPING / PARAPETS

1. Verify all surfaces are properly secured and fully primed, ready to receive flashings.

2. Base ply membrane is to run horizontally tight up to the vertical or cant as required.

3. Install base ply flashing as specified. Carry flashing up the vertical surface, over the top and down the outside face of the parapet a minimum of 3-inches. Fasten along outside edge at 4 inch centers using roofing nails.

a. Install a continuous metal cleat (material) and edge as detailed.

(1) Prime all dissimilar surfaces prior to membrane or flashing installation.

(2) Flange on edge to be 4-inch minimum.

(3) Nail flange to wood blocking at 4-inch center - staggered.

b. Cold apply top ply membrane and flashing as detailed and specified.

4. Install metal coping in lieu of edge as per manufacturer's or SMACNA specifications when applicable.

N. FIELD QUALITY CONTROL

1. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports.

2. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:

a. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.

b. Test specimens will be examined for interply voids according to ASTM D 3617 and to comply with criteria established in Appendix 3 in ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing."

c. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.

3. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

a. Notify Architect and Owner 48 hours in advance of date and time of inspection.

4. Roofing system will be considered defective if it does not pass tests and inspections.

a. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

O. PROTECTING AND CLEANING

1. Protect roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

2. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 07710 MANUFACTURED ROOF SPECIALTIES

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Copings.

b. Roof-edge flashings.

c. Roof-edge drainage systems.

d. Reglets and counterflashings.

2. Related Sections:

a. Section 06100 "Rough Carpentry" for wood nailers, curbs, and blocking.

b. Section 07920 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

C. PERFORMANCE REQUIREMENTS

1. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2. Wind Design Standard: Manufacture and install copings and roof-edge flashings tested according to FBC and capable of resisting the following design pressures:

a. Design Pressure: As indicated on Drawings.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. ACTION SUBMITTALS

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:

   a. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.

   b. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.

   c. Details of termination points and assemblies, including fixed points.

   d. Details of special conditions.

3. Samples for Verification: For copings, roof-edge flashings and roof-edge drainage systems made from 12-inch (300-mm) lengths of full-size components including fasteners, cover joints, accessories, and attachments.

E. INFORMATIONAL SUBMITTALS

1. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for roof-edge flashings.

2. Warranty: Sample of special warranty.

F. CLOSEOUT SUBMITTALS

1. Maintenance Data: For roofing specialties to include in maintenance manuals.

G. DELIVERY, STORAGE, AND HANDLING

1. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

2. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

PART 2 - PRODUCTS

A. EXPOSED METALS

1. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

B. CONCEALED METALS

1. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

a. Finish: No. 4 (fine reflective, polished directional satin)

C. UNDERLAYMENT MATERIALS

1. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

a. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).

b. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).

c. Products: Subject to compliance with requirements, provide one of the following:

(1) Carlisle Coatings & Waterproofing; CCW WIP 300HT.

(2) Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.

(3) Henry Company; Blueskin PE200 HT.

(4) Metal-Fab Manufacturing, LLC; MetShield.

(5) Owens Corning; WeatherLock Metal High Temperature Underlayment.

2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.

3. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

D. MISCELLANEOUS MATERIALS

1. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

2. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

a. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

3. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

4. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

5. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

E. COPINGS

1. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet (3.6 m), concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.

   a. Basis-of-Design Product: Subject to compliance with requirements, provide Perma-Tite coping, Flat version by Metal Era; or comparable product by one of the following:

      (1) Architectural Products Company.

      (2) ATAS International, Inc.

      (3) Castle Metal Products.

      (4) Cheney Flashing Company.

      (5) Hickman Company, W. P.

      (6) Johns Manville.

      (7) Merchant & Evans, Inc.

      (8) Metal-Fab Manufacturing, LLC.

      (9) National Sheet Metal Systems, Inc.

      (10) Petersen Aluminum Corporation.

   b. Coping Cap Material: Stainless steel, minimum 24 gage, formed as indicated on the Drawings and as required for the installation. Support shall be coping chairs with perforated cleats. Concealed splice plate shall match color and finish of coping caps.

   c. Corners: Factory mitered and continuously welded.

   d. Coping-Cap Attachment Method: Snap-on, fabricated from coping-cap material.

   e. Snap-on-Coping Anchor Plates: Concealed, stainless steel sheet, 12 inches (300 mm) wide, with integral cleats.

   f. Cleats: Concealed, continuous stainless steel.

F. ROOF-EDGE DRAINAGE SYSTEMS

1. Downspouts: Plain rectangular complete with mitered and fully welded elbows, manufactured from the same metal as conductor head. Furnish with metal hangers, from same material as downspouts, and anchors.

2. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof.

   a. Fabricate from the following exposed metal:

      (1) Stainless Steel: 0.019 inch (0.48 mm) thick.

3. Conductor Heads: Manufactured conductor(1) heads, each with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, and built-in overflow.

   a. Fabricate from the following exposed metal:

      (1) Stainless Steel: 0.016 inch (0.40 mm) thick.

4. Stainless-Steel Finish: No. 4 (bright, polished directional satin).

G. REGLETS AND COUNTERFLASHINGS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Castle Metal Products.

   b. Cheney Flashing Company.

   c. Fry Reglet Corporation.

   d. Heckmann Building Products Inc.

   e. Hickman Company, W. P.

   f. Keystone Flashing Company, Inc.

   g. Metal-Era, Inc.

   h. Metal-Fab Manufacturing, LLC.

i. MM Systems Corporation.

j. National Sheet Metal Systems, Inc.

2. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:

a. Stainless Steel: 0.019 inch (0.48 mm) thick.

b. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.

c. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.

3. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets and compress against base flashings with joints lapped, from the following exposed metal:

a. Stainless Steel: 0.019 inch (0.48 mm) thick.

4. Accessories:

a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.

b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

5. Stainless-Steel Finish: No. 4 (bright, polished directional satin).

H. GENERAL FINISH REQUIREMENTS

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

2. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

3. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

4. Proceed with installation only after unsatisfactory conditions have been corrected.

B. UNDERLAYMENT INSTALLATION

1. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

2. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

3. Polyethylene Sheet: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed

water, with lapped and taped joints of not less than 2 inches (50 mm).

4. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

C. INSTALLATION, GENERAL

1. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

   a. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.

   b. Provide uniform, neat seams with minimum exposure of solder and sealant.

   c. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.

   d. Torch cutting of roof specialties is not permitted.

   e. Do not use graphite pencils to mark metal surfaces.

2. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

   a. Coat concealed side of stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.

   b. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install

a course of self-adhering, high-temperature sheet underlayment.

c. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

3. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

a. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise shown on Drawings.

b. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

4. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

5. Seal joints with elastomeric sealant as required by roofing-specialty manufacturer.

6. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

D. COPING INSTALLATION

1. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

2. Anchor copings to meet performance requirements.

a. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.

E. ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

1. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

2. Downspouts: Join sections with continuous welds. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c.

   a. Provide elbows at base of downspout to direct water away from building.

3. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch (25 mm) below discharge.

F. REGLET AND COUNTERFLASHING INSTALLATION

1. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

2. Embedded Reglets: See Section 03300 "Cast-in-Place Concrete" and Section 04810 "Unit Masonry Assemblies" for installation of reglets.

3. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.

4. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches (100 mm) over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with elastomeric sealant. Fit counterflashings tightly to base flashings.

G. CLEANING AND PROTECTION

1. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

2. Clean and neutralize flux materials. Clean off excess solder and sealants.

3. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

4. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07920 JOINT SEALANTS

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

   a. Silicone joint sealants.

   b. Latex joint sealants.

2. Related Sections:

   a. Section 02764 "Pavement Joint Sealants" for sealing joints in pavements, walkways, and curbing.

   b. Section 04810 "Unit Masonry Assemblies" for masonry control and expansion joint fillers and gaskets.

   c. Section 08800 "Glazing" for glazing sealants.

   d. Section 09250 "Gypsum Board" for sealing perimeter joints.

C. ACTION SUBMITTALS

1. Product Data: For each joint-sealant product indicated.

2. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

3. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

4. Joint-Sealant Schedule: Include the following information:

   a. Joint-sealant application, joint location, and designation.

   b. Joint-sealant manufacturer and product name.

   c. Joint-sealant formulation.

   d. Joint-sealant color.

D. INFORMATIONAL SUBMITTALS

1. Qualification Data: For qualified Installer.

2. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

3. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

4. Field-Adhesion Test Reports: For each sealant application tested.

5. Warranties: Sample of special warranties.

E. QUALITY ASSURANCE

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

2. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

3. Product Testing: Test joint sealants using a qualified testing agency.

4. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

F. PROJECT CONDITIONS

1. Do not proceed with installation of joint sealants under the following conditions:

a. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).

b. When joint substrates are wet.

c. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.

d. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

G. WARRANTY

1. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

   a. Warranty Period: Two (2) years from date of Substantial Completion.

2. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

   a. Warranty Period: Five (5) years from date of Substantial Completion.

3. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

   a. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.

   b. Disintegration of joint substrates from natural causes exceeding design specifications.

c. Mechanical damage caused by individuals, tools, or other outside agents.

d. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

A. MATERIALS, GENERAL

1. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

   a. Architectural Sealants: 250 g/L.

   b. Sealant Primers for Nonporous Substrates: 250 g/L.

   c. Sealant Primers for Porous Substrates: 775 g/L.

3. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

4. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

5. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

B. SILICONE JOINT SEALANTS

1. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.

a. Products: Subject to compliance with requirements, provide one of the following:

(1) Dow Corning Corporation; 790.

(2) GE Advanced Materials - Silicones; SilPruf LM SCS2700.

(3) May National Associates, Inc.; Bondaflex Sil 290.

(4) Pecora Corporation; 301 NS.

(5) Sika Corporation, Construction Products Division; SikaSil-C990.

(6) Tremco Incorporated; Spectrem 1.

b. Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.

(1) Products: Subject to compliance with requirements, provide one of the following:

(2) Dow Corning Corporation; 790.

(3) May National Associates, Inc.; Bondaflex Sil 728 NS.

(4) Pecora Corporation; 301 NS.

(5) Tremco Incorporated; Spectrem 800.

C. LATEX JOINT SEALANTS

1. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

a. Products: Subject to compliance with requirements, provide one of the following:

(1) BASF Building Systems; Sonolac.

(2) Bostik, Inc.; Chem-Calk 600.

(3) May National Associates, Inc.; Bondaflex 600.

(4) Pecora Corporation; AC-20+.

(5) Schnee-Morehead, Inc.; SM 8200.

(6) Tremco Incorporated; Tremflex 834.

D. JOINT SEALANT BACKING

1. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

2. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

3. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

E. MISCELLANEOUS MATERIALS

1. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way,

and formulated to promote optimum adhesion of sealants to joint substrates.

3. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

   a. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

   b. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

      (1) Concrete.

      (2) Masonry.

c. Remove laitance and form-release agents from concrete.

d. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

(1) Metal.

(2) Glass.

e. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

f. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

C. INSTALLATION OF JOINT SEALANTS

1. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

2. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

3. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

4. Do not leave gaps between ends of sealant backings.

5. Do not stretch, twist, puncture, or tear sealant backings.

6. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

7. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

8. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

    a. Place sealants so they directly contact and fully wet joint substrates.

    b. Completely fill recesses in each joint configuration.

    c. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

9. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

    a. Remove excess sealant from surfaces adjacent to joints.

    b. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

    c. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

        (1) Use masking tape to protect surfaces adjacent to recessed tooled joints.

D. FIELD QUALITY CONTROL

1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

   a. Extent of Testing: Test completed and cured sealant joints as follows:

      (1) Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.

   b. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

      (1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

   c. Inspect tested joints and report on the following:

      (1) Whether sealants filled joint cavities and are free of voids.

      (2) Whether sealant dimensions and configurations comply with specified requirements.

      (3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

   d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.

e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

2. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

E. CLEANING

1. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

F. PROTECTION

1. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

G. JOINT-SEALANT SCHEDULE

1. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

a. Joint Locations:

(1) Isolation and contraction joints in cast-in-place concrete slabs.

b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing.

c. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

2. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

   a. Joint Locations:

      (1) Construction joints in cast-in-place concrete.

      (2) Control and expansion joints in unit masonry.

      (3) Perimeter joints between materials listed above and frames of doors windows and louvers.

   b. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50.

   c. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

3. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

   a. Joint Locations:

      (1) Isolation joints in cast-in-place concrete slabs.

   b. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing.

   c. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

4. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.

   a. Joint Locations:

      (1) Control and expansion joints on exposed interior surfaces of exterior walls.

      (2) Perimeter joints of exterior openings.

      (3) Vertical joints on exposed surfaces of walls and partitions.

(4) Perimeter joints between interior wall surfaces and frames of interior doors and windows.

b. Joint Sealant: Latex.

c. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION

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DIVISION 8 - OPENINGS

08110	Steel Doors and Frames
08331	Overhead Coiling Doors
08710	Door Hardware
08952	Fiberglass-Sandwich-Panel Assemblies

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SECTION 08110 STEEL DOORS AND FRAMES

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section includes hollow-metal work.

2. Related Requirements:

a. Section 08710 "Door Hardware" for door hardware for hollow-metal doors.

C. DEFINITIONS

1. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

D. COORDINATION

1. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

E. ACTION SUBMITTALS

1. Product Data: For each type of product.

a. Include construction details, material descriptions, core descriptions, and finishes.

2. Shop Drawings: Include the following:

a. Elevations of each door type.

b. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.

c. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

d. Locations of reinforcement and preparations for hardware.

e. Details of each different wall opening condition.

f. Details of anchorages, joints, field splices, and connections.

g. Details of accessories.

h. Details of moldings, removable stops, and glazing.

i. Details of conduit and preparations for power, signal, and control systems.

3. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

F. DELIVERY, STORAGE, AND HANDLING

1. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

2. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

3. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch-(102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:

   a. Amweld International, LLC.

   b. Ceco Door Products; an Assa Abloy Group company.

   c. Commercial Door & Hardware Inc.

   d. Custom Metal Products.

   e. Daybar.

   f. Hollow Metal Inc.

   g. MPI Group, LLC (The).

   h. North American Door Corp.

   i. Republic Doors and Frames.

   j. Steelcraft; an Ingersoll-Rand company.

2. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

B. INTERIOR DOORS AND FRAMES

1. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

2. Standard-Duty Doors and Frames: SDI A250.8, Level 1. At locations indicated in the Door and Frame Schedule.

   a. Physical Performance: Level C according to SDI A250.4.

   b. Doors:

      (1) Type: As indicated in the Door and Frame Schedule.

      (2) Thickness: 1-3/4 inches (44.5 mm) .

(3) Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.032 inch (0.8 mm).

(4) Edge Construction: Model 1, Full Flush.

(5) Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.

c. Frames:

(1) Materials: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch (1.0 mm).

(2) Construction: Full profile welded.

d. Exposed Finish: Prime.

C. EXTERIOR HOLLOW-METAL DOORS AND FRAMES

1. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

2. Heavy-Duty Doors and Frames: SDI A250.8, Level 2. At locations indicated in the Door and Frame Schedule.

a. Physical Performance: Level B according to SDI A250.4.

b. Doors:

(1) Type: As indicated in the Door and Frame Schedule.

(2) Thickness: 1-3/4 inches (44.5 mm.)

(3) Face: Metallic-coated steel sheet, minimum thickness of 0.042 inch (1.0 mm), with minimum A40 (ZF120) coating.

(4) Edge Construction: Model 1, Full Flush.

(5) Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical

steel-stiffener core at manufacturer's discretion.

(a) Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu (0.370 K x sq. m/W) 10 R-value when tested according to ASTM C 1363.

c. Frames:

(1) Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch (1.3 mm), with minimum A40 (ZF120) coating.

(2) Construction: Full profile welded.

d. Exposed Finish: Prime.

D. MATERIALS

1. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

4. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

5. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

a. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

6. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

7. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

8. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

9. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

10. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

E. FABRICATION

1. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

2. Hollow-Metal Doors:

   a. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.

   b. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches (3.2 mm in 51 mm).

c. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.

d. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.

e. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

3. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

a. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

b. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

c. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

d. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

e. Jamb Anchors: Provide number and spacing of anchors as follows:

(1) Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:

(a) Two anchors per jamb up to 60 inches (1524 mm) high.

(b) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.

(c) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.

(d) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.

(2) Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

(a) Three anchors per jamb up to 60 inches (1524 mm) high.

(b) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.

(c) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.

(d) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.

(3) Compression Type: Not less than two anchors in each frame.

(4) Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

f. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

(1) Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

4. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

5. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping

according to SDI A250.6, the Door Hardware Schedule, and templates.

a. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

b. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. STEEL FINISHES

1. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

a. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

2. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

2. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

C. INSTALLATION

1. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

2. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

   a. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

      (1) Install door silencers in frames before grouting.

      (2) Remove temporary braces necessary for installation only after frames have been properly set and secured.

      (3) Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

      (4) Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

   b. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

      (1) Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

   c. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.

   d. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

   e. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.

f. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

g. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.

h. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

(1) Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

(2) Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.

(3) Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

(4) Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

i. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

j. Non-Fire-Rated Steel Doors:

(1) Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).

(2) At Bottom of Door: 5/8 inch (15.8 mm) plus or minus 1/32 inch (0.8 mm).

(3) Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).

D. ADJUSTING AND CLEANING

1. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

2. Remove grout and other bonding material from hollow-metal work immediately after installation.

3. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

4. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

5. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

6. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 08331 OVERHEAD COILING DOORS

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Service doors.

b. Insulated service doors.

2. Related Requirements:

a. Section 05500 "Metal Fabrications" for miscellaneous steel supports.

C. ACTION SUBMITTALS

1. Product Data: For each type and size of overhead coiling door and accessory.

a. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.

b. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

2. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

a. Include plans, elevations, sections, and mounting details.

b. Include details of equipment assemblies, and indicate dimensions, required clearances, method of

field assembly, components, and location and size of each field connection.

c. Include points of attachment and their corresponding static and dynamic loads imposed on structure.

d. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.

e. Include diagrams for power, signal, and control wiring.

3. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

a. Curtain slats.

b. Bottom bar with sensor edge.

c. Guides.

d. Brackets.

e. Hood.

f. Locking device(s).

g. Include similar Samples of accessories involving color selection.

D. INFORMATIONAL SUBMITTALS

1. Qualification Data: For Installer.

E. CLOSEOUT SUBMITTALS

1. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

F. QUALITY ASSURANCE

1. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

a. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

PART 2 - PRODUCTS

A. MANUFACTURERS, GENERAL

1. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

a. Obtain operators and controls from overhead coiling door manufacturer.

B. PERFORMANCE REQUIREMENTS

1. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

a. Design Wind Load: See Structural drawings.

b. Testing: Doors must meet State of Florida Product Approval.

c. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.

C. DOOR ASSEMBLY: 10’ X 10’

1. Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(1) Alpine Overhead Doors, Inc.

(2) ASTA Door Corporation.

(3) C.H.I. Overhead Doors.

(4) Cookson Company.

(5) Cornell Iron Works, Inc.

(6) McKeon Rolling Steel Door Company, Inc.

(7) Metro Door.

(8) Overhead Door Corporation.

(9) Raynor.

(10) Wayne-Dalton Corp.

2. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

   a. Include tamperproof cycle counter.

3. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h) when tested according to ASTM E 283 or DASMA 105.

4. Door Curtain Material: Galvanized steel.

5. Door Curtain Slats: Flat profile slats of2-5/8-inch (67-mm) center-to-center height.

6. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from hot-dip galvanized steel and finished to match door.

7. Curtain Jamb Guides: Galvanized steel] with exposed finish matching curtain slats.

8. Hood: Galvanized steel.

   a. Shape: Round.

   b. Mounting: Face of wall.

9. Electric Door Operator:

   a. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.

   b. Operator Location: Wall.

c. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 feet (2.44 m) or lower.

d. Motor Exposure: Exterior, wet, and humid.

e. Emergency Manual Operation: Chain type.

f. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar.

(1) Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.

g. Control Station(s): Interior mounted.

h. Other Equipment: Portable radio-control system.

10. Curtain Accessories: Equip door with weatherseals.

11. Door Finish:

a. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.

b. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

D. DOOR ASSEMBLY: 16’ X 14’

1. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

(1) Alpine Overhead Doors, Inc.

(2) ASTA Door Corporation.

(3) C.H.I. Overhead Doors.

(4) Cookson Company.

(5) Cornell Iron Works, Inc.

(6) McKeon Rolling Steel Door Company, Inc.

(7) Metro Door.

(8) Overhead Door Corporation.

(9) Raynor.

(10) Wayne-Dalton Corp.

2. Operation Cycles: Door components and operators capable of operating for not less than 50,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

   a. Include tamperproof cycle counter.

3. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h) when tested according to ASTM E 283 or DASMA 105.

4. Curtain R-Value: 5.0 deg F x h x sq. ft./Btu (0.881 K x sq. m/W).

5. Door Curtain Material: Galvanized steel.

6. Door Curtain Slats: Flat profile slats of2-5/8-inch (67-mm) center-to-center height.

7. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from hot-dip galvanized steel and finished to match door.

8. Curtain Jamb Guides: Galvanized steel] with exposed finish matching curtain slats.

9. Hood: Galvanized steel.

   a. Shape: Round.

   b. Mounting: Face of wall.

10. Electric Door Operator:

    a. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.

b. Operator Location: Wall.

c. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use; moving parts of operator enclosed or guarded if exposed and mounted at 8 feet (2.44 m) or lower.

d. Motor Exposure: Exterior, wet, and humid.

e. Emergency Manual Operation: Chain type.

f. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar.

(1) Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.

g. Control Station(s): Interior mounted [.

h. Other Equipment: Portable radio-control system.

11. Curtain Accessories: Equip door with weatherseals.

12. Door Finish:

a. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.

b. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

E. MATERIALS, GENERAL

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. DOOR CURTAIN MATERIALS AND CONSTRUCTION

1. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

a. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm); and as required.

b. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces.

c. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch (0.25 mm).

2. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

G. HOODS

1. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

a. Galvanized Steel: Nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.

H. CURTAIN ACCESSORIES

1. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

a. At door head, use 1/8-inch- (3-mm-) thick, replaceable, continuous-sheet baffle secured to inside of hood or field- installed on the header.

b. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- (3-mm-) thick seals of flexible vinyl, rubber, or neoprene.

I. COUNTERBALANCING MECHANISM

1. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

2. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

3. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

4. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

5. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

J. ELECTRIC DOOR OPERATORS

1. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral

gearing for locking door, and accessories required for proper operation.

a. Comply with NFPA 70.

b. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

2. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

3. Door Operator Location(s): Operator location indicated for each door.

a. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

4. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated.

a. Electrical Characteristics:

(1) Phase: 3 Phase.

(2) Volts: 460V.

(3) Hertz: 60.

b. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.

c. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.

d. Coordinate wiring requirements and electrical characteristics of motors and other electrical

devices with building electrical system and each location where installed.

5. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

6. Obstruction Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening.[For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

   a. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

      (1) Self-Monitoring Type: Four-wire configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

7. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

   a. Interior-Mounted Units: Full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

8. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N).

9. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

10. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

11. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

12. Portable Radio-Control System: Consisting of two of the following per door operator:

    a. Three-channel universal coaxial receiver to open, close, and stop door.

    b. Portable control device to open and stop door may be momentary-contact type; control to close door shall be sustained- or constant-pressure type.

    c. Remote-antenna mounting kit.

K. GENERAL FINISH REQUIREMENTS

1. Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.

2. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

L. STEEL AND GALVANIZED-STEEL FINISHES

1. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate

construction and other conditions affecting performance of the Work.

2. Examine locations of electrical connections.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. INSTALLATION

1. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

2. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

3. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

C. STARTUP SERVICE

1. Engage a factory-authorized service representative to perform startup service.

   a. Perform installation and startup checks according to manufacturer's written instructions.

   b. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

D. ADJUSTING

1. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

   a. Adjust exterior doors and components to be weather-resistant.

2. Lubricate bearings and sliding parts as recommended by manufacturer.

3. Adjust seals to provide tight fit around entire perimeter.

E. MAINTENANCE SERVICE

1. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of coiling-door Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

    a. Perform maintenance, including emergency callback service, during normal working hours.

F. DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 08331

SECTION 08710 DOOR HARDWARE

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section includes:

a. Mechanical door hardware for the following:

(1) Swinging doors.

2. Related Sections:

a. Section 08110 "Steel Doors and Frames" for door silencers provided as part of hollow-metal frames.

b. Section 08411 "Aluminum-Framed Entrances and Storefronts" for installation of entrance door hardware, including cylinders.

3. Products furnished, but not installed, under this Section include the products listed below. Coordinating and scheduling the purchase and delivery of these products remain requirements of this Section.

a. Permanent lock cores to be installed by Owner.

C. ACTION SUBMITTALS

1. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Samples for Verification: For exposed door hardware of each type required, in each finish specified, prepared on Samples of size indicated below. Tag Samples with full description for coordination with the door hardware schedule. Submit Samples before, or concurrent with, submission of door hardware schedule.

a. Sample Size: Full-size units or minimum 2-by-4-inch (51-by-102-mm) Samples for sheet and 4-inch (102-mm) long Samples for other products.

(1) Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

3. Other Action Submittals:

a. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

(1) Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

(2) Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.

(3) Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.

(4) Content: Include the following information:

(a) Identification number, location, hand, fire rating, size, and material of each door and frame.

(b) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.

(c) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.

(d) Fastenings and other pertinent information.

(e) Explanation of abbreviations, symbols, and codes contained in schedule.

(f) Mounting locations for door hardware.

(g) List of related door devices specified in other Sections for each door and frame.

b. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

D. INFORMATIONAL SUBMITTALS

1. Qualification Data: For Installer].

2. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

3. Warranty: Special warranty specified in this Section.

E. CLOSEOUT SUBMITTALS

1. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware schedule.

F. QUALITY ASSURANCE

1. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

a. Warehousing Facilities: In Project's vicinity.

b. Scheduling Responsibility: Preparation of door hardware and keying schedules.

2. Source Limitations: Obtain each type of door hardware from a single manufacturer.

3. Means of Egress Doors: Latches do not require more than 5 lbf (22.2 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

4. Accessibility Requirements: For door hardware on doors in an accessible route, comply with 2010 Florida Building Code Accessibility requirements.

a. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N).

b. Comply with the following maximum opening-force requirements:

(1) Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.

(2) Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.

(3) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

c. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.

d. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.

G. DELIVERY, STORAGE, AND HANDLING

1. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

2. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

3. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

H. COORDINATION

1. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

2. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

I. WARRANTY

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fails in materials or workmanship within specified warranty period.

   a. Failures include, but are not limited to, the following:

      (1) Structural failures including excessive deflection, cracking, or breakage.

      (2) Faulty operation of doors and door hardware.

      (3) Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

   b. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

      (1) Manual Closers: 10 years from date of Substantial Completion.

J. MAINTENANCE SERVICE

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions

for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

A. SCHEDULED DOOR HARDWARE

1. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

   a. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.

   b. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

2. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

   a. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.

B. HINGES

1. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

   a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

      (1) Baldwin Hardware Corporation.

      (2) Bommer Industries, Inc.

      (3) Cal-Royal Products, Inc.

(4) Hager Companies.

(5) IVES Hardware; an Ingersoll-Rand company.

(6) Lawrence Hardware Inc.

(7) McKinney Products Company; an ASSA ABLOY Group company.

(8) PBB, Inc.

(9) Stanley Commercial Hardware; Div. of The Stanley Works.

C. MECHANICAL LOCKS AND LATCHES

1. Lock Functions: As indicated in door hardware schedule.

2. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

   a. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.

   b. Deadbolts: Minimum 1-inch (25-mm) bolt throw.

3. Lock Backset: 2-3/4 inches (70 mm), unless otherwise indicated.

4. Lock Trim:

   a. Description: Per manufacturer’s specifications.

   b. Levers: Cast.

   c. Knobs: Wrought.

   d. Escutcheons (Roses): Wrought.

5. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

6. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

(1) Arrow USA; an ASSA ABLOY Group company.

(2) Best Access Systems; Div. of Stanley Security Solutions, Inc.

(3) Corbin Russwin Architectural Hardware; n ASSA ABLOY Group Company.

(4) Falcon Lock; An Ingersoll-Rand Company.

(5) Marks USA.

(6) SARGENT Manufacturing Company; an ASSA ABLOY Group company.

(7) Schlage Commercial Lock Division; an Ingersoll-Rand company.

(8) Yale Security Inc.; an ASSA ABLOY Group company.

D. LOCK CYLINDERS

1. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

a. Manufacturer: Same manufacturer as for locking devices.

2. Standard Lock Cylinders: BHMA A156.5; Grade 1; permanent cores that are removable; face finished to match lockset.

3. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 3 construction master keys.

E. KEYING

1. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

a. Master Key System: Change keys and a master key operate cylinders.

F. Keys: Brass.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

   a. Notation: "DO NOT DUPLICATE."

2. Quantity: In addition to one extra key blank for each lock, provide the following:

   a. Cylinder Change Keys: Three.

   b. Master Keys: Five.

G. DOOR GASKETING

1. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

   a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

      (1) Hager Companies.

      (2) M-D Building Products, Inc.

      (3) National Guard Products.

      (4) Pemko Manufacturing Co.; an ASSA ABLOY Group company.

      (5) Reese Enterprises, Inc.

      (6) Sealeze; a unit of Jason Incorporated.

      (7) Zero International.

H. THRESHOLDS

1. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

(1) Hager Companies.

(2) M-D Building Products, Inc.

(3) National Guard Products.

(4) Pemko Manufacturing Co.; an ASSA ABLOY Group company.

(5) Reese Enterprises, Inc.

(6) Rixson Specialty Door Controls; an ASSA ABLOY Group company.

(7) Sealeze; a unit of Jason Incorporated.

(8) Zero International.

I. FABRICATION

1. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

a. Manufacturer's identification is permitted on rim of lock cylinders only.

2. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

3. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

a. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

J. FINISHES

1. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

3. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

C. INSTALLATION

1. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

   a. Standard Steel Doors and Frames: ANSI/SDI A250.8.

2. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

   a. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

   b. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

3. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

4. Lock Cylinders: Install construction cores to secure building and areas during construction period.

   a. Furnish permanent cores to Owner for installation.

5. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07920 "Joint Sealants."

6. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

7. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

D. ADJUSTING

1. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

E. CLEANING AND PROTECTION

1. Clean adjacent surfaces soiled by door hardware installation.

2. Clean operating items as necessary to restore proper function and finish.

3. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

F. DOOR HARDWARE SCHEDULE

Door Hardware Set No. 1
Provide each SGL door(s) with the following:

Quantity	Item	Manufacturer	Product	Finish
3 each	Butts	STH	CB179 4 ½ x 4 ½	626
1 each	Lock Set	CR	CL3557 - NZD	626
1 each	Kick Plate	TBM	K0050 x 12″	630

Door Hardware Set No. 2
Provide each SGL door(s) with the following:

Quantity	Item	Manufacturer	Product	Finish
3 each	Butts	STH	CB179 4 ½ x 4 ½	626
1 each	Lock Set	CR	CL3520 - NZD	626
1 each	Kick Plate	TBM	K0050 x 12″	630

Door Hardware Set No. 3
Provide each SGL door(s) with the following:

Quantity	Item	Manufacturer	Product	Finish
3 each	Butts	STH	CB179 4 ½ x 4 ½	626
1 each	Lock Set	CR	CK4210 - GRC	626
1 each	Deadlock	CR	DL3013	626
1 each	Threshold	PEM	2001AT	Alum
1 set	Seals	PEM	P243	-
1 each	Rain Drip	PEM	346C	Alum

END OF SECTION

SECTION 08952 - FIBERGLASS-SANDWICH-PANEL ASSEMBLIES

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section includes aluminum-framed assemblies incorporating fiberglass-sandwich panels as follows:

   a. Wall assemblies.

2. Related Sections:

C. ACTION SUBMITTALS

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum components of panel assemblies.

2. Shop Drawings: For panel assemblies. Include plans, elevations, sections, details, and attachments to other work.

   a. Include details of provisions for assembly expansion and contraction and for draining moisture within the assembly to the exterior.

3. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

4. Fabrication Samples: Of each framing system intersection and adjacent panels, made from 12-inch (305-mm) lengths of full-size framing members and showing details of the following:

   a. Joinery.

   b. Anchorage.

c. Expansion provisions.

d. Fiberglass-sandwich panels.

e. Flashing and drainage.

5. Delegated-Design Submittal: For panel assemblies indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. INFORMATIONAL SUBMITTALS

1. Qualification Data: For qualified manufacturer.

2. Field quality-control reports.

3. Warranties: Sample of special warranties.

E. CLOSEOUT SUBMITTALS

1. Maintenance Data: For panel assemblies to include in maintenance manuals.

F. QUALITY ASSURANCE

1. Manufacturer Qualifications: For fiberglass-sandwich panels, a qualified manufacturer whose facilities, processes, and products are monitored by an independent, accredited quality-control agency for compliance with applicable requirements in ICC-ES AC04, "Sandwich Panels," or ICC-ES AC177, "Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems."

2. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of panel assemblies required for this Project.

3. Product Options: Information on Drawings and in Specifications establishes requirements for panel assemblies' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria

subject to verification by one or more methods including testing conducted by an independent testing agency and in-service performance.

a. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

4. Preconstruction Testing: Provide panel assemblies that comply with test-performance requirements indicated, as evidenced by reports of tests performed on manufacturer's standard panel assemblies by a qualified independent testing agency.

5. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

a. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

b. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. WARRANTY

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of panel assemblies that fail in materials or workmanship within specified warranty period.

a. Failures include, but are not limited to, the following:

(1) Structural failures including, but not limited to, excessive deflection.

(2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.

(3) Water leakage.

b. Warranty Period: Five years from date of Substantial Completion.

2. Special Fiberglass-Sandwich-Panel Warranty: Manufacturer's standard form in which manufacturer agrees to replace panels that exhibit defects in materials or workmanship.

a. Defects include, but are not limited to, the following:

(2) Fiberbloom.

(3) Delamination of coating, if any, from exterior face sheet.

(4) Color change exceeding requirements.

(5) Delamination of panel face sheets from panel cores.

b. Warranty Period: 20 years from date of Substantial Completion.

3. Special Aluminum-Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

a. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.

b. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Basis-of-Design Product: Subject to compliance with requirements, provide 4” Insulated Translucent Fiberglass Sandwich Panel Wall System by Kalwall Corporation or comparable product by one of the following:

a. Major Industries, Inc.

b. Skywall Translucent Systems; Vistawall Group (The).

c. Structures Unlimited, Inc.

B. PERFORMANCE REQUIREMENTS

1. General Performance: Fiberglass-sandwich-panel assemblies shall withstand the effects of the following forces without failure due to defective manufacture, fabrication, installation, or other defects in construction:

a. Structural loads.

b. Thermal movements.

c. Movements of supporting structure.

d. Dimensional tolerances of building frame and other adjacent construction.

e. Failure includes, but is not limited to, the following:

(1) Deflection exceeding specified limits.

(2) Water leakage.

(3) Thermal stresses transferred to building structure.

(4) Noise or vibration created by wind, thermal, or structural movements.

(5) Loosening or weakening of fasteners, attachments, and other components.

2. Structural Loads:

a. Wind Loads: See structural drawings

3. Deflection Limits:

a. Vertical Panel Assemblies: Limited to 1/180 of clear span for each assembly component.

4. Structural-Test Performance: Provide panel assemblies tested according to ASTM E 330, as follows:

a. When tested at positive and negative wind-load design pressures, assemblies do not show evidence of deflection exceeding specified limits.

5. Water Penetration under Static Pressure: Provide panel assemblies that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (480 Pa).

   a. Maximum Water Leakage: According to AAMA 501.1. Water leakage does not include water that is controlled by flashing and gutters and drained to the exterior, or water that cannot damage adjacent materials or finishes.

6. Thermal Movements: Allow for thermal movements from ambient- and surface-temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

   a. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

7. Energy Performance: Provide panel assemblies with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below and certified and labeled according to NFRC:

   a. Thermal Transmittance (U-Factor): Fixed glazing and framing areas shall have U-factor of not more than 0.65 Btu/sq. ft. x h x deg F (3.69 W/sq. m x K) as determined according to NFRC 100.

   b. Solar-Heat-Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.6 as determined according to NFRC 200.

   c. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).

C. ALUMINUM FRAMING SYSTEMS

1. Components: Manufacturer's standard extruded-aluminum members of thickness required and reinforced as required to support imposed loads.

   a. Construction: One-piece, extruded aluminum.

2. Aluminum: Alloy and temper recommended in writing by manufacturer for type of use and finish indicated.

   a. Sheet and Plate: ASTM B 209 (ASTM B 209M).

   b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).

   c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.

   d. Structural Profiles: ASTM B 308/B 308M.

3. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning skylight components.

4. Fasteners and Accessories: Manufacturer's standard, corrosion-resistant, nonstaining, and nonbleeding fasteners and accessories; compatible with adjacent materials.

   a. At closures, retaining caps, or battens, use ASTM A 193/A 193M, 300 series stainless-steel screws.

   b. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.

   c. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended in writing by manufacturer.

5. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

6. Concealed Flashing: Corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

7. Exposed Flashing and Closures: Aluminum sheet not less than 0.050 inch (1.27 mm) thick, finished to match framing.

8. Framing Gaskets: Manufacturer's standard.

9. Frame-System Sealants: As recommended in writing by manufacturer.

10. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

D. FIBERGLASS-SANDWICH PANELS

1. Description: Assembly of uniformly colored, translucent, thermoset, fiberglass-reinforced-polymer face sheets bonded to both sides of a grid core.

   a. Self-Ignition Temperature: 650 deg F (343 deg C) or more per ASTM D 1929.

   b. Smoke-Developed Index: 450 or less per ASTM E 84, or 75 or less per ASTM D 2843.

   c. Flame-Spread Index: Not more than 25 per ASTM E 84.

   d. Combustibility Classification: Class CC1 per ASTM D 635.

2. Panel Thickness: 4 inches.

   a. Grid Core: Mechanically interlocked, extruded-aluminum I-beams, with a minimum flange width of 7/16 inch (11.1 mm).

   b. Extruded Aluminum: ASTM B 221 (ASTM B 221M), in alloy and temper recommended in writing by manufacturer.

   c. I-Beam Construction: One-piece, extruded aluminum

   d. Grid Pattern: Inline rectangle, nominal 12 by 24 inches (305 by 610 mm).

3. Exterior Face Sheet:

a. Thickness: 0.070 inches (1.78 mm).

b. Color: Crystal.

c. Color Change: Not more than 3.0 units Delta E when measured according to ASTM D 2244, after outdoor weathering in southern Florida compliant with procedures in ASTM D 1435, with panels mounted facing south and as follows:

(1) Panel Mounting Angle: Not more than 5 degrees from horizontal.

(2) Exposure Period: 60 months.

a. Erosion Protection: Manufacturer's standard.

4. Interior Face Sheet:

a. Thickness: 0.060 inch (1.52 mm).

b. Color: Crystal.

5. Fiberglass-Sandwich-Panel Adhesive: ASTM D 2559.

a. Compatible with facing and core materials.

b. Tensile and shear bond strength of aged adhesive ensures permanent adhesion of facings to cores, as evidenced by testing tensile strength according to ASTM C 297 and shear bond strength according ASTM D 1002. Use accelerated aging procedures that comply with aging requirements for adhesives with high resistance to moisture in ICC-ES AC05, "Sandwich Panel Adhesives."

E. FABRICATION

1. Frame System Fabrication:

a. Fabricate components before finishing.

b. Fabricate components that, when assembled, have the following characteristics:

(1) Profiles that are sharp, straight, and free of defects or deformations.

(2) Accurately fitted joints with ends coped or mitered.

(3) Internal guttering systems or other means to drain water passing through joints, condensation occurring within components, and moisture migrating within assembly to exterior.

c. Fabricate sill closures with weep holes and for installation as continuous component.

d. Reinforce components as required to receive fastener threads.

2. Panel Fabrication: Factory assemble and seal panels.

a. Laminate face sheets to grid core under a controlled process using heat and pressure to produce straight adhesive bonding lines that cover width of core members and that have sharp edges.

(1) White spots indicating lack of bond at intersections of grid-core members are limited in number to four for every 40 sq. ft. (3.7 sq. m) of panel and limited in diameter to 3/64 inch (1.2 mm).

b. Fabricate with grid pattern that is symmetrical about centerlines of each panel.

c. Fabricate panel to allow condensation within panel to escape.

d. Reinforce panel corners.

F. ALUMINUM FINISHES

1. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine areas and conditions, with Installer present, for compliance with requirements for installation

tolerances and other conditions affecting performance of the Work.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. INSTALLATION

1. General:

   a. Comply with manufacturer's written instructions.

   b. Do not install damaged components.

   c. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.

   d. Rigidly secure nonmovement joints.

   e. Install anchors with separators and isolators to prevent metal corrosion, electrolytic deterioration, and immobilization of moving joints.

   f. Seal joints watertight unless otherwise indicated.

2. Metal Protection: Where aluminum components will contact dissimilar materials, protect against galvanic action by painting contact surfaces with corrosion-resistant coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.

3. Install continuous aluminum sill closures with weatherproof expansion joints and locked and sealed corners. Locate weep holes at rafters.

4. Install components to drain water passing through joints, condensation occurring within aluminum members and panels, and moisture migrating within assembly to exterior.

5. Install components plumb and true in alignment with established lines and elevations.

6. Erection Tolerances: Install panel assemblies to comply with the following maximum tolerances:

   a. Alignment: Limit offset from true alignment to 1/32 inch (0.8 mm) where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding

element separates aligned surfaces by less than 3 inches (76 mm); otherwise, limit offset to 1/8 inch (3.2 mm).

b. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m), but no greater than 1/2 inch (13 mm) over total length.

C. FIELD QUALITY CONTROL

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

   a. Water-Spray Test: Before installation of interior finishes has begun, panel assemblies shall be tested according to AAMA 501.2 and shall not show evidence of water penetration.

2. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

3. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

4. Prepare test and inspection reports.

END OF SECTION

DIVISION 9 – FINISHES

09111	Non-Load Bearing Steel Framing
09220	Portland Cement Plaster
09250	Gypsum Board
09511	Acoustical Panel Ceilings
09900	Painting and Coating
09911	Exterior Painting
09912	Interior Painting
09952	Cold Applied Wax Tape Coatings
09954	Polyethylene Sheet Encasement (AWWA C105)
09961	Fusion-Bonded Epoxy Linings and Coatings

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SECTION 09111 NON-LOAD-BEARING STEEL FRAMING

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Non-load-bearing steel framing systems for interior gypsum board assemblies.

b. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

C. ACTION SUBMITTALS

1. Product Data: For each type of product.

PART 2 - PRODUCTS

A. FRAMING SYSTEMS

1. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

a. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

b. Protective Coating: ASTM A 653/A 653M, G60 (Z180), hot-dip galvanized unless otherwise indicated.

3. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.

a. Steel Studs and Runners:

(1) Minimum Base-Metal Thickness: 0.027 inch (0.68 mm).

(2) Depth: As indicated on Drawings.

b. Dimpled Steel Studs and Runners:

(1) Minimum Base-Metal Thickness: 0.025 inch (0.64 mm).

(2) Depth: As indicated on Drawings.

4. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

a. Minimum Base-Metal Thickness: 0.027 inch (0.68 mm).

5. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and 1-1/2 inch (38 mm) depth required to fit insulation thickness indicated.

B. SUSPENSION SYSTEMS

1. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

2. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

3. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.

a. Depth: 2-1/2 inches (64 mm).

4. Furring Channels (Furring Members):

a. Cold-Rolled Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.

b. Steel Studs and Runners: ASTM C 645.

(1) Minimum Base-Metal Thickness: 0.027 inch (0.68 mm).

(2) Depth: 1-5/8 inches (41 mm).

C. AUXILIARY MATERIALS

1. General: Provide auxiliary materials that comply with referenced installation standards.

   a. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2. Isolation Strip at Exterior Walls: Provide one of the following:

   a. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.

   b. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

   a. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

C. INSTALLATION, GENERAL

1. Installation Standard: ASTM C 754.

   a. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

2. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

3. Install bracing at terminations in assemblies.

D. INSTALLING FRAMED ASSEMBLIES

1. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

   a. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.

   b. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.

   c. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.

2. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

3. Install studs so flanges within framing system point in same direction.

4. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

   a. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

(1) Install two studs at each jamb unless otherwise indicated.

(2) Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

b. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

5. Direct Furring:

a. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

6. Z-Furring Members:

a. Erect insulation, specified in Section 07210 "Building Insulation," vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.

b. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

c. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

7. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

E. INSTALLING SUSPENSION SYSTEMS

1. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

a. Hangers: 48 inches (1219 mm) o.c.

b. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.

c. Furring Channels (Furring Members): 16 inches (406 mm) o.c.

2. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

3. Suspend hangers from building structure as follows:

a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

(1) Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

(1) Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

c. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.

d. Do not attach hangers to steel roof deck.

e. Do not connect or suspend steel framing from ducts, pipes, or conduit.

4. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

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SECTION 09220 - PORTLAND CEMENT PLASTER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Nonstructural steel framing and furring.

2. Interior portland cement plasterwork on metal lath and solid-plaster bases.

3. Exterior portland cement plasterwork (stucco) on solid-plaster bases.

B. Related Sections include the following:

1. Division 7 Section "Joint Sealants" for sealants installed with exterior portland cement plaster (stucco).

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Delivery tickets showing exact quantities and full descriptions of cementitious materials, fiber reinforcement and liquid acrylic admixtures delivered to the job.

1.4 QUALITY ASSURANCE

A. Waterproofing of Stucco: It is the intention that exterior cement plaster stucco be mixed and applied to provide an effective rain shield that resists moisture entry into wall construction. It is intended that the paint film and stucco together form an effective barrier to vapor infusion into the wall from the exterior. Fiber reinforcement and acrylic

admixtures shall be used to improve stucco strength and bond, reduce cracking and make it more resistant to moisture.

B. PVC accessories shall not be used for exterior plaster work except in areas completely protected from rain.

C. Fire-Test-Response Characteristics: For portland cement plaster assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

D. Mockups: Before plastering, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Install mockups for each type of finish indicated.

2. For interior plasterwork, simulate finished lighting conditions for review of mockups.

3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination." Include the following topics as major points of discussion.

1. Preparation of concrete surfaces and the need for bonding agents.

2. Locations of control joints, and how accuracy of placement will be maintained.

3. Proposed method of monitoring the mix of each batch of cement plaster stucco, to ensure that materials are used in the correct proportion, that acrylic admixture is used in every batch, that materials are not overmixed, and that excessive water is not added to the mix.

4. Methods of properly curing exterior cement plaster to avoid rapid drying from wind and sun, use of damp curing and plastic sheeting to protect exterior plaster work.

F. Develop method to account for correct usage of liquid acrylic latexes as admixture. Provide quantity of liquid latex in proper proportion to bag goods as recommended by manufacturers. Submit delivery tickets as evidence and retain all empty latex containers. Unused acrylic latex admixture shall become property of the Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes.

1.6 PROJECT CONDITIONS

A. Comply with ASTM C 926 requirements.

B. Interior Plasterwork: Maintain room temperatures at greater than 50 deg F for at least 48 hours before plaster application, and continuously during and after application.

1. Avoid conditions that result in plaster drying out during curing period. Distribute heat evenly; prevent concentrated or uneven heat on plaster.

2. Ventilate building spaces as required to remove water in excess of that required for hydrating plaster in a manner that prevents drafts of air from contacting surfaces during plaster application and until plaster is dry.

C. Exterior Plasterwork:

1. Apply and cure plaster to prevent plaster drying out during curing period. Use procedures required by climatic conditions, including moist curing, providing coverings, and providing barriers to deflect sunlight and wind.

2. Apply plaster when ambient temperature is greater than 50 deg F.

3. Protect plaster coats from freezing for not less than 48 hours after set of plaster coat has occurred.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2. Products: Subject to compliance with requirements, provide one of the products specified.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 NONSTRUCTURAL STEEL FRAMING MEMBERS, GENERAL

A. Available Manufacturers:

1. Clark Steel Framing Systems.

2. Consolidated Systems, Inc.

3. Dale/Incor.

4. Dietrich Industries, Inc.

5. Marino/Ware; Division of Ware Industries, Inc.

6. Phillips Manufacturing Co.

7. SCAFCO Corporation.

8. Unimast, Inc.

B. Components, General: Comply with ASTM C 1063. For steel sheet components not included in ASTM C 1063, comply with

ASTM C 645 requirements for metal, unless otherwise indicated.

C. Cold-Rolled Channels: Base metal thickness of 0.0538 inch with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

D. Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, not less than 0.0475-inch diameter, unless otherwise indicated.

2.3 STEEL FRAMING FOR CEILINGS

A. Suspended Furring:

1. Main Runners (Carrying Channels): Cold-rolled channels, in depth indicated or if not indicated 1-1/2 inches deep.

2. Cross Furring: Cold-rolled channels, 3/4 inch deep.

B. Direct Furring: Cold-rolled channels, 3/4 inch deep.

C. Tie Wire:

1. For tying main runners directly to beams or joists (where wire hangers are used between beams or joists), use double loop of 0.1205-inch- diameter wire.

2. For tying furring directly to concrete structure without main runners, use 0.0800-inch- diameter wire.

3. For tying furring directly to steel or wood structure without main runners, use double loop of 0.0625-inch-diameter wire, or quadruple loop of 0.0475-inch-diameter wire.

4. For saddle tying cross furring to main runners use 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.

D. Wire Hangers: 0.162-inch- diameter wire.

E. Rod Hangers: ASTM A 510, mild carbon steel, ASTM A 153/A 153M, hot-dip galvanized.

1. Diameter: As recommended by ACI 524R.

F. Flat Hangers: Commercial-steel sheet, 1 by 3/16 inch, with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

G. Hanger Attachments to Concrete: Power-actuated fasteners that use explosive powder, gas combustion, or compressed air or other gas to embed fasteners in concrete and that are suitable for application indicated. Fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers. Capable of sustaining, without failure, a load equal to **10** times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.

2.4 STEEL FRAMING FOR PARTITIONS

A. Steel Studs and Runners: ASTM C 645.

1. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

2. Minimum Base Metal Thickness: 0.027 inch.

3. Depth: 3-5/8 inches unless otherwise indicated.

B. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

2. Minimum Base Metal Thickness: 0.027 inch.

C. Channel Bridging: Cold-rolled channels, 1-1/2 inches deep.

1. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick, galvanized steel.

D. Vertical Furring:

1. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

a. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

b. Minimum Base Metal Thickness: 0.0179 inch.

c. Depth: As indicated 7/8 inch or 1-1/2 inches.

2. Furring Channels: Cold-rolled channels, 3/4 inch deep.

    a. Furring Brackets: Adjustable, corrugated-edge type fabricated from steel sheet with minimum bare steel thickness of 0.0312 inch.

3. Runners: L-runners with perforated or plain legs to suit lath attachment requirements, in 0.0329-inch base metal thickness where attached to overhead support and in 0.0428-inch base metal thickness where attached to floor.

2.5 METAL LATH

A. Expanded-Metal Lath: ASTM C 847 with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

1. Manufacturers:

    a. Alabama Metal Industries Corporation (AMICO).

    b. Dale/Incor.

    c. Marino/Ware; Division of Ware Industries, Inc.

    d. Phillips Manufacturing Co.

    e. Unimast, Inc.

2. Diamond-Mesh Lath: Flat and Self-furring.

    a. Weight: 3.4 lb/sq. yd..

3. Flat Rib Lath: Rib depth of not more than 1/8 inch.

    a. Weight: 3.4 lb/sq. yd..

B. Paper Backing: FS UU-B-790, Type I Grade D, Style 2 vapor-permeable paper.

1. Provide paper-backed lath unless otherwise indicated.

2.6 ACCESSORIES

A. General: Comply with ASTM C 1063 and coordinate depth of trim and accessories with thicknesses and number of plaster coats required.

B. Zinc Accessories:

1. Manufacturers:

a. Alabama Metal Industries Corporation (AMICO).

b. Dale/Incor.

c. Dietrich Industries, Inc.

d. Phillips Manufacturing Co.

e. Unimast, Inc.

2. Cornerite: Fabricated from metal lath with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

3. External-Corner Reinforcement: Fabricated from metal lath with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.

4. Casing Beads: Fabricated from zinc; square-edged style; with expanded flanges.

5. Two-Piece Expansion Joints: Fabricated from zinc; formed to produce slip-joint and square-edged reveal that is adjustable from 1/4-to-5/8-inch wide; with perforated flanges.

C. Plastic Trim: Fabricated from high-impact PVC.

1. Manufacturers:

a. Alabama Metal Industries Corporation (AMICO).

b. Plastic Components, Inc.

c. Vinyl Corp.

2.7 MISCELLANEOUS MATERIALS

A. Water for Mixing: Potable and free of substances capable of affecting plaster set or of damaging plaster, lath, or accessories.

B. Fiber for Base Coat: Alkaline-resistant glass or, if approved, polypropylene fibers, 1/2-inch to ¾-inch long, free of contaminants, manufactured for use in portland cement plaster.

1. Subject to compliance with requirements provide Saint-Gobain AR Glass Strand, or if approved, Durafiber or Swicofil PP Fibers.

C. Bonding Compound: ASTM C 932.

D. Acrylic Admixture: Non-reemulsifiable, acrylic latex bonding agent and admixture that when substituted for part of mixing water for cement plaster, improves flexural strength, workability, reduces shrinkage, and increases bond strength.

1. Subject to compliance with requirements provide one of the following:

a. El Rey Stucco Company Inc.; Superior Additive 200

b. Euclid Chemical Co; Flex-Con.

c. Conproco Corp.; K-88 Admix.

d. Nox-Crete Products Group; Acryl-Binder.

e. Sika; Sika Latex R.

f. Silpro Corp.; C-21

g. Thoro Products; Acryl 60.

h. US Mix Products Co.; Acrylcoat

E. Steel Drill Screws: For metal-to-metal fastening, ASTM C 1002 or ASTM C 954, as required by thickness of metal being fastened; with pan head that is suitable for application; in lengths required to achieve penetration through joined materials of not fewer than three exposed threads.

F. Acid-Etching Solution: Muriatic acid (10 percent solution of commercial hydrochloric acid) mixed 1 part to not less than 6 nor more than 10 parts water.

G. Line Wire: 0.0475-inch-diameter, zinc-coated (galvanized), soft, annealed steel wire.

H. Fasteners for Attaching Metal Lath to Substrates: Complying with ASTM C 1063.

I. Isolation Strip at Exterior Walls:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), unperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

2.8 PLASTER MATERIALS

A. Portland Cement: ASTM C 150, Type I or Type II.

1. Color for Finish Coats: Gray.

B. Masonry Cement: ASTM C 91, Type N.

1. Color for Finish Coats: Gray.

C. Lime: ASTM C 206, Type S; or ASTM C 207, Type S.

D. Sand Aggregate: ASTM C 897.

2.9 PLASTER MIXES

A. General: Comply with ASTM C 926 for applications indicated.

1. Fiber Content: Add fiber to all base-coat mixes (not finish coat) after ingredients have mixed at least two minutes. Comply with fiber manufacturer's written instructions for fiber quantities in mixes, but do not exceed 1 lb of fiber/cu. ft. of cementitious materials. Reduce aggregate quantities accordingly to maintain workability. Do not over-mix after fibers are added.

2. Acrylic Admixture: At exterior (only) cement plaster work use as substitute for a portion of the mixing water according to the manufacturer’s printed instructions, but not less than one part admixture to three parts water for each batch of cement plaster; for base coat mixes and finish coat.

B. Base-Coat Mixes for Use over Metal Lath: Scratch and brown coats for three-coat plasterwork as follows:

1. Portland Cement Mixes:

a. Scratch Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 parts lime, except up to 1-1/2 parts lime may be used for interior ceilings. Use 2-1/2 to 4 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

b. Brown Coat: For cementitious material, mix 1 part portland cement and 0 to 3/4 parts lime, except up to 1-1/2 parts lime may be used for interior ceilings. Use 3 to 5 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

2. Masonry Cement Mixes:

a. Scratch Coat: 1 part masonry cement and 2-1/2 to 4 parts aggregate.

b. Brown Coat: 1 part masonry cement and 3 to 5 parts aggregate.

C. Base-Coat Mixes for Use over Monolithic Concrete: Single base coats for two-coat plasterwork as follows:

1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 0 to 3/4 part lime. Use 2-1/2 to 4 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

2. Portland and Masonry Cement Mix: For cementitious material, mix 1 part portland cement and 1 part masonry cement. Use 2-1/2 to 4 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

D. Base-Coat Mixes for Use over Concrete Unit Masonry: Single base coats for two-coat plasterwork as follows:

1. Portland Cement Mix: For cementitious material, mix 1 part portland cement and 3/4 to 1-1/2 parts lime. Use 2-1/2 to 4 parts aggregate per part of cementitious

material (sum of separate volumes of each component material).

2. Masonry Cement Mix: Use 1 part masonry cement and 2-1/2 to 4 parts aggregate.

E. Job-Mixed Finish-Coat Mixes:

1. Portland Cement Mix: For cementitious materials, mix 1 part portland cement and 3/4 to 1-1/2 for exterior work and 1-1/2 to 2 parts lime for interior work. Use 1-1/2 to 3 parts aggregate per part of cementitious material (sum of separate volumes of each component material).

2. Masonry Cement Mix: 1 part masonry cement and 1-1/2 to 3 parts aggregate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect adjacent work from soiling, spattering, moisture deterioration, and other harmful effects caused by plastering.

B. Prepare solid-plaster bases that are smooth or that do not have the suction capability required to bond with plaster according to ASTM C 926.

C. Accurately install line wires as guides for tooled architectural reveals.

3.3 INSTALLING NONSTRUCTURAL STEEL FRAMING, GENERAL

A. General: Comply with requirements in ASTM C 1063 for applications indicated.

1. Comply with ASTM C 754 for installation of items not addressed in ASTM C 1063.

B. Install supplementary framing, blocking, and bracing at terminations in plaster assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement.

1. Isolate ceiling assemblies where they abut or are penetrated by building structure.

2. Isolate partition framing and wall furring where it abuts structure, except at floor. At head of assemblies, install slip-type joints that avoid axial loading and that support assembly laterally.

D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

E. Soffits: Unless otherwise detailed on Drawings, install furred or suspended soffits to comply with requirements for ceiling installation; install framed soffits to comply with requirements for partition installation.

3.4 INSTALLING STEEL FRAMING FOR CEILINGS

A. Suspend ceiling hangers from building structure as follows:

1. Install hangers plumb and free of contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support

standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to limit deflection to 1/360 of span while supporting ceiling loads.

3. Wire Hangers: Secure by looping and tying, either directly to structure or directly to fasteners that are secure and appropriate for substrate, in a manner that will not cause them to deteriorate or otherwise fail.

4. Rod and Flat Hangers: Secure to structure, including intermediate framing members, by attaching to fasteners that are secure and appropriate for substrate and hanger, in a manner that will not cause hangers to deteriorate or otherwise fail.

5. Do not connect steel framing to or suspend it from ducts, pipes, or conduit.

B. Installation Tolerances: Install steel framing components for ceilings so members are level to within 1/4 inch in 10 feet measured lengthwise on each member and transversely between parallel members.

C. Install steel framing components for ceilings in sizes and spacings indicated but not less than that required by the referenced steel framing and installation standards.

1. Hanger Spacing: 48 inches o.c.

2. Main Runner (Carrying Channel) Spacing: For suspended ceilings, 36 inches o.c.

3. Cross-Furring Spacing: For suspended ceilings, 16 inches o.c., except where closer spacing required at curves.

3.5 INSTALLING STEEL PARTITION FRAMING

A. Install runners (tracks) at floors, ceilings, and structural walls and columns where plaster assemblies abut other construction.

1. Where studs are installed directly against exterior walls, install asphalt-felt or foam-gasket isolation strip between studs and wall.

B. Installation Tolerance: Install each steel framing member so fastening surfaces vary in plane not more than 1/4 inch in 10 feet.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling.

D. Install steel studs so flanges point in the same direction.

E. Frame door openings with two studs installed at each jamb, unless otherwise indicated.

1. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.

F. Support Spacing:

1. Install steel studs at 16 inches o.c., unless otherwise indicated.

2. Install vertical furring at 16 inches o.c., unless otherwise indicated.

3.6 INSTALLING METAL LATH

A. Expanded-Metal Lath: Install according to ASTM C 1063.

1. Partition Framing and Vertical Furring: Install flat diamond-mesh or flat rib lath.

2. Flat-Ceiling and Horizontal Framing: Install flat rib lath.

3. Curved-Ceiling Framing: Install flat diamond-mesh lath and adjust support spacing as required for curves.

4. On Solid Surfaces, Not Otherwise Furred: Install self-furring diamond-mesh lath at all joints between concrete masonry units and concrete to reinforce joint between differing materials.

3.7 INSTALLING ACCESSORIES

A. Install according to ASTM C 1063 and at locations indicated on Drawings.

B. Reinforcement for External Corners:

1. Install lath-type external-corner reinforcement at exterior locations, do not use corner beads at exterior locations.

2. Install cornerbead only at interior locations.

C. Install zinc casing bead as termination to cement plaster at expansion joints and elsewhere as required for clean termination of plaster coat.

1. Casing beads may be indicated as “J-Bead” or “Stop Bead” on Drawings. Provide solid zinc not galvanized even if galvanized indicated on Drawings.

D. Control Joints: Install control joints at locations indicated on Drawings, and in specific locations approved by Architect for visual effect as follows:

1. As required to delineate plasterwork into areas (panels) of the following maximum sizes:

a. Vertical Surfaces: 144 sq. ft..

b. Horizontal and other Nonvertical Surfaces: 100 sq. ft..

2. At distances between control joints of not greater than 18 feet o.c.

3. As required to delineate plasterwork into areas (panels) with length-to-width ratios of not greater than 2-1/2:1.

4. Where control joints occur in surface of construction directly behind plaster.

5. Where plasterwork areas change dimensions, to delineate rectangular-shaped areas (panels) and to relieve the stress that occurs at the corner formed by the dimension change.

3.8 PLASTER APPLICATION

A. General: Comply with ASTM C 926.

1. Do not deviate more than plus or minus 1/4 inch in 10 feet from a true plane in finished plaster surfaces, as measured by a 10-foot straightedge placed on surface.

2. Grout hollow-metal frames, bases, and similar work occurring in plastered areas, with base-coat plaster material, before lathing where necessary. Fully grout any door frames which were not grouted during installation as part of masonry work.

3. Finish plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where casing bead does not terminate plaster at metal frame, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.

4. Provide plaster surfaces that are ready to receive field-applied finishes indicated.

B. Bonding Compound: Apply as required on concrete plaster bases.

C. Plaster Finish Coats: Apply to provide smooth float finish to match Architect's sample.

D. Concealed Interior Plasterwork:

1. Where plaster application will be concealed behind built-in cabinets, similar furnishings, and equipment, apply finish coat.

2. Where plaster application will be concealed above suspended ceilings and in similar locations, finish coat may be omitted.

3. Where plaster application will be used as a base for adhesive application of tile and similar finishes, finish coat may be omitted.

3.9 CUTTING AND PATCHING

A. Cut, patch, replace, and repair plaster as necessary to accommodate other work and to restore cracks, dents, and imperfections. Repair or replace work to eliminate

blisters, buckles, crazing and check cracking, dry outs, efflorescence, sweat outs, and similar defects and where bond to substrate has failed.

3.10 CLEANING AND PROTECTION

A. Remove temporary protection and enclosure of other work. Promptly remove plaster from doorframes, windows, and other surfaces not indicated to be plastered. Repair floors, walls, and other surfaces stained, marred, or otherwise damaged during plastering.

END OF SECTION

SECTION 09250 GYPSUM BOARD

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section Includes:

a. Interior gypsum board.

2. Related Requirements:

a. Section 09111 "Non-Load-Bearing Steel Framing" for non-structural framing and suspension systems that support gypsum board panels.

C. ACTION SUBMITTALS

1. Product Data: For each type of product.

D. DELIVERY, STORAGE AND HANDLING

1. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

E. FIELD CONDITIONS

1. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

2. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

3. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

A. GYPSUM BOARD, GENERAL

1. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

2. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

3. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. INTERIOR GYPSUM BOARD

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following.:

a. American Gypsum.

b. CertainTeed Corp.

c. Georgia-Pacific Gypsum LLC.

d. Lafarge North America Inc.

e. National Gypsum Company.

f. PABCO Gypsum.

g. Temple-Inland.

h. USG Corporation.

2. Gypsum Wallboard: ASTM C 1396/C 1396M.

    a. Thickness: 5/8 inch (15.9 mm).

    b. Long Edges: Tapered.

3. Gypsum Ceiling Board: ASTM C 1396/C 1396M.

    a. Thickness: 1/2 inch (12.7 mm).

    b. Long Edges: Tapered.

4. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

    a. Core: 5/8 inch (15.9 mm).

    b. Long Edges: Tapered.

    c. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. TRIM ACCESSORIES

1. Interior Trim: ASTM C 1047.

    a. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

    b. Shapes:

        (1) Cornerbead.

D. JOINT TREATMENT MATERIALS

1. General: Comply with ASTM C 475/C 475M.

2. Joint Tape:

    a. Interior Gypsum Board: Paper.

3. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

    a. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.

b. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

(1) Use setting-type compound for installing paper-faced metal trim accessories.

c. Fill Coat: For second coat, use setting-type, sandable topping compound.

d. Finish Coat: For third coat, use setting-type, sandable topping compound.

e. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

E. AUXILIARY MATERIALS

1. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

2. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

a. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

a. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

2. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. APPLYING AND FINISHING PANELS, GENERAL

1. Comply with ASTM C 840.

2. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

3. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

4. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

5. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

   a. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.

   b. Fit gypsum panels around ducts, pipes, and conduits.

   c. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

   d. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

C. APPLYING INTERIOR GYPSUM BOARD

1. Install interior gypsum board in the following locations:

   a. Wallboard Type: Vertical surfaces unless otherwise indicated.

   b. Ceiling Type: As indicated on Drawings..

   c. Moisture- and Mold-Resistant Type: In Restroom and Mechanical Room.

2. Single-Layer Application:

   a. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.

   b. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

      (1) Stagger abutting end joints not less than one framing member in alternate courses of panels.

      (2) At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

   c. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

   d. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

D. INSTALLING TRIM ACCESSORIES

1. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

2. Interior Trim: Install in the following locations:

   a. Cornerbead: Use at outside corners.

E. FINISHING GYPSUM BOARD

1. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

2. Prefill open joints and damaged surface areas.

3. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

4. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

   a. Level 1: Ceiling plenum areas, concealed areas, and where indicated.

   b. Level 5: At panel surfaces that will be exposed to view unless otherwise indicated.

      (1) Primer and its application to surfaces are specified in other Section 09912 "Interior Painting."

F. PROTECTION

1. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

2. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

3. Remove and replace panels that are wet, moisture damaged, and mold damaged.

   a. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

   b. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 09511 ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section includes acoustical panels and exposed suspension systems for ceilings.

C. ACTION SUBMITTALS

1. Product Data: For each type of product.

2. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.

3. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

   a. Acoustical Panel: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.

   b. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- (150-mm-) long Samples of each type, finish, and color.

D. INFORMATIONAL SUBMITTALS

1. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

2. Evaluation Reports: For each acoustical panel ceiling suspension system, from ICC-ES.

E. CLOSEOUT SUBMITTALS

1. Maintenance Data: For finishes to include in maintenance manuals.

F. MAINTENANCE MATERIAL SUBMITTALS

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   a. Acoustical Ceiling Panels: 1-box of spare parts.

   b. Suspension-System Components: Quantity of each exposed component equal to 5 percent of quantity installed.

G. DELIVERY, STORAGE, AND HANDLING

1. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

2. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

3. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

H. FIELD CONDITIONS

1. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

   a. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

A. PERFORMANCE REQUIREMENTS

1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.

b. Smoke-Developed Index: 50 or less.

B. ACOUSTICAL PANELS, GENERAL

1. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.

2. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

3. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

a. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.

4. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

C. ACOUSTICAL PANELS

1. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries Cirrus Open Plan or comparable product by one of the following:

a. CertainTeed Corp.

b. Chicago Metallic Corporation.

c. Tectum Inc.

d. USG Interiors, Inc.; Subsidiary of USG Corporation.

2. Classification: Provide panels complying with ASTM E 1264 for type, form, and pattern as follows:

a. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.

b. Pattern: As indicated by manufacturer's designation.

3. Color: White.

4. LR: Not less than 0.85.

5. NRC: Not less than 0.75.

6. CAC: Not less than 35.

7. AC: Not less than 170.

8. Edge/Joint Detail: 15/16” Angled Tegular.

9. Thickness: 7/8 inch (22 mm).

10. Modular Size: 24 by 24 inches (610 by 610 mm).

11. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM G 21.

D. METAL SUSPENSION SYSTEMS, GENERAL

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25percent.

2. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

3. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

   a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

4. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

   a. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

b. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm-) diameter wire.

E. METAL SUSPENSION SYSTEM

1. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries Prelude or comparable product by one of the following:

a. CertainTeed Corp.

b. Chicago Metallic Corporation.

c. USG Interiors, Inc.; Subsidiary of USG Corporation.

2. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation; with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.

a. Structural Classification: Intermediate-duty system.

b. End Condition of Cross Runners: Override (stepped)type.

c. Face Design: Flat, flush.

d. Cap Material: Steel cold-rolled sheet.

e. Cap Finish: Painted white.

F. METAL EDGE MOLDINGS AND TRIM

1. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc. Prelude or comparable product by one of the following:

a. CertainTeed Corp.

b. Chicago Metallic Corporation.

c. Fry Reglet Corporation.

d. Gordon, Inc.

e. USG Interiors, Inc.; Subsidiary of USG Corporation.

2. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations ; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

   a. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.

   b. For lay-in panels with reveal edge details, provide nominal 15/16″, angle molding.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

2. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. PREPARATION

1. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

C. INSTALLATION

1. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

2. Suspend ceiling hangers from building's structural members and as follows:

   a. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.

   b. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

   c. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.

   d. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

   e. Do not attach hangers to steel deck tabs.

   f. Do not attach hangers to steel roof deck. Attach hangers to structural members.

   g. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.

   h. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

3. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

   a. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.

   b. Do not use exposed fasteners, including pop rivets, on moldings and trim.

4. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

5. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

   a. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

D. CLEANING

1. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 09900 PAINTING AND COATING

PART 1 - GENERAL

A. Description

This section includes materials and application of painting and coating systems for the following surfaces:

1. Submerged metal.
2. Exposed metal, including galvanized metal.
3. Buried metal.
4. Concrete and masonry.
5. PVC
6. Metal in contact with concrete.
7. Masonry
8. Exterior architectural coatings and finishes.
9. Interior architectural coatings and finishes.
10. Exposed Conduits and pipes.

It does not include coating steel water tanks and reservoirs.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.
2. Submit manufacturer's data sheets showing the following information:
    a. Percent solids by volume.
    b. Minimum and maximum recommended dry-film thickness per coat for prime, intermediate, and finish coats.
    c. Recommended surface preparation.
    d. Recommended thinners.

e. Statement verifying that the specified prime coat is recommended by the manufacturer for use with the specified intermediate and finish coats.

f. Application instructions including recommended equipment and temperature limitations.

g. Curing requirements and instructions.

3. Submit color swatches.

4. Submit certificate identifying the type and gradation of abrasives used for surface preparation.

5. Submit material safety data sheets for each coating.

PART 2 - MATERIALS

A. Painting and Coating Systems

The following index lists the various painting and coating systems by service and generic type:

PAINT COATINGS SYSTEM INDEX

No.	**Title**	**Generic Coating**
Submerged Metal Coating Systems		
1.	Submerged Metal, Raw Water (Nonpotable) or Raw Sewage	Epoxy
2.	Submerged Metal, Raw Water (Nonpotable), Raw Sewage, or Chemical Waste Immersion	Epoxy
6.	Submerged Metal, Raw Sewage or Grit Slurries	Epoxy resin/ceramic
7.	Submerged Metal, Potable or Nonpotable Water	Epoxy
10.	Exposed Metal, Corrosive Environment	High-build epoxy with polyurethane topcoat
15.	Exposed Metal, Atmospheric Weathering Environment	Alkyd enamel
17.	Exposed Metal, High Temperature	Silicon acrylic

No.	Title	Generic Coating
18.	Exposed Metal, Organic Zinc Primer for Shop Coating and Field Touch-Up	Organic zinc
19.	Exposed/Immersed Metal	Epoxy
Buried Metal Coating Systems		
21.	Buried Metal	Epoxy
22.	Buried Metal	Polyurethane
23.	Buried Metal	Thixotropic coal-tar pitch
24.	Buried Metal	Corrosion-resisting grease
Concrete and Masonry Coating Systems		
31.	Exposed Concrete and Masonry, Corrosive Environment	Polyurethane
32.	Exposed Concrete and Masonry, Atmospheric Weathering Environment	Acrylic
33.	Submerged Concrete, Raw Water or Raw Sewage	Vinyl ester
34.	Concrete Floors, Wet Environment	Epoxy
36.	Exposed Concrete and Masonry, Corrosive Environment	High-build epoxy with polyurethane topcoat
37.	Exposed Masonry or Concrete, Atmospheric Weathering Environment	Cement-based grouting
38.	Concrete in Chemical Containment Service	Novalac Epoxy
PVC Coating System		
41.	PVC, Ultraviolet Exposure	Polyurethane
Coating Systems for Nonferrous Metals		
51.	Aluminum Insulation from Concrete and Carbon Steel	Bituminous
52.	Exposed Metal, Galvanized Steel	Synthetic resin
55.	Repair of Galvanized Surfaces	Cold galvanizing compound
Plaster, Wood, Masonry, and Drywall Coating Systems		

No.	Title	Generic Coating
66.	Fusion Epoxy-Coated Steel, Color Coding	Epoxy
Exterior Architectural Coatings and Finishes		
71.	Flat Finish on Exterior Concrete and Cement Plaster	Acrylic latex
72.	Semi-Gloss Finish on Exterior Metal	Acrylic latex
73.	Clear Sealer on Exterior Concrete and Masonry	Silane
Interior Architectural Coatings and Finishes		
81.	Semi-Gloss Finish on Concrete, Masonry, or Plaster	Vinyl acrylic
83.	Semi-Gloss Finish on Gypsum Wallboard	Vinyl acrylic
84.	Flat Finish on Gypsum Wallboard	Vinyl acrylic

These systems are specified in detail in the following paragraphs. For each coating, the required surface preparation, prime coat, intermediate coat (if required), topcoat, and coating thicknesses are described. Mil thicknesses shown are minimum dry-film thicknesses.

B. Submerged Metal Coating Systems

1. System No. 1--Submerged Metal—Raw Water (Nonpotable) or Raw Sewage:

   Type: Epoxy having a minimum volume solids of 80%.

   Service Conditions: For use with metal pipes or structures (such as scum troughs, sluice gates, or piping) alternately submerged in raw sewage or raw water (nonpotable) and exposed to a moist saturated hydrogen sulfide atmosphere, as in raw sewage wet wells. Minimum temperature resistance of the coating shall be 140°F for moist heat conditions.

   Surface Preparation: SSPC SP-10.

   Prime Coat: Carboline Carboguard 891HS; Sherwin-Williams Tank Clad HS B62-W80; Tnemec Series 446-1223 (red), 8 mils; or equal.

Finish Coat: Carboline Carboguard 891HS; Sherwin-Williams Tank Clad HS B60-V80; Tnemec Series 446-1222 (gray), 8 mils; or equal.

2. System No. 2--Submerged Metal, Raw Water (Nonpotable) Raw Sewage, or Chemical Waste Immersion:

   Type: Polyamide cured epoxy prime, intermediate, and finish coats.

   Service Conditions: For use with metal pipes or structures (such as tanks, clarifier mechanisms, scum troughs, slide gates) immersed in raw water (nonpotable), raw sewage, or alkaline wastes or acidic wastes having a pH range of 5 to 11.

   Surface Preparation: SSPC SP-10.

   Prime Coat: Carboline Carboguard 891HS; Sherwin-Williams Tank Clad HS B62-W80; Tnemec Pota-Pox Series N140, 8 mils; or equal.

   Intermediate/Finish Coats: One coat of Carboline Carboguard 891HS; Sherwin-Williams Tank Clad HS B60-V80; one coat of Tnemec Pota-Pox Series N140, 8 mils; or equal.

   Total system thickness of prime, intermediate, and finish coats shall be 16 mils minimum.

3. System No. 6--Submerged Metal, Raw Sewage or Grit Slurries:

   Type: Two-component epoxy resin/ceramic having a 100% volume solids and having the following characteristics:

Tensile shear adhesion (ASTM D1002):	2,500 psi (min)
Shore D hardness (minimum):	85
Abrasion resistance (ASTM D4060):	0.8 mg (max) loss per 1,000 cycles

   Service Conditions: For use as a lining for pump volutes, pump impellers, piping, valves, and heat exchanger tubes, subject to severe abrasion service.

   Surface Preparation: SSPC SP-10.

Coating System: Apply two coats (of two different colors) to a minimum thickness of 10 mils per coat. Minimum total coating thickness shall be 20 mils. Product: THORTEX Cerami-Tech C.R. as applied by Western Industrial Technology, Inc., Fullerton, California, or Paragon Industries, Horsham, Pennsylvania; Belzona 1341; or equal.

4. System No. 7--Submerged Metal, Potable or Nonpotable Water:

Type: Epoxy.

Service Conditions: For use with structures, valves, piping, or equipment immersed in potable or nonpotable water. For potable water service, coating must comply with NSF 61.

Surface Preparation: SSPC SP-10.

Coating System: Apply the manufacturer's recommended number of coats to attain the specified minimum coating thickness. Products: Carboline Carboguard 891HS, Tnemec N140, Sherwin-Williams Tank Clad HS B62-W80/B60-V80, or equal; 16 mils total. Color of topcoat: white. Each coat shall be different color than the one preceding it.

C. Exposed Metal Coating Systems

1. System No. 10--Exposed Metal, Corrosive Environment:

Type: High-build epoxy intermediate coat having a minimum volume solids of 60%, with an inorganic zinc prime coat and a pigmented polyurethane finish coat having a minimum volume solids of 52%.

Service Conditions: For use with metal structures or pipes subjected to water condensation; chemical fumes, such as hydrogen sulfide; salt spray; and chemical contact.

Surface Preparation: SSPC SP-10.

Prime Coat: Self-curing, two-component inorganic zinc-rich coating recommended by the manufacturer for overcoating with a high-build epoxy finish coat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of 3 mils. Products: Carboline Carbozinc 11,

11VOC or 11HS, Tnemec 90-97, Sherwin-Williams Zinc-Clad II Plus, or equal.

Intermediate Coat: Carboline Carboguard 60, Tnemec 104, Sherwin-Williams Macropoxy 646 B58-600, or equal; 5 mils.

Finish Coat: Two-component pigmented acrylic or aliphatic polyurethane recommended by the manufacturer for overcoating a high-build epoxy coating. Apply to a thickness of at least 2 mils. Products: Carboline Carbothane 134HG, Tnemec Series 1075, Sherwin-Williams Acrolon Ultra, B65-800, or equal.

2. System No. 15--Exposed Metal, Atmospheric Weathering Environment:

Type: Semi-gloss acrylic having a minimum volume solids content of 46% with alkyd primer.

Service Conditions: For use on exterior metal and piping subject to sunlight and weathering.

Surface Preparation: SSPC SP-6.

Prime Coat: Carboline Carbocoat 115, Tnemec Primer Series V10, Sherwin-Williams Kem-Bond HS B50NZ series, or equal, applied to minimum dry-film thickness of 2 mils.

Finish Coat: Two coats of Carboline Carbocrylic 3359, two coats of Tnemec Series 1028, two coats of Sherwin-Williams DTM Acrylic B66 Series, or equal. Apply to a minimum dry-film thickness of 1.5 mils per coat.

3. System No. 17--Exposed Metal, High-Temperature Resistant (350°F):

Type: Silicone acrylic with a minimum volume solids of 30% (ASTM D 2697) with inorganic zinc prime coat.

Service Conditions: For use on exterior metal piping, such as air blower piping, having a maximum temperature of 350°F.

Surface Preparation: SSPC SP-10.

Prime Coat: Two-component inorganic zinc pigmented coating recommended by the manufacturer to be coated

with a silicone acrylic topcoat. Minimum zinc content shall be 12 pounds per gallon. Apply to a thickness of 3 mils. Products: Carboline Carbozinc 11, 11VOC or 11 HS; Sherwin-Williams Zinc-Clad II Plus, B69-VZ12/B69-VZ15/B69-D11; Tnemec 90-96, or equal.

Finish Coat: Carboline Thermaline 4900, Flame Control 600, or equal; 1.5 mils

4. System No. 18— Exposed Metal, Organic zinc primer for shop coating and field touch-up

   Type: Organic zinc primer having a minimum zinc content of 14 pounds per gallon.

   Service Conditions: For use as a shop-applied primer or field touch-up primer over inorganic zinc prime coatings on exposed metal.

   Surface Preparation: SSPC SP-10.

   Coating: Coating shall be of the two- or three-component converted epoxy, epoxy phenolic, or urethane type. Products: Carboline Carbozinc 859, Tnemec 90-97, Sherwin-Williams Corothane I GalvaPac B65G11, or equal; applied to a minimum dry-film thickness of 3 mils. Organic zinc primer shall be manufactured by the prime coat manufacturer.

5. System No. 19--Exposed/Immersed Metal:

   Type: Epoxy having a minimum solids content of 55% by volume.

   Service Conditions: For use with metal (steel, iron) such as canal gates, slide gates, and dam gates alternately immersed in raw water and exposed to an atmospheric weathering environment.

   Surface Preparation: SSPC SP-5.

   Prime Coat: Apply Carboline Carboguard 891HS (gray), Tnemec Series 1 Omnithane, Sherwin-Williams Macropoxy 646 (gray), or equal to a minimum dry-film thickness of 5 mils.

   Finish Coat: Apply Carboline Carboguard 891HS (white), Tnemec Series 446-1222 (Gray), Sherwin-Williams

Macropoxy 646 (white), or equal to a minimum dry-film thickness of 6 mils.

D. Buried Metal Coating Systems

1. System No. 21--Buried Metal:

Type: High solids epoxy or phenolic epoxy having a minimum volume solids of 80% (ASTM D2697).

Service Conditions: Buried metal, such as valves, flanges, bolts, nuts, structural steel, and fittings.

Surface Preparation: SSPC SP-10.

Coating System: Apply three or more coats of Carboline Carboguard 891HS, Tnemec 104HS, Sherwin-Williams Tank Clad HS B62-W80/B60-V80, or equal; 30 mils total. Maximum thickness of an individual coating shall not exceed the manufacturer's recommendation.

2. System No. 22--Buried Metal:

Type: Two-component polyurethane having the following characteristics:

a. Coatings shall contain no tar or hydrocarbon additives or solvent.

b. Hardness (ASTM D2240, Shore "D"): 65 to 85.

c. Abrasion Resistance (ASTM D4060, Taber CS-17): 25 mg (maximum) loss per 1,000 cycles or a maximum loss of 65 mg per ASTM C501.

Service Conditions: Buried metal, such as valves, flanges, bolts, nuts, structural steel, and fittings.

Surface Preparation: SSPC SP-10.

Coating System: Carboline Polyclad 767, Madison Chemical Industries, Inc. Corrocote Plus (CM), Sherwin-Williams Poly-Cote 115 or equal. Apply to a total thickness of 30 mils.

3. System No. 23--Buried Metal:

Type: Thixotropic, coal-tar pitch having a minimum volume solids of 68% and complying with MIL-C-18480A.

Service Conditions: Buried metal, such as flanges, nuts and bolts, fittings, structural steel especially subjected to corrosive conditions, such as acidic groundwater.

Surface Preparation: SSPC SP-10.

Prime Coat: Not required.

Finish Coat: Apply two coats of Carboline Bitumastic 50, 15 mils each; two or more coats of Tnemec 46-465, to a total thickness of 30 mils; or equal.

4. System No. 24--Buried Metal:

Type: Corrosion-resisting grease.

Service Conditions: Buried metal, such as bolts, bolt threads, tie rods, and nuts.

Surface Preparation: SSPC SP-3 or SP-6.

Coating: NO-OX-ID "GG-2" as manufactured by Sanchem, Inc. Apply to a minimum thickness of 1/4-inch.

E. Concrete and Masonry Coating Systems

1. System No. 31 - Exposed Concrete and Masonry, Corrosive Environment

Type: two-component, minimum 98% solids, polyurethane, with primer having the following characteristics.

Tensile Strength on Concrete:	2,500 psi (minimum) per ASTM D412
Flexibility:	No effect bending 0.50 mm plate with 30-mil coating over 1/8-inch mandrel per ASTM D1737 or no effect bending 180 degrees over 1-inch mandrel with 15-mil coating per ASTM D522
Elongation:	50% (minimum) recoverable, per ASTM D412

Surface Hardness:	60 minimum, Shore "D" per ASTM D2240
Abrasion Resistance:	Weight loss of 80 mg (maximum) on Taber abraser, CS-17 wheel, 1,000 grams, 1,000 cycles per ASTM D4060

Service Conditions: Buried concrete and concrete submerged in raw wastewater and exposed to an atmosphere containing up to 1,000-ppm hydrogen sulfide, saturated with water vapor.

Surface Preparation: Prepare surface in accordance with ASTM D4259 to create a surface profile equal to ICRI CSP 5 or greater.

Concrete Resurfacing: Apply Carboguard 510, Tnemec Series 218 Mortarclad, or Sherwin-Williams Corobond 300 B58A310/B58V310/B58D310 to all surfaces at an average of 1/16-inch to fill voids and bugholes, restore surface to a paintable condition and to mitigate concrete outgassing.

Product: Carboline Primer (Self priming when concrete is dry. Use Carboguard 1340WB, Phenoline 311, Carboguard 690 or Plasite 4503 as primer when concrete is damp) with Carboline Reactamine 760; Sherwin-Williams Primer (Dura-Plate 235, B67-V235 Series) with Sherflex B65-V910 topcoat; Tnemec Series 27WB Primer with Tnemec Series 406 Elastoshield. Apply prime coat and finish coats to give a total dry coating thickness of at least 80 mils on walls and 125 mils on floor or ceiling slabs.

2. System No. 32--Exposed Concrete and Masonry, Atmospheric Weathering Environment:

   Type: Acrylic enamel or acrylic latex having a minimum volume solids of 36%.

   Service Conditions: Exposed concrete or masonry exposed to normal sunlight and weathering.

   Surface Preparation: In accordance with Part 3, subsection on “Preparation of Concrete and Masonry Surfaces To Be Coated.”

Prime Coat: Water-borne acrylic or cementitious acrylic emulsion having a minimum solids volume of 40%. Apply one coat of Carboline Sanitile 100 to fill all voids, pores, and cracks; Tnemec 1254 Masonry Filler; Sherwin-Williams Heavy Duty Block Filler B42W46; or equal to masonry only from 75-125 square feet per coat.

Finish Coat: Two coats of Carboline Carbocrylic 3359, two coats Tnemec Series 6, Sherwin-Williams DTM Acrylic Coating Semi-Gloss B66-100 series, or equal. Apply to a thickness of 2 mils per coat.

3. System No. 33--Submerged Concrete, Raw Sewage or Raw Water:

   Modified aliphatic amine epoxy mortar, followed by Modified Polyamine Epoxy Topcoat. Must pass ASTM C 868 (Atlas Cell), no blistering, cracking, erosion, softening, loss of adhesion or gloss loss after 100 days continuous immersion at 100 deg f in 25% Sulfuric Acid. Not less than 12,331 psi Compressive Strength (ASTM D 695) (mortar), and not less than 9,427 psi Compressive Strength (ASTM D 695) (finish coat).

   Service Conditions: Concrete submerged in raw sewage and structures containing moist hydrogen sulfide such as manholes and sewage pumping station wet wells.

   Surface Preparation: In accordance with Part 3, subsection on "Preparation of Concrete and Masonry Surfaces To Be Coated." Prepare surface in accordance with ASTM D4259 to create a surface profile equal to ICRI CSP 5 or greater.

   Concrete Resurfacing: Apply Carboguard 510, Tnemec Series 218 Mortarclad, or Sherwin-Williams Corobond 300 B58A310/B58V310/B58D310 to all surfaces at an average of 1/16-inch to fill voids and bugholes, restore surface to a paintable condition and to mitigate concrete outgassing.

   a. Prime Coat: Apply Carboline Plasite 5371; Tnemec Series 434 Perma-Shield H2S, or Cor-Cote SC Plus Mortar, 125 mils DFT.

   b. Finish Coat: Apply Carboline Plasite 4500S; Tnemec Series 435 Perma-Glaze; or Cor-Cote SC Plus; 15-20 mils DFT.

4. System No. 34--Concrete Floors, Wet Environment:

   Type: Polyamide cured epoxy having a minimum volume solids of 53%.

   Service Conditions: Concrete floors subject to pedestrian traffic or exposure to water splashing from pump seal water, cleaning, etc.

   Surface Preparation: In accordance with Part 3, subsection on "Preparation of Concrete and Masonry Surfaces To Be Coated."

   Coating System: Two coats of Carboline Carboguard 890, two coats of Tnemec Series N69, two coats of Sherwin-Williams Macropoxy 646 B58-600 series, or equal. Apply to a minimum dry-film thickness of 5 mils per coat.

5. System No. 36--Exposed Concrete and Masonry, Corrosive Environment:

   Type: High-build epoxy intermediate coat having a minimum volume solids of 60%, with an epoxy filler prime coat and a pigmented polyurethane finish coat.

   Service Conditions: Concrete and masonry block exposed to corrosive atmospheres, such as hydrogen sulfide gas, chlorine gas, or chlorinated effluent sprays in wastewater treatment plants.

   Surface Preparation: In accordance with Part 3, subsection on "Preparation of Concrete and Masonry Surfaces To Be Coated."

   Prime Coat: Epoxy filler compound or epoxy masonry filler having a minimum solids volume of 60%. Apply one coat to fill voids, pores, and cracks in masonry only. Products: Carboline Sanitile 600, Tnemec 1254, Sherwin-Williams Kem Cati-Coat HS B42 W400 series, or equal.

   Intermediate Coats: Carboline Carboguard 890, Tnemec 104, Sherwin-Williams Macropoxy 646 B58-600 series, or equal. Apply multiple coats to a total minimum thickness of 15 mils. Thickness of any single coat shall not exceed 6 mils.

   Finish Coat: Two-component pigmented acrylic or aliphatic polyurethane recommended by the manufacturer

for overcoating a high-build epoxy coating. Minimum volume of solids shall be 52%. Apply to a thickness of at least 2 mils. Products: Carboline Carbothane 134HG, Tnemec Series 1075, Sherwin-Williams Acrolon Ultra B65-800 series, or equal.

6. System No. 37--Exposed Masonry or Concrete, Atmospheric Weathering Environment:

   Type: Cement-base, waterproofing grouting for concrete and masonry.

   Service Conditions: For use in waterproofing concrete, block, brick, stone, and other masonry.

   Surface Preparation: In accordance with Part 3, subsection on "Preparation of Concrete and Masonry Surfaces To Be Coated." Dampen surface immediately ahead of application with clean water. Follow manufacturer's instructions on mixing and application.

   Coatings: Apply two or more coats of Bonsal Sure-Coat to minimum total thickness of 1/16 inch or evenly distribute a base coat of Thoro Systems Products "Thoroseal" or equal, minimum 2 pounds per square yard. Then apply another coat at 1 pound per square yard for a total of 3 pounds per square yard.

7. System No. 38--Novalac Epoxy

   Type: 100% solids Novalac epoxy coating system. Water vapor transmission shall not exceed 0.0120 grain per hour per square foot per ASTM E 96. Permeability shall not exceed 0.0042 perm-inch.

   Service Conditions: Concrete submerged or intermittently exposed to 93% Sulfuric Acid, 25% Sodium Hydroxide and 100% Scale Inhibitor at a maximum temperature of 120°F.

   Secondary containment area concrete surfaces including floor, ramps, Equipment pads, sump pumps, and walls. Mix or broadcast sand or other fine material into coating as recommended by coating manufacturer for floor and stair tread surfaces where foot traffic is prevalent.

   Surface Preparation: SSPC SP13

Concrete Resurfacing (as required): Apply Carboguard 510 blended with Portland cement (Type 1) and sand, Tnemec Series 218 Mortarclad or Sherwin-Williams Corobond 300 B58A310/B58V310/B58D310 to all surfaces at an average of 1/16-inch to fill voids and bugholes, restore surface to a paintable condition and to mitigate concrete outgassing.

Prime Coat: Apply Carboline "Semstone 110", Tnemec 201 epoxy primer, or Sherwin-Williams Corobond 100 Epoxy Primer to a thickness of at least 8 mils DFT.

Apply filler and prime coat with roller or squeegee so that exposed aggregate is covered and the surface is level with the surrounding concrete.

Finish Coats: Apply one or more coats to a total thickness of 80 mils minimum. Observe manufacturer's recommended recoating time between coats. Products: Carboline Semstone 145 AFC, Tnemec 252SC-MK, Sherwin-Williams Cor-Cote HCR with 19lbs. Type S aggregate per 1.25 gallons @ 60.0-65.0 mils DFT. Topcoat with 1 coat of Cor-Cote HCRFF @ 10.0-15.0 mils DFT.

F. PVC Coating Systems

1. System No. 41-Color Coding of PVC exposed to sunlight

Type: Epoxy primer with a minimum volume solids of 54% and a pigmented polyurethane enamel having a minimum volume solids of 52%.

Service Conditions: Color coding of PVC exposed to sunlight.

Surface Preparation: SSPC SP-1. Then lightly abrade the surface with medium-grain sandpaper.

Prime Coat: One coat of Carboline Carboguard 60, Tnemec Series N69 Epoxoline, Sherwin-Williams Macropoxy 646 B58 series, or equal. Apply to a minimum dry-film thickness of 4 mils.

Finish Coat: One coat of Carboline Carbothane 134HG, Tnemec Series 1075, Sherwin-Williams Acrolon Ultra B65-800 series, or equal. Apply to a minimum dry-film thickness of 3 mils.

G. Coating Systems for Nonferrous Metals

1. System No. 51--Aluminum Insulation from Concrete and Carbon Steel:

   Type: Bituminous paint having a minimum volume solids of 68% coal-tar pitch based.

   Service Conditions: Coat areas of aluminum grating, stairs, structural members or aluminum fabrications, in contact with concrete or carbon steel with this system.

   Surface Preparation: Solvent or steam cleaning per SSPC SP-1; do not use alkali cleaning. Then dust blast.

   Prime Coat: No primer required for Carboline or Tnemec.

   Finish Coat: Carboline Bitumastic 50, Tnemec 46-465, or equal. Apply two coats to a minimum dry-film thickness of 12 mils each.

2. System No. 52--Exposed Metal, Galvanized Steel:

   Type: Synthetic resin or epoxy primer.

   Service Conditions: Coat galvanized steel and aluminum surfaces with this system before applying topcoat.

   Surface Preparation of Galvanized Steel: Surfaces shall be flat with no protrusions. Remove high spots and tears in the galvanizing with hand and power grinders. Comply with ASTM D6386, paragraph 5.2.1. Do not remove the galvanized coating below the specified thickness. Solvent clean galvanized surfaces per ASTM D6386, paragraph 5.3.2. Then sweep blast per ASTM D6386, paragraph 5.4.1. Use one of the abrasive materials that is described in ASTM D6386, paragraph 5.4.1. Surface preparation for weathered and partially weathered galvanized steel shall be in accordance with ASTM D6386, paragraphs 6 and 7. Apply prime coating within one hour of the surface preparation.

   Surface Preparation of Aluminum: Solvent clean or steam clean aluminum surfaces per SSPC SP-1; do not use alkali cleaning. Prime Coat: Carboline Galoseal WB, Tnemec N69-1211, Sherwin-Williams Macropoxy 646 B58-600 series, or equal. Apply to a minimum thickness of 4 mils.

Intermediate and Finish Coats: Epoxy and polyurethane as described in System No. 10. Do not include the inorganic zinc prime coat described in that system.

3. System No. 55--Repair of Galvanized Steel Surfaces:

Type: Cold galvanizing compound consisting of paint containing oils, solvents, and zinc dust and complying with MIL-P-21035. Minimum metallic zinc content in the cured coating shall be 90%.

Service Conditions: Repair of damaged galvanized coatings on steel surfaces. Do not utilize if galvanized steel is being topcoated.

Surface Preparation: Clean damaged surfaces per SSPC SP-1 and SP-11.

Coating System: Apply Z.R.C. Galvanizing Compound, RAMCO Specialty Products "Zinckit," NuWave "Galv-Match-Plus," Devcon "Cold Galvanizing," Clearco "Cold Galvanizing Spray," or equal to a minimum dry-film thickness of 3 mils. Apply per ASTM A780, Annex A2.

H. Plaster, Wood, Masonry, and Drywall Coating System

1. System No. 66--Fusion Epoxy-Coated Steel, Color Coding:

Type: Epoxy having a minimum volume solids content of 60%.

Application: Color coding of pipe or steel surfaces already coated with fusion bonded epoxy.

Surface Preparation: SSPC SP-1. Then roughen the epoxy surface with power tool cleaning per SP-3 or a light sandblast per SP-7.

Prime Coat: None.

Finish Coat: One coat of Carboline Carboguard 890, Tnemec 104, Sherwin-Williams Macropoxy 646 B58-600 series, or equal. Apply to a minimum dry-film thickness of 5 mils.

I. Exterior Architectural Coatings and Finishes

1. System No. 71--Flat Finish on Exterior Concrete and Cement Plaster:

Type: Acrylic flat with minimum volume solids of 40% with an epoxy acrylic sealer prime coat.

Surface Preparation: In accordance with Part 3, subsection on "Preparation of Concrete and Masonry Surfaces To Be Coated."

Prime Coat: Carboline Sanitile 120 or equal; Tnemec Series 6; 2 to 3 mils.

Intermediate Coat: Carboline Sanitile 155 or Sherwin-Williams Loxon Conditioner, or equal; 2 mils.

Finish Coat: Two coats, 1.5 mils dry each, or one coat, 3 mils total, of Carboline Sanitile 155, Sherwin-Williams A-100 A6 series, Tnemec Series 6, or equal.

2. System No. 72--Semi-Gloss Finish on Exterior Metal:

Type: Acrylic semi-gloss enamel with minimum volume solids of 35% with an acrylic or water-based inorganic zinc silicate metal primer.

Surface Preparation: Exterior exposed galvanized surfaces shall be sweep abrasive blasted per ASTM D6286 to achieve a uniform anchor profile (1 – 2 mils).

Prime Coat: Carboline Carbocrylic 3358 (ferrous) and Galoseal WB; Tnemec Series 18, Sherwin-Williams Pro-Cryl Universal Primer B66W310 or equal; 3 mils.

Finish Coat: Two coats, 1.5 mils dry each, of Carboline Carbocrylic 3359, Tnemec Series 1029, Sherwin-Williams Metalatex B42-100, or equal.

3. System No. 73--Clear Sealer on Exterior Concrete and Masonry:

Type: Silane with minimum solids of 22%.

Surface Preparation: In accordance with Part 3, subsection on "Preparation of Concrete and Masonry Surfaces To Be Coated."

Prime Coat: One coat Carboline Carbocrete Sealer WB, one coat Prime-A-Pell, one coat Monochem Silane 20 Penetrating Sealer or Hydrozo Enviroseal 7, two coats Okon Block Plugger, one coat Rainstopper 140 or one coat

of Sherwin-Williams Loxon 40% A31T40. Apply at 80 square feet per gallon.

Finish Coat: One coat Carboline Carbocrete Sealer WB, one coat Prime-A-Pell, two coats Hydrozo Enviroseal 7, one coat Okon W-2, one coat Rainstopper 140 or one coat of Sherwin-Williams Loxon 40% A31T40. Apply at 80 square feet per gallon.

J. Interior Architectural Coatings and Finishes

1. System No. 81--Semi-Gloss Finish on Concrete, Masonry, or Plaster:

Type: Acrylic semi-gloss enamel with minimum volume solids of 30% with an acrylic primer-sealer.

Surface Preparation: In accordance with Part 3, subsection on "Preparation of Concrete and Masonry Surfaces To Be Coated." Apply one coat of Carboline Sanitile 100 to fill all voids, pores, and cracks; Tnemec 1254 Masonry Filler; Sherwin-Williams Heavy Duty Block Filler B42W46; or equal to masonry only from 75-125 square feet per coat.

Prime Coat: Carboline Sanitile 120, Tnemec Series 6, Sherwin-Williams DTM Acrylic B66 Series or equal; 2 mils.

Finish Coat: Two coats, 1.5 mils dry each, of Carboline Carbocrylic 3359, Tnemec Series 1029, Sherwin-Williams DTM Acrylic B66 Series, or equal.

2. System No. 83--Semi-Gloss Finish on Gypsum Wallboard:

Type: Acrylic semi-gloss enamel with minimum volume solids of 45% with an acrylic primer with minimum volume solids of 55%.

Surface Preparation: Surfaces shall be dry, clean, and free of contaminants. Sand joint compound smooth and feather edges.

Prime Coat: Carboline Sanitile 120, Tnemec PVA Sealer 51, Sherwin-Williams Prep Rite B28W400, or equal; 1.4 mils.

Finish Coat: Two coats, 1.5 mils dry each, Carboline Carbocrylic 3359, Tnemec Series 1029, Sherwin-Williams Pro Mar 200S/G B31W200, or equal.

3. System No. 84--Flat Finish on Gypsum Wallboard:

   Type: Acrylic flat with minimum volume solids of 29%, with a vinyl acrylic latex primer with minimum volume solids of 55%.

   Surface Preparation: Surfaces shall be dry, clean, and free of contaminants. Sand joint compound smooth and feather edges.

   Prime Coat: Carboline Sanitile 120, Tnemec PVA Sealer 51, Sherwin-Williams Prep Rite B28W400, or equal; 1.5 mils.

   Finish Coat: Two coats, 1.5 mils dry each, of Carboline Sanitile 155, Tnemec Series 6, Sherwin-Williams Pro Mar 200 Flat B30W200, or equal.

K. Abrasives for Surface Preparation

1. Abrasives used for preparation of ferrous (excluding stainless steel) surfaces shall be one of the following:

   a. 16 to 30 or 16 to 40 mesh silica sand or mineral grit.

   b. 20 to 40 mesh garnet.

   c. Crushed iron slag, 100% retained on No. 80 mesh.

   d. SAE Grade G-40 or G-50 iron or steel grit.

2. Abrasives used for preparation of copper and aluminum surfaces shall be one of the following:

   a. Crushed slag, 80 to 100 mesh.

   b. Very fine silica sand, 80 to 100 mesh.

3. Abrasives used for preparation of concrete and masonry surfaces shall be 16 to 30 or 16 to 40 mesh silica sand.

4. In the above gradations, 100% of the material shall pass through the first stated sieve size and 100% shall be retained on the second stated sieve size.

L. Organic Zinc Primer for Field Touch-Up and Shop Coating

Where shop-applied inorganic zinc primers cannot be used because of volatile organic compound (VOC) regulations, the organic zinc primer described in System No. 18 may be substituted for the specified inorganic zinc primers.

PART 3 - EXECUTION

A. Weather Conditions

1. Do not paint in the rain, wind, snow, mist, and fog or when steel or metal surface temperatures are less than 5°F above the dew point.

2. Do not apply paint when the relative humidity is above 85%.

3. Do not paint when temperature of metal to be painted is above 120°F.

4. Do not apply alkyd, inorganic zinc, silicone aluminum, or silicone acrylic paints if air or surface temperature is below 40°F or expected to be below 40°F within 24 hours.

5. Do not apply epoxy, acrylic latex, and polyurethane paints on an exterior or interior surface if air or surface temperature is below 60°F or expected to drop below 60°F in 24 hours.

B. Surface Preparation Procedures

1. Remove oil and grease from metal surfaces in accordance with SSPC SP-1. Use clean cloths and cleaning solvents and wipe dry with clean cloths. Do not leave a film or greasy residue on the cleaned surfaces before abrasive blasting.

2. Remove weld spatter and weld slag from metal surfaces and grind smoothly rough welds, beads, peaked corners, and sharp edges including erection lugs in accordance with SSPC SP-2 and SSPC SP-3. Grind 0.020 inch (minimum) off the weld caps on pipe weld seams. Grind outside sharp corners, such as the outside edges of flanges, to a minimum radius of 1/4 inch.

3. Do not abrasive blast or prepare more surface area in one day than can be coated in one day; prepare surfaces and apply coatings the same day. Remove sharp edges, burrs, and weld spatter.

4. Do not abrasive blast PVC piping or equipment. Do not abrasive blast epoxy- or enamel-coated pipe that has already been factory coated, except to repair scratched or damaged coatings.

5. For carbon steel, do not touch the surface between the time of abrasive blasting and the time the coating is applied. Apply coatings within two hours of blasting or before any rust bloom forms.

6. Surface preparation shall conform with the SSPC specifications as follows:

Solvent Cleaning	SP-1
Hand Tool Cleaning	SP-2
Power Tool Cleaning	SP-3
White Metal Blast Cleaning	SP-5
Commercial Blast Cleaning	SP-6
Brush-Off Blast Cleaning	SP-7
Pickling	SP-8
Near-White Blast Cleaning	SP-10
Power Tool Cleaning to Bare Metal	SP-11
Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting Prior to Recoating	SP-12
Surface Preparation of Concrete	SP-13

7. Wherever the words “solvent cleaning,” “hand tool cleaning,” “wire brushing,” or “blast cleaning” or similar words are used in these specifications or in paint manufacturer’s specifications, they shall be understood to refer to the applicable SSPC (Steel Structure Painting Council), surface preparation specifications listed above.

8. Dust blasting is defined as cleaning the surface through the use of very fine abrasives, such as siliceous or mineral abrasives, 80 to 100 mesh. Apply a fine etch to

the metal surface to clean the surface of any contamination or oxide and to provide a surface profile for the coating.

9. Brush-off blasting of concrete and masonry surfaces is defined as opening subsurface holes and voids and etching the surface for a coating to bond.

10. For carbon steel surfaces, after abrasive blast cleaning, the height of the surface profile shall be 2 to 3 mils. Verify the surface profile by measuring with an impresser tape acceptable to the Owner's Representative. Perform a minimum of one test per 100 square feet of surface area. Testing shall be witnessed by the Owner's Representative. The impresser tape used in the test shall be permanently marked with the date, time, and locations where the test was made. Test results shall be promptly presented to the Owner's Representative.

11. Do not apply any part of a coating system before the Owner's Representative has reviewed the surface preparation. If coating has been applied without this review, if directed by the Owner's Representative, remove the applied coating by abrasive blasting and reapply the coat in accordance with this specification.

12. Examine substrates, areas and conditions, with Applicator and factory representative present for compliance with requirements for paint application. Comply with procedures in PDCA P4.

    a. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

    b. Start of painting will be construed as Factory Representative and Applicator's acceptance of surfaces and conditions within a particular area.

    c. Factory Representative will provide documentation of acceptance of substrates prior to the application of coating.

13. On flanged pipe joints, trim excess gasket material and caulk joint prior to coating.

C. Abrasive Blast Cleaning

1. Use dry abrasive blast cleaning for metal surfaces. Do not use abrasives in automatic equipment that have become contaminated. When shop or field blast cleaning with handheld nozzles, do not recycle or reuse blast particles.

2. After abrasive blast cleaning and prior to application of coating, dry clean surfaces to be coated by dusting, sweeping, and vacuuming to remove residue from blasting. Apply the specified primer or touch-up coating within the period of an eight-hour working day. Do not apply coating over damp or moist surfaces. Reclean prior to application of primer or touch-up coating any blast cleaned surface not coated within said eight-hour period.

3. Keep the area of the work in a clean condition and do not permit blasting particles to accumulate and constitute a nuisance or hazard.

4. During abrasive blast cleaning, prevent damage to adjacent coatings. Schedule blast cleaning and coating such that dust, dirt, blast particles, old coatings, rust, mill scale, etc., will not damage or fall upon wet or newly coated surfaces.

D. Preparation of Concrete and Masonry Surfaces To Be Coated

1. Surface preparation of concrete and masonry surfaces shall be in accordance with SSPC SP-13 and the following.

2. Do not apply coating until concrete has cured at least 30 days. Finish concrete surfaces per Section 03350. Do not use curing compound on surfaces that are to be coated.

3. Concrete and masonry surfaces on which coatings are to be applied shall be of even color, gray or gray-white. The surface shall have no pits, pockets, holes, or sharp changes of surface elevation. Scrubbing with a stiff-bristle fiber brush shall produce no dusting or dislodging of cement or sand. Sprinkling water on the surface shall produce no water beads or standing droplets. Concrete and masonry shall be free of laitance and slick surfaces.

4. Detergent clean the concrete or masonry surface with trisodium phosphate per ASTM D4258. Then sandblast surfaces (brush-off blast). Floor slabs may be acid etched per ASTM D4260 in lieu of sandblasting. After sandblasting, wash surfaces with water to remove dust and salts, per ASTM D4258 or D4261. The grain of the concrete surface to touch shall not be rougher than that of No. 10 mesh sand.

5. Prior to coating concrete, plaster, and masonry with System No. 31, 32, 33, 34, or 36, determine the presence of capillary moisture per ASTM D4263, except as modified below. Tape a 4-foot by 4-foot sheet of polyethylene plastic to the concrete surface to be coated. Allow the plastic sheet to remain in place at least 24 hours. After the specified time has elapsed, remove the plastic sheet and visually examine both the underside of the plastic sheet and the concrete surface beneath it. There shall be no indication of moisture on either surface. If moisture is indicated, allow additional curing time for the concrete and then retest. Provide one test sheet for every 500 square feet of concrete surface to be coated. For walls, provide one test sheet for each 10 feet (or fraction thereof) of vertical rise in all elevations starting within 12 inches of the floor or base slab.

6. Acceptance criteria for concrete surfaces shall be in accordance with SSPC SP-13, Table 1, "Severe Service."

7. Do not apply coatings to concrete when the concrete is outgassing. Apply coatings only when the concrete surface temperature is stable, not rising.

E. Procedures for Items Having Shop-Applied Prime Coats

1. After application of primer to surfaces, allow coating to cure for a minimum of two hours before handling to minimize damage.

2. When loading for shipment to the project site, use spacers and other protective devices to separate items to prevent damaging the shop-primed surfaces during transit and unloading. If wood spacers are used, remove wood splinters and particles from the shop-primed surfaces after separation. Use padded chains or ribbon binders to secure the loaded items and minimize damage to the shop-primed surfaces.

3. Cover shop-primed items 100% with protective coverings or tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit.

4. Handle shop-primed items with care during unloading, installation, and erection operations to minimize damage. Do not place or store shop-primed items on the ground or on top of other work unless ground or work is covered with a protective covering or tarpaulin. Place shop-primed items above the ground upon platforms, skids, or other supports.

F. Field Touch-Up of Shop-Applied Prime Coats

1. Remove oil and grease surface contaminants on metal surfaces in accordance with SSPC SP-1. Use clean rags wetted with a degreasing solution, rinse with clean water, and wipe dry.

2. Remove dust, dirt, salts, moisture, chalking primers, or other surface contaminants that will affect the adhesion or durability of the coating system. Use a high-pressure water blaster or scrub surfaces with a broom or brush wetted with a solution of trisodium phosphate, detergent, and water. Before applying intermediate or finish coats to inorganic zinc primers, remove any soluble zinc salts that have formed by means of scrubbing with a stiff bristle brush. Rinse scrubbed surfaces with clean water.

3. Remove loose or peeling primer and other surface contaminants not easily removed by the previous cleaning methods in accordance with SSPC SP-7. Take care that remaining primers are not damaged by the blast cleaning operation. Remaining primers shall be firmly bonded to the steel surfaces with blast cleaned edges feathered.

4. Remove rust, scaling, or primer damaged by welding or during shipment, storage, and erection in accordance with SSPC SP-10. Take care that remaining primers are not damaged by the blast cleaning operation. Areas smaller than 1 square inch may be prepared per SSPC SP-11. Remaining primers shall be firmly bonded to the steel surfaces with cleaned edges feathered.

5. Use repair procedures on damaged primer that protects adjacent primer. Blast cleaning may require the use of lower air pressure, smaller nozzles, and abrasive

particle sizes, short blast nozzle distance from surface, shielding, and/or masking.

6. After abrasive blast cleaning of damaged and defective areas, remove dust, blast particles, and other debris by dusting, sweeping, and vacuuming; then apply the specified touch-up coating.

7. Surfaces that are shop primed with inorganic zinc primers shall receive a field touch-up of organic zinc primer per System No. 18 to cover scratches or abraded areas.

8. Other surfaces that are shop primed shall receive a field touch-up of the same primer used in the original prime coat.

G. Painting Systems

1. All materials of a specified painting system, including primer, intermediate, and finish coats, shall be produced by the same manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the paint manufacturer for the particular coating system.

2. Deliver paints to the jobsite in the original, unopened containers.

H. Paint Storage and Mixing

1. Store and mix materials only in areas designated for that purpose by the Owner's Representative. The area shall be well-ventilated, with precautionary measures taken to prevent fire hazards. Post "No Smoking" signs. Storage and mixing areas shall be clean and free of rags, waste, and scrapings. Tightly close containers after each use. Store paint at an ambient temperature from 50°F to 100°F.

2. Prepare multiple-component coatings using all of the contents of the container for each component as packaged by the paint manufacturer. Do not use partial batches. Do not use multiple-component coatings that have been mixed beyond their pot life. Provide small quantity kits for touch-up painting and for painting other small areas. Mix only the components specified and furnished by the paint manufacturer. Do not intermix additional

components for reasons of color or otherwise, even within the same generic type of coating.

I. Procedures for the Application of Coatings

1. Conform to the requirements of SSPC PA-1. Follow the recommendations of the coating manufacturer including the selection of spray equipment, brushes, rollers, cleaners, thinners, mixing, drying time, temperature and humidity of application, and safety precautions.

2. Prior to painting, Contractor shall verify that conditions meet coating Manufacturer's weather conditions in presence of the Owner. Information form shall be completed daily and at four (4) hour intervals during the work day.

3. Stir, strain, and keep coating materials at a uniform consistency during application. Power mix components. For multiple component materials, premix each component before combining. Apply each coating evenly, free of brush marks, sags, runs, and other evidence of poor workmanship. Use a different shade or tint on succeeding coating applications to indicate coverage where possible. Finished surfaces shall be free from defects or blemishes.

4. Do not use thinners unless recommended by the coating manufacturer. If thinning is allowed, do not exceed the maximum allowable amount of thinner per gallon of coating material. Stir coating materials at all times when adding thinner. Do not flood the coating material surface with thinner prior to mixing. Do not reduce coating materials more than is absolutely necessary to obtain the proper application characteristics and to obtain the specified dry-film thicknesses.

5. Remove dust, blast particles, and other debris from blast cleaned surfaces by dusting, sweeping, and vacuuming. Allow ventilator fans to clean airborne dust to provide good visibility of working area prior to coating applications. Remove dust from coated surfaces by dusting, sweeping, and vacuuming prior to applying succeeding coats.

6. Apply coating systems to the specified minimum dry-film thicknesses as determined per SSPC PA-2.

7. Apply primer immediately after blast cleaning and before any surface rusting occurs, or any dust, dirt, or any foreign matter has accumulated. Reclean surfaces by blast cleaning that have surface colored or become moist prior to coating application.

8. Apply a brush coat of primer on welds, sharp edges, nuts, bolts, and irregular surfaces prior to the application of the primer and finish coat. Apply the brush coat prior to and in conjunction with the spray coat application. Apply the spray coat over the brush coat.

9. Before applying subsequent coats, allow the primer and intermediate coats to dry for the minimum curing time recommended by the manufacturer. In no case shall the time between coats exceed the manufacturer's recommendation.

10. Each coat shall cover the surface of the preceding coat completely, and there shall be a visually perceptible difference in applied shade or tint of colors.

11. Applied coating systems shall be cured at 75°F or higher for 48 hours. If temperature is lower than 75°F, curing time shall be in accordance with printed recommendations of the manufacturer, unless otherwise allowed by the Owner's Representative.

12. Assembled parts shall be disassembled sufficiently before painting or coating to ensure complete coverage by the required coating.

J. Surfaces Not To Be Coated

Do not paint the following surfaces unless otherwise noted in the drawings or in other specification sections. Protect during the painting of adjacent areas:

1. Concrete walkways.

2. Mortar-coated pipe and fittings.

3. Stainless steel.

4. Metal letters.

5. Glass.

6. Roofings.

7. Fencing.

8. Electrical fixtures except for factory coatings.

9. Nameplates.

10. Grease fittings.

11. Brass and copper, submerged.

12. Buried pipe, unless specifically required in the piping specifications.

13. Fiberglass items, unless specifically required in the FRP specifications.

14. Aluminum handrail, stairs, and grating.

15. Insulated pipe.

K. Protection of Surfaces Not To Be Painted

Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Mask openings in motors to prevent paint and other materials from entering the motors.

L. Surfaces To Be Coated

The exact coating to be applied in any location is not designated by the descriptive phrases in the coating system titles such as “corrosive environment,” “buried metal,” or “submerged metal.” Coat surfaces with the specific coating systems as described below:

1. Coat mechanical equipment, such as pumps, blowers, clarifier mechanisms, as described in the various mechanical equipment specifications. Color of finish coat shall match the color of the connecting piping.

2. Coat aboveground and exposed piping or piping in vaults and structures as described and as shown in the Piping Schedule/flow stream identification in the drawings. Color of finish coat shall be as shown in the Piping Schedule/flow stream identification in the drawings.

3. Coat submerged steel and ductile iron piping and piping in wet wells per System No. 1.

4. Coat valves the same as the adjacent piping. Aboveground valves, or valves in vaults and structures, shall match the color of the connecting piping.

5. Coat aluminum surfaces in contact with concrete per System No. 51.

6. Coat buried flanges, nuts and bolts, valves, flexible pipe couplings, and valve boxes per System No. 21. Coat buried bolt threads, tie bolt threads, and nuts per System No. 24.

7. Coat exposed indoor electrical conduit per System No. 52. Color of finish coat shall be specified by Owner.

8. Coat flashing and sheet metal per Section 07710.

9. Coat hollow metal doors and frames per Section 08110.

10. Coat gypsum wallboard as shown in the finish schedule in the drawings, system 81. Color of finish coat shall be as shown on the finish schedule in the drawings.

11. Concrete Coating Schedule:

    The following coating schedule is a general table to aid the General Contractor in describing the coating system to be applied within the major structures. The Contractor shall be responsible to reference the remainder of the Contract Documents for all other areas that require coating. Not all structures to be coated are identified within the following table.

Process Number(s)	Process Name	Exterior		Interior
		Below Grade	Above Grade	
155	North Control Building	N/A	Ref Arch Dwgs	System 34 (Floors) Reference Architectural Drawings
210-230	Phase I/II BNRs 1-4	N/A	N/A	System 31 (Underside of suspended slabs, & top of wall to 2 ft below LWL)
310-330	Phase III BNRs 5 & 6	N/A	N/A	System 31 (Underside of suspended slabs, & top of wall to 2 ft below LWL)
360	Flocculation Basin/ Filter Splitter Box	N/A	N/A	System 31 (underside of suspended slabs, troughs [interior and exterior] and walls)
500	Preliminary Treatment Structure	N/A	N/A	System 34 (Floors) Reference Structural & Architectural Drawings

Process Number(s)	Process Name	Exterior		Interior
		Below Grade	Above Grade	
520	Supplemental Carbon Metering & Storage Building	N/A	System 32	System 38 (floor and all containment walls and channel bottom). Reference Section 13121
540	Clarifier No. 11	N/A	N/A	System 31 (Top of Wall & Launders [Interior & Exterior] to 2 ft below weirs) System 33(Scum Box)
560	Secondary Effluent Reject Pump Station	N/A	N/A	System 31 (Underside of suspended slabs, & top of wall to 2 ft below LWL)
561, 562, 563 and 564	Secondary Effluent Reject Diversion Boxes	N/A	N/A	System 31 (Underside of suspended slabs, troughs [interior and exterior] & top of wall to 2 ft below LWL)
565	Secondary Effluent Reject Outfall	N/A	N/A	System 33

Process Number(s)	Process Name	Exterior		Interior
		Below Grade	Above Grade	
575	West Electrical Building	N/A	Ref Arch Dwgs	System 34 (Floors) Reference Architectural Drawings
580	Chlorine Contact Tank	N/A	NA	System 31 (Underside of suspended slabs, & top of wall to 2 ft below LWL)

12. If no coating system is specified for new structures provide coatings in accordance with the following:

Surface or Item	Coating System No.
Exposed interior concrete surfaces	31
Exposed exterior concrete surfaces	32
Interior masonry surfaces	81
Exterior masonry surfaces	71
Clear Sealer on Exterior Concrete & Masonry	73

M. Dry-Film Thickness Testing

1. Measure coating thickness specified for carbon steel surfaces with a magnetic-type dry-film thickness gauge in accordance with SSPC PA-2. Measure coating thickness specified for aluminum with an eddy-current type thickness gauge per ASTM D1400. Provide certification that the gauge has been calibrated by a certified laboratory within the past six months. Provide dry-film thickness gauge as manufactured by Mikrotest or Elcometer.

2. Test the finish coat of metal surfaces (except zinc primer and galvanizing) for holidays and discontinuities with an electrical holiday detector, low-voltage, wet-

sponge type. Provide measuring equipment. Provide certification that the gauge has been calibrated by a certified laboratory within the past six months. Provide detector as manufactured by Tinker and Rasor or K-D Bird Dog.

3. Measure coating thickness specified for concrete or masonry surfaces in accordance with ASTM D4138. Test the finish coat of concrete and masonry surfaces in accordance with NACE RP-0188-90 or ASTM D4787. Patch coatings at the points of thickness measurement or holiday detection.

4. Check each coat for the correct dry-film thickness. Do not measure within eight hours after application of the coating.

5. For metal surfaces, make five separate spot measurements (average of three readings) spaced evenly over each 100 square feet of area (or fraction thereof) to be measured. Make three readings for each spot measurement of either the substrate or the paint. Move the probe or detector a distance of 1 to 3 inches for each new gauge reading. Discard any unusually high or low reading that cannot be repeated consistently. Take the average (mean) of the three readings as the spot measurement. The average of five spot measurements for each such 100-square-foot area shall not be less than the specified thickness. No single spot measurement in any 100-square-foot area shall be less than 80%, nor more than 120%, of the specified thickness. One of three readings which are averaged to produce each spot measurement may underrun by a greater amount as defined by SSPC PA-2.

6. For concrete surfaces, make five separate spot measurements spaced evenly over each 100 square feet of area (or fraction thereof) to be measured. The average of five spot measurements for each such 100-square-foot area shall not be less than the specified thickness. No single spot measurement in any 100-square-foot area shall be less than 80%, nor more than 120%, of the specified thickness.

7. Perform tests in the presence of the Owner’s Representative.

8. All completed surfaces will be checked by the Owners Representative, and the Contractor shall provide the necessary properly calibrated gauges and the Contractor shall provide scaffolding and ladders as necessary for access to all coated areas. All nonferrous surfaces shall be checked for number of coats and thickness by use of a Tooke gauge. All ferrous surfaces shall be checked for film thickness by use of a magnetic dry film gauge properly calibrated. In addition, submerged tank linings and metals shall be tested for freedom from holidays and pinholes by use of a TinkerRasor Model # M1. All defects shall be corrected to the satisfaction of the Owners Representative. Contractor shall provide two (2) each of the following equipment with all appurtenances to be retained by the owner: Bacharach Sling Psychrometer, wet film thickness gauges appropriate to coating system thickness, TinkerRasor Holiday detector Model # M1, Tooke gauge and DeFelsko Positector No. 6000 or Elcometer dry film thickness gauge for ferrous metals with plastic shims.

N. Repair of Improperly Coated Surfaces

If the item has an improper finish color or insufficient film thickness, clean and topcoat the surface with the specified paint material to obtain the specified color and coverage. Sandblast or power-sand visible areas of chipped, peeled, or abraded paint, feathering the edges. Then prime and finish coat in accordance with the specifications. Work shall be free of runs, bridges, shiners, laps, or other imperfections.

O. Cleaning

1. During the progress of the work, remove discarded materials, rubbish, cans, and rags at the end of each day's work.

2. Thoroughly clean brushes and other application equipment at the end of each period of use and when changing to another paint or color.

3. Upon completion of painting work, remove masking tape, tarps, and other protective materials, using care not to damage finished surfaces.

END OF SECTION

SECTION 09911 EXTERIOR PAINTING

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section includes surface preparation and the application of paint systems on the following exterior substrates:

   a. Concrete.

   b. Concrete masonry units (CMU).

   c. Steel.

   d. Galvanized metal.

2. Related Requirements:

   a. Section 05120 "Structural Steel" for shop priming of metal substrates with primers specified in this Section.

   b. Section 09912 "Interior Painting" for surface preparation and the application of paint systems on interior substrates.

C. DEFINITIONS

1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

2. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

3. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

4. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

5. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

6. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

D. ACTION SUBMITTALS

1. Product Data: For each type of product. Include preparation requirements and application instructions.

2. Samples for Initial Selection: For each type of topcoat product.

3. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

   a. Submit Samples on rigid backing, 8 inches (200 mm) square.

   b. Step coats on Samples to show each coat required for system.

   c. Label each coat of each Sample.

   d. Label each Sample for location and application area.

4. Product List: For each product indicated, include the following:

   a. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

   b. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

   c. VOC content.

E. MAINTENANCE MATERIAL SUBMITTALS

1. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   a. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

F. DELIVERY, STORAGE, AND HANDLING

1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

    a. Maintain containers in clean condition, free of foreign materials and residue.

    b. Remove rags and waste from storage areas daily.

G. FIELD CONDITIONS

1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

2. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements provide products by one of the following.:

    a. Benjamin Moore & Co.

    b. Color Wheel Paints & Coatings.

    c. Coronado Paint.

    d. Duron, Inc.

    e. ICI Paints.

    f. Kwal Paint.

    g. M.A.B. Paints.

    h. PPG Architectural Finishes, Inc.

    i. Pratt & Lambert.

    j. Sherwin-Williams Company (The).

B. PAINT, GENERAL

1. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

2. Material Compatibility:

   a. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

   b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

3. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

4. Colors: As selected by Architect from manufacturer's full range .

C. BLOCK FILLERS

1. Block Filler, Latex, Interior/Exterior: MPI #4.

D. PRIMERS/SEALERS

1. Primer, Alkali Resistant, Water Based: MPI #3.

E. METAL PRIMERS

1. Primer, Alkyd, Anti-Corrosive for Metal: MPI #79.

F. WATER-BASED PAINTS

1. Light Industrial Coating, Exterior, Water Based (Gloss Level 3): MPI #161.

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

2. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

   a. Concrete: 12 percent.

   b. Masonry (Clay and CMU): 12 percent.

3. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

4. Proceed with coating application only after unsatisfactory conditions have been corrected.

   a. Application of coating indicates acceptance of surfaces and conditions.

B. PREPARATION

1. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

2. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

   a. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

3. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

   a. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

4. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

5. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

6. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer[] but not less than the following:

   a. SSPC-SP 2, "Hand Tool Cleaning."

7. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

8. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

C. APPLICATION

1. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."

   a. Use applicators and techniques suited for paint and substrate indicated.

   b. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

   c. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.

   d. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

   e. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

2. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

3. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

4. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

   a. Paint the following work where exposed to view:

      (1) Equipment, including panelboards and switch gear.

      (2) Uninsulated metal piping.

      (3) Uninsulated plastic piping.

      (4) Pipe hangers and supports.

      (5) Metal conduit.

      (6) Plastic conduit.

      (7) Tanks that do not have factory-applied final finishes.

D. FIELD QUALITY CONTROL

1. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

   a. Contractor shall touch up and restore painted surfaces damaged by testing.

   b. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

E. CLEANING AND PROTECTION

1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

F. EXTERIOR PAINTING SCHEDULE

1. Concrete Substrates, Nontraffic Surfaces:

a. Latex System:

(1) Prime Coat: Primer, alkali resistant, water based, MPI #3.

(2) Intermediate Coat: Latex, exterior, matching topcoat.

(3) Topcoat: Latex, exterior flat (Gloss Level 1), MPI #10.

2. CMU Substrates:

a. Latex System:

(1) Prime Coat: Block filler, latex, interior/exterior, MPI #4.

(2) Intermediate Coat: Latex, exterior, matching topcoat.

(3) Topcoat: Latex, exterior flat (Gloss Level 1), MPI #10.

3. Steel Substrates:

a. Water-Based Light Industrial Coating System:

b. Prime Coat: Primer, alkyd, anti-corrosive for metal, MPI #79.

c. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.

d. Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5), MPI #163.

4. Galvanized-Metal Substrates:

a. Water-Based Light Industrial Coating System:

(1) Prime Coat: Primer, galvanized, water based, MPI #134.

(2) Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.

(3) Topcoat: Light industrial coating, exterior, water based, semi-gloss (Gloss Level 5), MPI #163.

END OF SECTION

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SECTION 09912 INTERIOR PAINTING

PART 1 - GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY

1. Section includes surface preparation and the application of paint systems on the following interior substrates:

   a. Steel.

   b. Gypsum board.

2. Related Requirements:

   a. Section 05120 "Structural Steel" for shop priming of metal substrates with primers specified in this Section.

   b. Section 09931 "Wood Stains and Transparent Finishes" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

C. DEFINITIONS

1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

5. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

6. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

7. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

D. ACTION SUBMITTALS

1. Product Data: For each type of product. Include preparation requirements and application instructions.

2. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

   a. Submit Samples on rigid backing, 8 inches (200 mm) square.

   b. Step coats on Samples to show each coat required for system.

   c. Label each coat of each Sample.

   d. Label each Sample for location and application area.

   e. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

   f. VOC content.

E. MAINTENANCE MATERIAL SUBMITTALS

1. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   a. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

F. DELIVERY, STORAGE, AND HANDLING

1. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

   a. Maintain containers in clean condition, free of foreign materials and residue.

b. Remove rags and waste from storage areas daily.

G. FIELD CONDITIONS

1. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

2. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements provide products by one of the following.:

a. Benjamin Moore & Co.

b. Color Wheel Paints & Coatings.

c. Coronado Paint.

d. Duron, Inc.

e. ICI Paints.

f. Kwal Paint.

g. M.A.B. Paints.

h. PPG Architectural Finishes, Inc.

i. Pratt & Lambert.

j. Sherwin-Williams Company (The).

B. PAINT, GENERAL

1. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

2. Material Compatibility:

a. Provide materials for use within each paint system that are compatible with one another and substrates

indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

b. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

3. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

a. Flat Paints and Coatings: 50 g/L.

b. Nonflat Paints and Coatings: 150 g/L.

c. Dry-Fog Coatings: 400 g/L.

d. Primers, Sealers, and Undercoaters: 200 g/L.

e. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.

f. Zinc-Rich Industrial Maintenance Primers: 340 g/L.

g. Pretreatment Wash Primers: 420 g/L.

h. Floor Coatings: 100 g/L.

i. Shellacs, Clear: 730 g/L.

j. Shellacs, Pigmented: 550 g/L.

4. Colors: As selected by Architect from manufacturer's full range.

C. PRIMERS/SEALERS

1. Primer Sealer, Latex, Interior: MPI #50.

D. METAL PRIMERS

1. Primer, Rust-Inhibitive, Water Based: MPI #107.

E. WATER-BASED PAINTS

1. Latex, Interior, (Gloss Level 3): MPI #52.

2. Latex, Interior, Semi-Gloss, (Gloss Level 5): MPI #54.

F. SOURCE QUALITY CONTROL

PART 3 - EXECUTION

A. EXAMINATION

1. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

2. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

   a. Gypsum Board: 12 percent.

3. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

4. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

5. Proceed with coating application only after unsatisfactory conditions have been corrected.

   a. Application of coating indicates acceptance of surfaces and conditions.

B. PREPARATION

1. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

2. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

a. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

   a. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

4. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.

C. APPLICATION

1. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

   a. Use applicators and techniques suited for paint and substrate indicated.

   b. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

   c. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

   d. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

   e. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

2. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

3. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks,

roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

4. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

   a. Paint the following work where exposed in equipment rooms:

      (1) Equipment, including panelboards and switch gear.

      (2) Uninsulated metal piping.

      (3) Uninsulated plastic piping.

      (4) Pipe hangers and supports.

      (5) Metal conduit.

      (6) Plastic conduit.

      (7) Tanks that do not have factory-applied final finishes.

      (8) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

   b. Paint the following work where exposed in occupied spaces:

      (1) Equipment, including panelboards.

      (2) Uninsulated metal piping.

      (3) Uninsulated plastic piping.

      (4) Pipe hangers and supports.

      (5) Metal conduit.

      (6) Plastic conduit.

      (7) Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

      (8) Other items as directed by Architect.

c. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

D. CLEANING AND PROTECTION

1. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

2. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

3. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

4. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. INTERIOR PAINTING SCHEDULE

1. Steel Substrates:

a. Latex over Alkyd Primer System:

(1) Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.

(2) Intermediate Coat: Latex, interior, matching topcoat.

(3) Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

2. Gypsum Board Substrates:

a. Latex System:

(1) Prime Coat: Primer sealer, latex, interior, MPI #50.

(2) Intermediate Coat: Latex, interior, matching topcoat.

(3) Topcoat: Latex, interior, (Gloss Level 3), MPI #52.

(4) Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

END OF SECTION

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SECTION 09952 COLD-APPLIED WAX TAPE COATING

PART 1 - GENERAL

A. Description

This section includes materials and application of a three-part, cold-applied wax tape coating system for buried piping.

B. Submittals

1. Submit shop drawings in accordance with the General Provisions.

2. Submit manufacturer's catalog data sheets and application instructions.

PART 2 - MATERIALS

A. Primer

1. Primer shall be a blend of petrolatums, plasticizers, and corrosion inhibitors having a paste-like consistency. The primer shall have the following properties:

a. Pour Point: 100°F to 110°F.

b. Flash Point: 350°F.

c. Coverage: 1 gallon/100 square feet.

2. Primer shall be Trenton Wax Tape Primer, Denso Paste Primer, or equal.

B. Wax Tape

1. Wax tape shall consist of a synthetic-fiber felt, saturated with a blend of microcrystalline wax, petrolatums, plasticizers, and corrosion inhibitors, forming a tape coating that is easily formable over irregular surfaces. The tape shall have the following properties:

a. Saturant Pour Point: 115°F to 120°F.

b. Thickness: 50 to 70 mils.

c. Tape Width: 6 inches.

d. Dielectric Strength: 100 volts/mil.

2. Wax tape shall be Trenton No. 1 Wax Tape, Denso "Densyl Tape," or equal.

C. Plastic Wrapper

1. Wrapper shall be a polyvinylidene chloride plastic with three 50-gauge plies wound together as a single sheet. The wrapper shall have the following properties:

a. Color: Clear.

b. Thickness: 1.5 mils.

c. Tape Width: 6 inches.

2. Plastic wrapper shall be Trenton Poly-Ply, Denso Tape PVC Self-Adhesive, or equal.

D. Polyethylene Sheet Coating

See Section 09954.

PART 3 - EXECUTION

A. Wax Tape Coating Application

1. Surfaces shall be clean and free of all dirt, grease, water, and other foreign material prior to the application of the primer and wax tape.

2. Apply primer by hand or brush to all surfaces of the fitting. Work the primer into all crevices and completely cover all exposed metal surfaces.

3. Apply the wax tape immediately after the primer application. Work the tape into the crevices around fittings. Wrap the wax tape spirally around the pipe and across the fitting. Use a minimum overlap of 55% of the tape width. Apply tape to flanges, mechanical and

restrained joint bolts, nuts and glands, and grooved-end couplings to 6 inches beyond each side of the item.

4. Work the tape into the crevices and contours of irregularly shaped surfaces and smooth out so that there is a continuous protective layer with no voids or spaces under the tape.

5. Overwrap the completed wax tape installation with the plastic wrapping material. Wrap spirally around the pipe and across the fitting. Use a minimum overlap of 55% of the tape width and apply two layers or applications of overwrap. Secure plastic wrapper to pipe with adhesive tape.

B. Application of Polyethylene Sheet Coating to Buried Piping

Wrap completed wax tape coating system with polyethylene film per Section 09954 and secure around the adjacent pipe circumference with adhesive tape.

END OF SECTION

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SECTION 09954 POLYETHYLENE SHEET ENCASEMENT (AWWA C105)

PART 1 - GENERAL

A. Description

This section includes materials and installation of a polyethylene sheet encasement for buried steel and iron pipe, fittings, and valves.

B. Submittals

1. Submit shop drawings in accordance with General Conditions, Section 01300 and the following.

2. Submit manufacturer's catalog literature and product data sheets describing the physical, chemical, and electrical properties of the encasement material.

PART 2 - MATERIALS

A. Polyethylene Wrap

1. The encasement shall consist of low-density polyethylene wrap of at least 8-mil thickness conforming to AWWA C105. The polyethylene wrap shall be colored per process, refer to flow stream identification in the drawings.

2. Polyethylene encasement for ductile-iron pipe shall be supplied as a flat tube meeting the dimensions of Table 1 in AWWA C105 and shall be supplied by the ductile-iron pipe manufacturer.

B. Plastic Adhesive Tape

1. Tape shall consist of polyolefin backing and adhesive which bonds to common pipeline coatings including polyethylene.

2. Minimum Width: 2 inches.

3. Products: Canusa Wrapid Tape; Tapecoat 35; Polyken 934; AA Thread Seal Tape, Inc.; or equal.

PART 3 - EXECUTION

A. Application of Moldable Mastic Filler to Irregular Adjacent Surfaces

When the adjacent joints are bell-and-spigot or mechanical joints and any associated welding specifications do not require an external full fillet weld, apply a moldable mastic filler (per Section 15050) at the step-down area prior to the application of the sheet encasement and tape.

B. Applying Sheet Coating to Buried Piping and Fittings

1. Apply wrapping per AWWA C105 as modified herein.

2. Apply a single wrapping.

3. Install the polyethylene to completely encase the pipe and fittings to provide a watertight corrosion barrier. Continuously secure overlaps and ends of sheet and tube with polyethylene tape. Make circumferential seams with two complete wraps, with no exposed edges. Tape longitudinal seams and longitudinal overlaps, extending tape beyond and beneath circumferential seams.

4. Wrap bell-spigot interfaces, restrained joint components, and other irregular surfaces with wax tape or moldable sealant prior to placing polyethylene encasement.

5. Minimize voids beneath polyethylene. Place circumferential or spiral wraps of polyethylene tape at 2-foot intervals along the barrel of the pipe to minimize the space between the pipe and the polyethylene.

6. Overlap adjoining polyethylene tube coatings a minimum of 1 foot and wrap prior to placing concrete anchors, collars, or supports. Hand wrap the polyethylene sheet, apply two complete wraps with no exposed edges to provide a watertight corrosion barrier, and secure in place with 2-inch-wide plastic adhesive tape.

C. Applying Sheet Coating to Buried Valves

1. Wrap flanges and other irregular surfaces with wax tape or moldable sealant. Press tightly into place leaving no

voids underneath and a smooth surface under coating for polyethylene sheet.

2. Wrap with a flat sheet of polyethylene. Place the sheet under the valve and the flanges or joints with the connecting pipe and fold in half. Extend the sheet to the valve stem and secure the sheet in place with 2-inch-wide plastic adhesive tape. Apply a second layer and secure with tape. Make two complete wraps, with no exposed edges, to provide a watertight corrosion barrier. Secure the sheets with tape around the valve stem below the operating nut and around the barrel of the connecting pipe to prevent the entrance of water and soil. Place concrete anchor and support blocks after the wrap has been installed.

D. Applying Sheet Coating to Buried Flexible Pipe Couplings

1. Wrap irregular surfaces with wax tape or moldable sealant. Press tightly into place leaving no voids underneath and a smooth surface under coating for polyethylene sheet.

2. Apply two layers or wraps around the coupling. Overlap the adjoining pipe or fitting a minimum of 1 foot and secure in place with tape. Provide sufficient slack in polyethylene to allow backfill to be placed around fitting without tearing polyethylene. Apply tape around the entire circumference of the overlapped section on the adjoining pipe or fitting in two complete wraps, with no exposed edges, to provide a watertight corrosion barrier.

E. Repair of Polyethylene Material

Repair polyethylene material that is damaged during installation. Use polyethylene sheet, place over damaged or torn area, and secure in place with 2-inch-wide plastic adhesive tape.

F. Applying Sheet Coating to Existing Buried Piping

When connecting polyethylene-encased pipe or fittings to existing pipe, expose existing pipe, thoroughly clean the surface, and securely tape the end of the polyethylene to the existing as specified above. When the existing pipe is polyethylene encased, wrap new polyethylene encasement over

the existing, with overlap of at least 2 feet. Tape securely as specified above.

G. Backfill for Polyethylene-Wrapped Pipe, Valves, and Fittings

Place sand backfill within 1 foot of the pipe, valves, and fittings wrapped with polyethylene encasement per Section 02223.

H. Repair of Polyethylene at Service Taps

1. Wrap two or three layers of polyethylene adhesive tape completely around the pipe to cover the area where the tapping machine and chain will be mounted.

2. Mount the tapping machine on the pipe area covered by the polyethylene tape. Then make the tap and install the corporation stop directly through the tape and polyethylene.

3. After making the direct service connection, inspect the entire circumferential area for damage and make repairs.

4. To minimize the possibility of dissimilar metal corrosion at service connections, wrap the corporation stop a minimum clear distance of 3 feet of copper service pipes with polyethylene or dielectric tape.

END OF SECTION

SECTION 09961 FUSION-BONDED EPOXY LININGS AND COATINGS

PART 1 - GENERAL

A. Description

This section includes materials, application, and testing of one-part, fusion-bonded, heat-cured, thermosetting, 100% solids epoxy linings and coatings on steel, cast-iron, and ductile-iron equipment, such as valves, slide gates, and structural steel.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following;

2. Submit manufacturer's catalog literature and product data sheets, describing the physical and chemical properties of the epoxy coating. Describe application and curing procedure.

3. Submit coating application test records for measuring coating thickness and holiday detection for each item or pipe section and fitting. Describe repair procedures used.

PART 2 - MATERIALS

A. Piping and Equipment Surfaces

1. The Contractor shall require the equipment suppliers to provide equipment that is free of salts, oil, and grease to the coating applicator.

2. The Contractor shall require pipe suppliers to provide bare pipe that is free of salts, oil, and grease to the coating applicator.

B. Shop-Applied Epoxy Lining and Coating

Lining and coating shall be a 100% solids, thermosetting, fusion-bonded, dry powder epoxy resin: Scotchkote 134 or 206N, Lilly Powder Coatings "Pipeclad 1500 Red, or equal. Epoxy lining and coating shall meet or exceed the following requirements:

Hardness (minimum)	Barcol 17 (ASTM D2583) Rockwell 50 ("M" scale)
Abrasion resistance (maximum value)	1,000 cycles: 0.05 gram removed
	5,000 cycles: 0.115 gram removed
	ASTM D1044, Tabor CS 17 wheel, 1,000-gram weight
Adhesion (minimum)	3,000 psi (Elcometer)
Tensile strength	7,300 psi (ASTM D2370)
Penetration	0 mil (ASTM G17)
Adhesion overlap shear, 1/8-inch steel panel, 0.010 glue line	4,300 psi, ASTM D1002
Impact (minimum value)	100 inch-pounds (Gardner 5/8-inch diameter tup)

C. Field-Applied Epoxy Coating for Patching

Use a two-component, 80% solids liquid resin, such as Scotchkote 306.

D. Painting and Coating of Grooved-End and Flexible Pipe Couplings

Line and coat couplings the same as the pipe. Color shall match the color of the pipe fusion epoxy coating.

PART 3 - EXECUTION

A. Shop Application of Fusion-Bonded Epoxy Lining and Coating--General

1. Grind surface irregularities, welds, and weld spatter smooth before applying the epoxy. The allowable grind area shall not exceed 0.25 square foot per location, and the maximum total grind area shall not exceed 1 square foot per item or piece of equipment. Do not use any item, pipe, or piece of equipment in which these requirements cannot be met.

2. Remove surface imperfections, such as slivers, scales, burrs, weld spatter, and gouges. Grind outside sharp corners, such as the outside edges of flanges, to a minimum radius of 1/4 inch.

3. Uniformly preheat the pipe, item, or piece of equipment prior to blast cleaning to remove moisture from the surface. The preheat shall be sufficient to ensure that the surface temperature is at least 5°F above the dew point temperature during blast cleaning and inspection.

4. Sandblast surfaces per SSPC SP-5. Protect beveled pipe ends from the abrasive blast cleaning.

5. After cleaning and surface preparation, test the surface for residual chloride concentration. If the residual chloride concentration exceeds 5 $\mu g/cm^2$, then apply a phosphoric acid wash to the surface after sandblasting. Apply a phosphoric acid wash to the pipe, item, or piece of equipment after sandblasting. The average temperature, measured in three different locations, shall be 80°F to 130°F during the acid wash procedure. The acid wash shall be a 5% by weight phosphoric acid solution. The duration in which the acid is in contact with the surface shall be determined by using the average temperature as tabulated below:

Surface Temperature (°F)	**Contact Time (seconds)**
80	52
85	45
90	36
95	33
100	28
105	24
110	21
130	10

After the acid wash has been completed, remove the acid with demineralized water having a maximum conductivity of 5 micromhos/cm at a minimum nozzle pressure of 2,500 psi.

6. Apply lining and coating by the electrostatic spray or fluidized bed process. Minimum thickness of lining or coating shall be 15 mils. Heat and cure per the epoxy manufacturer's recommendations. The heat source shall not leave a residue or contaminant on the metal surface. Do not allow oxidation of surfaces to occur prior to coating. Do not permit surfaces to flash rust before coating.

B. Shop Application of Fusion-Bonded Epoxy Lining and Coating to Pipe--Additional Requirements

1. Apply lining and coating per AWWA C213 except as modified herein.

2. Grind 0.020 inch (minimum) off the weld caps on the pipe weld seams before beginning the surface preparation and heating of the pipe.

C. Shop Application of Fusion-Bonded Epoxy Lining and Coating to Joint Areas of Ductile-Iron and Cast-Iron Fittings--Additional Requirements

Limit the protective coating thickness in the joints of ductile-iron and cast-iron fittings to maintain a leak-proof joint. However, the coating thickness in the joint area shall not be less than 4 mils.

D. Quality of Lining and Coating Applications

The cured lining or coating shall be smooth and glossy, with no graininess or roughness. The lining or coating shall have no blisters, cracks, bubbles, underfilm voids, mechanical damage, discontinuities, or holidays.

E. Factory Testing of Coating--General

1. Test linings and coatings with a low-voltage wet sponge holiday detector. Test pipe linings and coatings per AWWA C213, Section 5.3.3. If the number of holidays or pinholes is less than one per 20 square feet of coating surface, repair the holidays and pinholes by applying the coating manufacturer's recommended patching compound to each holiday or pinhole and retest. If the number of pinholes and holidays exceeds one per 20 square feet of coating surface, remove the entire lining or coating and recoat the item or pipe.

2. Measure the coating thickness at three locations on each item or piece of equipment or pipe section using a coating thickness gauge calibrated at least once per eight-hour shift. Record each measured thickness value. Where individual measured thickness values are less than the specified minimum thickness, measure the coating thickness at three additional points around the defective area. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than 2 mils below or 3 mils above the specified minimum value. If a

section of the pipe, item, or piece of equipment does not meet these criteria, remove the entire lining or coating and recoat the entire item or piece of equipment.

F. Factory Testing of Lining and Coating of Pipe--Additional Requirements

Check for coating defects on the weld seam centerlines. There shall be no porous blisters, craters, or pimples lying along the peak of the weld crown.

G. Field Repairs

Patch scratches and damaged areas incurred while installing fusion-bonded epoxy coated items with a two-component, 80% solids (minimum), and liquid epoxy resin. Wire brush or sandblast the damaged areas per SSPC SP-10. Lightly abrade or sandblast the coating or lining on the sides of the damaged area before applying the liquid epoxy coating. Apply a two-part epoxy coating to defective linings and coatings to areas smaller than 20 square inches. Patched areas shall overlap the parent or base coating a minimum of 0.5 inch. If a defective area exceeds 20 square inches, remove the entire lining and coating and recoat the entire item or piece of equipment. Apply the liquid epoxy coating to a minimum dry-film thickness of 15 mils.

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DIVISION 11 – EQUIPMENT

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SECTION 11214 VERTICAL TURBINE PUMPS

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of vertical turbine pumps in wet wells for reclaimed water service.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit dimensional drawings.

3. Submit manufacturer's catalog data and detail drawings showing all pump parts and described by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show linings and coatings. Identify each pump by tag number to which the catalog data and detail sheets pertain.

4. Submit pump manufacturer ISO-9001 certification per Part 2.A.1. As an alternative, provide a letter from the pump manufacturer accepting warranty responsibility for the entire pump, motor, and suction cans.

5. Submit manufacturer’s catalog data and detail drawings showing packing type and material and mechanical seal design and parts. Describe material of construction by specification (such as AISI, ASTM, SAE, or CDA) and grade or type. Identify each mechanical seal and type of packing by the tag number of the associated pump to which the catalog data and detail sheets pertain.

6. Submit pump curves on which the specified operating points are marked. Show efficiency and brake horsepower for the selected pump curve. Include moment of inertia of the complete pump unit. Show required submergence and NPSH.

7. As part of the field test procedure for the pumps, record measurements for impeller adjustment at the top of shaft and total radial shaft deflection (shaft runout) above the stuffing box or seal chamber.

8. Submit manufacturer's sample form for reporting performance test results at least two weeks before the tests. The test form should contain the data presented in the sample form in Section 6 of the ASME PTC 8.2 or ANSI/HI 2.6.

9. Submit manufacturer's certified performance curves for review at least two weeks prior to shipping the units from the factory. Show pump total head, torque, brake horsepower, pump efficiency and required submergence. Provide copies of the data recorded during the test and methods of data reduction for determining certified test results.

10. Provide factory certification that published NPSH curves are accurate based on past testing.

11. Submit motor data per Section 16150.

12. Submit manufacturer's requirements for pump alignment limits.

C. Definitions

1. Terms shall be as defined in ANSI/HI 2.1-2.5 for vertical pumps.

2. Additional terms are defined below:

   Submergence: Vertical distance in feet between the pumping water level and the bottom of the suction bell. Minimum submergence shall be calculated per Hydraulic Institute Standards.

D. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Pump Design

1. Equipment for the pumps, including discharge heads, shafting, columns, motors, and bases, shall be provided as a complete unit by the pump manufacturer in an ISO 9001 certified facility or by a pump manufacturer accepting warranty responsibility for the complete pump unit. Pump units assembled by entities other than the pump manufacturer will not be acceptable.

2. Pump curve shall be continuously rising and shall be free of dips and valleys from the design point to the shutoff head. The shutoff head shall be at least 120% of the head that occurs at the design point.

3. The NPSH required shall be at least 10 feet less than the minimum NPSH available at all points on the pump curve up to 120% of the flow at the BEP.

4. Design the pump and its components to operate continuously over a preferred operating range (POR, as defined in ANSI/HI 9.6.3-1997) of 55% to 130% of the flow at the BEP.

B. Motors

1. Motors shall be provided in accordance with Section 16150 and the following.

2. Motors shall be vertical high thrust, solid shaft. Motors shall be as further described in the subsection on "Service Conditions."

3. The driver motor thrust bearing loading shall include the total pump lineshaft downthrust. Design the motor bearings to withstand any momentary total upthrust equivalent to at least 30% of the maximum downthrust developed.

C. Couplings and Coupling Guards

For solid shaft motors, comply with ANSI/HI 2.3.3. Provide four-piece flanged adjustable spacer type couplings between the motor and pump shafts. Coupling shall be Type 316 Stainless steel. The spacer shall be of sufficient length to

permit the removal of the seal and sleeve without disturbing the driver. Provide coupling guards.

D. Discharge Heads

1. Provide a fabricated steel discharge head. The discharge head shall have bolted register or rabbet-fit connections for the motor. Discharge head shall have connections for the pump column and shall support the loadings which it imposes as well as contain the pump pressure.

2. Design columns and discharge heads for 150% of the pump discharge pressure (suction pressure plus pump differential pressure) at shutoff.

3. Access to the seal chamber or stuffing box shall be through windows placed 90 degrees from the discharge. Fit handholes and/or windows with Type 316 stainless steel expanded metal guards. Provide bolted or hinged Type 316 stainless steel guards.

4. Design fabricated steel discharge head to be aesthetically compatible with the mounted motor and with adjacent pumping units. Where the motor is smaller in horizontal dimension than the discharge pipe, shape a skirt to transition between the two masses. Where the motor is larger than the discharge head, a skirt of approximately motor diameter dimension shall enclose the discharge head so as to provide an adequate-appearing support.

5. The discharge shall be flanged, having a pressure rating as shown in the subsection on "Service Conditions."

   a. Class 150 flanges shall comply with AWWA C207, Class D.

   b. Flanges shall be flat face.

6. Provide for lifting the heads by means of lifting eyes that are capable of sustaining the weight of the complete unit less the motor.

7. Provide a 2-inch steel half coupling welded to the discharge pipe for an air release. Provide plug.

E. Mechanical Split Seal System

1. Seal Type: The seal shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Provide shafts for pumps specified with mechanical seals with no reduction in size through the seal area. Mechanical seals shall be the split type, requiring no field assembly, other than assembly around the shaft and insertion into the pump. For clear water services and solids concentrations up to 1/2% by weight, the face combination shall be hard/soft.

2. Seal Materials:

   a. Metals: Type 316 stainless steel for loaded parts over 0.060-inch cross-section. For thinner parts (springs), use Hastelloy-C®, Alloy 20®, AMS5876 (Elgiloy®), or other alloy that is not vulnerable to chloride stress corrosion.

   b. Elastomers: Fluorocarbon (Viton®), EPDM.

   c. Faces: Faces shall be of homogeneous construction. Do not use surface treatments and plated faces. Acceptable hard face materials include self-sintered silicon carbide or reaction bonded silicon carbide. Acceptable soft face is carbon-graphite, either Union Carbide 658RC or Purecarbon P8412.

3. Seal shall be hydraulically balanced and designed for the range of 28-inch Hg vacuum to 400-psig service or 200% of sealing area pressure, whichever is higher, at the design rotating speed, shaft diameter, temperature, and liquid of the pump for the service.

4. Products: Self-aligning, self-centering, single, Chesterton 442, Flowserve PSS III, or equal.

F. Lubrication

Pumps shall have open lineshafts as shown in the subsection on "Service Conditions." Open lineshaft pumps shall be self-lubricated.

G. Column Pipe

1. The column pipe joints shall be flanged and bolted to the discharge head and to the pump bowl assembly and shall have register fits at each end. Material shall be

as listed in the subsection on "Pump Materials of Construction." Provide bearing retainer containing a EPDM bearing as an integral part of the top end of each section where a lineshaft bearing is used. As an alternative, provide a separate retainer that is registered in the pipe flanges and easily removable for maintenance.

2. Top and bottom column pipe sections shall not exceed 5-foot length.

3. Column pipe joints shall be flanged.

H. Shafts and Bearings

1. Support the shafting by bearings at intervals so that the first natural frequency of the rotating assembly is at least 30% above the maximum operating speed. Provide an additional bearing retainer just below the head for added support. Calculate and size the shaft diameter for the pump shutoff head and the maximum horsepower conditions.

2. For metal or rigid bearings, support the shafting at intervals per ANSI/HI 2.3.3.1, with a maximum spacing of 5 feet.

3. For pumps having operating speeds 1,800 rpm and less with water-lubricated neoprene bearings, the bearing spacing for the intermediate columns shall not exceed 10-foot lengths. The bearing spacings for the top and bottom column sections shall not exceed 5 feet.

4. Pump shafts shall be machined or ground and finished throughout their entire length. The total indicated runout shall not exceed 0.0005 inch per foot of length. The pump shaft shall be in one piece unless otherwise approved by the County (because of total shaft length or shipping restrictions).

5. Shaft couplings for shaft diameters 2 inches or larger shall be of the key and thrust-ring types or other nonthreaded design. Threaded couplings may be used for shaft diameters 1-15/16 inches or smaller. Thrust rings, cap screws, and keys where used shall be Type 410 stainless steel.

I. Bowl Assembly

1. Each bowl assembly shall consist of the bowl, impeller and impeller shafting, and bearings. Bearings shall be sleeve type located above and below the impeller. Bearings (other than sleeve type) shall have an AFBMA L-10 life of at least 20,000 hours at any specified flow condition excluding the shutoff head. Impellers shall be dynamically balanced.

2. Pump bowls shall be of the material listed under the subsection on "Pump Materials of Construction." Bowls shall be sufficiently rigid to prevent adverse changes in bearing alignment and to maintain the running clearance of wear rings. Bowls shall be flanged with male and female rabbets or registers for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be smooth and free from nodules, bumps, and dips and coated with Scotchkote 134 fusion bonded epoxy.

J. Suction Bell

The suction bell shall have, as an integral part, vanes supporting a central hub in which the bottom bearing is carried below the impeller. The outer suction bell entrance shall be at least the size of the maximum pump bowl dimension and as much larger as is practical. Maximum entrance fluid velocity shall not exceed 6 fps at the specified maximum flow. The contour between the outer edge and the impeller suction eye shall be smooth, continuous, and bell shaped.

K. Impellers

Pump impellers shall be of the enclosed or semi-open type made of the material listed in the subsection on "Pump Materials of Construction" and shall be cast in one piece. Machine impellers to fit the contour of the bowl and hand file in the waterways. Equip impellers with replaceable wear rings. The impellers shall be attached to the shaft by means of an ASTM A582/276-416 stainless steel key/collet for positive driving of the impeller by the shaft. Provide for adjustment of the axial position of the impeller at the top of the pump or motor so that proper clearance between bowls and impellers may be maintained.

L. Vibration and Residual Unbalance

1. The maximum vibration levels shall not exceed those shown in Figures 9.6.4.13 and 9.6.4.14 in ANSI/HI 9.6.4-2000. Maximum residual unbalance in rotors shall not exceed that shown in Figure 9.6.4.15B in ANSI/HI 9.6.4.

2. At any operating speed, the ratio of the pump's natural reed frequency to the pump's rotating speed (f/N) shall be less than 0.8 or greater than 1.3.

3. The Contractor shall require that the pump manufacturer determine whether the infinite mass and rigidity described in ANSI/HI 9.6.4-2000, paragraph 9.6.4.5.2 is applicable to the service conditions in this project and to select the appropriate analytical method to determine the critical speed and resonant frequencies of the pump system. At a minimum, the pump system shall include the bowls, impellers, lineshaft diameters, lineshaft bearing spacing, column diameter and wall thickness, the design of the discharge stand or motor stand with discharge nozzle, and the baseplate and soleplate dimensions (length, width, and thickness).

M. Pump Materials of Construction

1. Materials of construction shall conform to the requirements listed below. Materials of construction for components not listed below shall conform to ANSI/HI 9.1 through 9.5.

Component	Material
Pump shafts and couplings	Stainless steel, ASTM A276, UNS Grade S41600
Bowl wear rings	Stainless steel, ASTM A743, Grade CF-8M or CA-15; or ASTM A276, Type 410; or bronze per paragraph 3 below.
Bearing retainers (fabricated integral)	Carbon steel, ASTM A283, Grade B.
Bearing retainers (insert type)	Bronze; see paragraph 3 below.
Lineshaft bearings	EPDM.
Impellers	Stainless Steel, ASTM A743, Grade CF-8M; or Bronze per paragraph 3 below.

Component	Material
Impeller wear rings	Stainless steel (if bowl wear rings are bronze) or bronze (if bowl wear rings are stainless steel). Stainless steel: ASTM A743, Grade CF-8M or CA-15 or ASTM A276, Type 410. Bronze: see paragraph 3 below.
Impeller keys/collets	Stainless steel, ASTM A582/276-416
Pump bowls and suction bell	Cast iron, ASTM A48, Class 30 or ductile iron, ASTM A536.
Bowl bearings	Bronze; see paragraph 3 below.
All parts made of fabricated steel including discharge head or motor stand	Carbon steel, ASTM A283, Grade B or C; ASTM A36; or ASTM A53, Grade B.
Column pipe	Carbon steel, ASTM A283, Grade B or C, or ASTM A53, Grade A or B.
Mounting plate (required for the Effluent Transfer Pump)	Carbon steel, ASTM A283, Grade A or B or ASTM A36.
Flanges	ASTM A105, A181, or A182.
Bolts and nuts for discharge heads, column pipe flanges, and bowl flanges. See paragraph 4 below	Bolts shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M. Nuts shall be Type 316 stainless steel conforming to ASTM A194, Grade 8M.
Gland bolts and nuts	Stainless steel, Type 316.
Any bronze components in contact with water	See paragraph 3 below.

2. Do not construct the impeller wear ring and bowl wear ring of the same material. Impeller and bowl wear ring materials shall have a minimum Brinell hardness difference of 50, unless both the stationary and the rotating wear surfaces have Brinell hardness numbers of at least 400.

3. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

N. Soleplate and Anchor Bolts

1. The Contractor shall assign the design and construction of the pump (including bowls, column, and discharge head), motor and supporting stand, and baseplate and soleplate system to the pump manufacturer. The pump manufacturer shall design and construct an integrated system to comply with the specified restraint, deflection, vibration, and critical speed criteria.

2. Provide a steel or cast iron soleplate for deck-mounted pumps to be permanently grouted in place. The thickness and bolting to the discharge head base shall be sufficient to restrain the discharge head against the discharge pressure at shut off head or any other pump operating condition and provide sufficient rigidity such that the pump and baseplate system meets the specified lateral vibration and critical speed criteria. Machine the soleplate topside to mate with a fully machined base of the discharge head.

3. Provide vertical leveling screws spaced for stability on the outside perimeter of the soleplate. Locate the leveling screws adjacent to anchor bolts to minimize distortion during the process of installation. These screws shall be numerous enough to carry the weight of the baseplate, pump, and drive train components without excessive deflection, but in no case shall fewer than six screws be provided. Sandblast the grout contact surfaces of the soleplate in accordance with SSPC SP-6, and coat those surfaces with a primer compatible with epoxy grout.

4. Provide anchor bolts of sufficient quantity and size to restrain any pump operating condition. The anchor bolts shall conform to ASTM A307, Grade B.

O. Spare Parts

1. Provide the following spare parts for each model of pump:

Quantity	Description
One Set	Impeller wear ring
One Set	Bowl wear ring
One	Lantern ring (for pumps specified to have packing)
Two sets	Bowl bearings
Two sets	Shaft bearings
One	Shaft coupling
Two sets	Packing (for pumps specified to have packing)
Two	Mechanical seals (for pumps specified to have mechanical seals)

PART 3 - EXECUTION

A. Shipment and Storage

1. Prepare equipment for shipment including blocking of the rotor when necessary. Identify blocked rotors by means of corrosion-resistant tags attached with stainless steel wire. The preparation shall make the equipment suitable for six months of outdoor storage from the time of shipment, with no disassembly required before operation, except for inspection of bearings and seals.

2. Identify the equipment with item and serial numbers and project equipment tag numbers. Material shipped separately shall be identified with securely affixed, corrosion-resistant metal tags indicating the item and serial number and project equipment tag numbers of the equipment for which it is intended. In addition, ship crated equipment with duplicate packing lists, one inside and one on the outside of the shipping container.

3. Pack and ship one copy of the manufacturer’s standard installation instructions with the equipment. Provide the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the jobsite and before start-up.

4. Store and protect pumps per ANSI/HI 2.4.1 and as described below.

5. Coat exterior machined surfaces with a rust preventative.

6. The interior of the equipment shall be clean and free from scale, welding spatter, and foreign objects.

7. Provide flanged openings with wood closures.

8. Provide threaded openings with steel caps or solid-shank steel plugs. Do not use nonmetallic (such as plastic) plugs or caps. Install plugs at place of pump manufacture prior to shipping.

9. Clearly identify lifting points and lifting lugs on the equipment or equipment package. Identify the recommended lifting arrangement on boxed equipment.

10. Wrap exposed shafts and shaft couplings with waterproof, moldable waxed cloth or volatile-corrosion-inhibitor paper. Seal the seams with oil-proof adhesive tape.

11. If electric motors are stored or installed outside or in areas subject to temperatures below 40°F or are exposed to the weather prior to permanent installation, provide the manufacturer’s recommended procedures for extended storage. Provide temporary covers over the motor electrical components. Provide temporary conduits, wiring, and electrical supply to space heaters. Inspect electrical contacts before start-up.

B. Pump Installation

1. Install equipment horizontal and vertical within 1 degree and according to the manufacturer's written instructions and the contract documents. Confirm that pump cans and pumps are set to meet the vertical alignment requirements established by the manufacturer.

2. Check to ensure that pump baseplates or soleplates have been provided with vertical leveling screws, as opposed to shims or wedges. Do not use shims and wedges.

3. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.

4. Verify that the installed pump is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the pump assembly. Adjust the position of the pump assembly so that the pump discharge flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning,

or supporting equipment. Provide final grouting of the pump assembly base according to Section 03300.

5. When the alignment is correct, tighten the foundation bolts evenly but not too firmly. Then grout the unit to the foundation. The leveling pieces may be grouted in place. Do not tighten foundation bolts until the grout is hardened a minimum of 48 hours after pouring.

6. Provide continuous protection of the installed equipment from the elements, dust, debris, paint spatter, or other conditions that will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing.

7. Installation of Mechanical Seals

   Install per ANSI/HI 2.4.5.2.

C. Mounting and Alignment of Vertical Solid Shaft Drivers

1. Before mounting the driver on the discharge head/driver stand, check the register fit, if furnished, and the mounting face on the driver for acceptable tolerance on runout and squareness, respectively, using a dial indicator mounted on the driver shaft. See ANSI/NEMA MG-1. Next, check the squareness of the face of the driver coupling half, mounted on the shaft with a tight fit and seated against a split ring, using a dial indicator on a firm base.

2. With the driver bolted to the discharge head, mount a dial indicator on the driver shaft above the coupling half and sweep the bore of the stuffing box. If excess runout exists, some adjustment can be made at the driver mounting fit and the stuffing box mounting fit. Before installing any additional coupling parts, check the driver for correct rotation, as given in the manufacturer’s installation instructions.

3. Next, mount the pump half coupling, shaft adjusting nut, and coupling spacer if applicable, and raise the impeller in accordance with the manufacturer’s instructions. Then secure the coupling bolts. Make a final check of the shaft runout below the pump half coupling with a dial indicator. If the runout is within acceptable tolerances, check the tightness of the driver hold-down bolts. If dowels are used to secure the driver location, then redoweling is required after

disassembly/reassembly, since tolerance buildup in the multiple vertical joints results in alignment variation.

D. Factory Performance Tests

1. Each bowl assembly shall be subjected to a nonwitnessed laboratory performance test. Conduct tests in accordance with the ASME PTC 8.2 or ANSI/HI 2.6, using a shop driver. The performance test shall be equivalent to ANSI/HI 2.6.

2. No motor overload above nameplate rating will be allowed at any flow up to 120% of the flow at the BEP.

3. Hydrostatically test columns, bowls and discharge heads at design pressure.

4. Deviations and fluctuations of test readings shall conform to ASME PTC 8.2, 1.11 (Type A) or ANSI/HI 2.6, paragraph 2.6.5.4.1.

5. Measure flow by the “Capacity Measurement by Weight,” the “Capacity Measurement by Volume,” or the “Capacity Measurement by Venturi Meter, Nozzle, or Thin Plate Orifice” methods in ASME PTC 8.2 or ANSI/HI 2.6.

6. Perform tests and record data, including head, flow rate, speed, and power at a minimum of seven points. These points shall include shutoff, minimum flow, midway between minimum flow and design flow, design flow, 120% of design flow, and maximum flow.

7. Conduct tests preferably at the same minimum submergence that will be realized in the field.

8. Locate the pressure tap for head measurement not less than 10 pipe diameters downstream from the discharge elbow of the test pump.

9. Should results of the full-scale tests indicate, in the opinion of the County’s Representative, that the pumps will fail to meet any of the specified requirements, the County’s Representative will notify the Contractor of such failure. The manufacturer shall thereupon, at no expense to the County, make such modifications and perform additional tests as may be necessary to comply with these specifications.

10. Perform a hydrostatic test on pump pressure-containing components per ANSI/HI 2.6, paragraph 2.6.4.

E. Painting and Coating

1. Line and coat interiors and exteriors of pump columns, discharge elbows, bowl assemblies, and suction bells with fusion-bonded epoxy per Section 09961. Apply coating at factory.

2. Coat exterior of discharge head, motor stand, and motor the same as the adjacent piping. If the adjacent piping is not coated, then coat per Section 09900, System No. 10. Apply the specified prime coat at the place of manufacture. Apply intermediate and finish coats in field. Finish coat color shall be selected by the County.

F. Service Conditions

1. Pump hydraulic performance characteristics shall be as shown below.

2. Pump Tag Numbers: 390-P-4, 390-P-5, 390-P-6, 390-P-7, and 390-P-8

Location:	Phase III Effluent Pump Station
Type of discharge:	Surface
Service:	Outdoors environmental temperature range of 20°F to 110°F
Bottom of Pump Bowl Elevation:	90 feet above mean sea level
Relative humidity:	Up to 100%
Fluid temperature range:	50°F to 90°F

Pump Data

Capacity (gpm)	**Pump Total Head (feet)**	**Minimum Bowl Efficiency (%)**
3,000	97	44
9,000(1)	51	76
10,000	35	62
(1) Design point.		

Liquid pumped:	Reclaimed water
Maximum pump speed:	1,200 rpm
Minimum Submergence	8.25 ft
Motor horsepower (minimum):	200
Motor type (per Section 16150):	NEMA WP-1, continuous duty, premium efficiency, 120-V heating element, thermostats, moisture shield motor winding, nonreversing ratchet, NEMA MG 1, and inverter duty.
Variable speed drive required per Section 16370:	Yes
Maximum Number of Stages:	1
Minimum shaft diameter:	1-11/16 inches
Pump lubrication:	Open lineshaft
Minimum discharge flange size:	20 inches
Minimum column size:	20 inches
Minimum column wall thickness:	3/8 inch
Bearing lubrication:	Water
Suction strainer:	No
Antivortex suction vane:	Yes
Pump manufacturers and models:	Layne Vertiline 23 EHL, Fairbanks Morse, ITT Goulds 24 GLC, Peerless 24HXB-1

3. Pump Tag Numbers: 395-P-1, 395-P-2, 395-P-3, and 395-P-4

Location:	In-Plant Reuse Water Pump Station
Type of discharge:	Surface
Service:	Outdoors environmental temperature range of 20°F to 110°F
Bottom of Pump Bowl Elevation:	90 feet above mean sea level
Relative humidity:	Up to 100%
Fluid temperature range:	50°F to 90°F

Pump Data

Capacity (gpm)	Pump Total Head (feet)	Minimum Bowl Efficiency (%)
700	231	
940	234	
1,200[(1)]	237	80
1,440	174	73
[(1)] Design point.		

Liquid pumped:	Reclaimed water
Maximum pump speed:	1,800 rpm
Minimum Submergence	8.25 ft
Motor horsepower (maximum):	100
Motor type (per Section 16150):	NEMA WP-1, continuous duty, premium efficiency, 120-V heating element, thermostats, moisture shield motor winding, nonreversing ratchet, NEMA MG 1, and inverter duty.
Variable speed drive required per Section 16370:	Yes
Maximum Number of Stages:	6
Minimum shaft diameter:	1-1/4″
Pump lubrication:	Open lineshaft
Discharge flange size:	8 inches
Minimum column size:	10″
Minimum column wall thickness:	0.277″
Bearing lubrication:	Water
Suction strainer:	No
Antivortex suction vane:	Yes

Pump manufacturers and models:	Layne Vertiline 12RM, Fairbanks Morse, ITT Goulds 14RHMC, Peerless 12MB

G. Field Testing

1. Bump motor to ensure that motor has been connected for proper rotation prior to coupling pump.

2. Perform field tests for 24 consecutive hours on each pump. Measure flows at the following head points:

Tag Numbers	390-P-4, 5, 6, 7, and 8
Location	Effluent Pump Station
Service	Reuse Water
Maximum rpm	1,200
Test Points (Feet)	35, 51 and 97

3. Perform field tests for 24 consecutive hours on each pump. Measure flows at the following head points:

Tag Numbers	395-P-1, 2, 3, and 4
Location	In-Plant Reuse Pump Station
Service	Reuse Water
Maximum rpm	1,200
Test Points (Feet)	234, 237, and 174

4. If the measured flows at the above tabulated pump heads are more than 5% below the flows obtained from the laboratory or factory test, adjust the impellers or provide new impellers or otherwise repair or replace the pumps or calibrate meters or pressure gauges.

5. Conduct vibration level tests with pumps operating at their rated capacity. Adjust or replace pumps that exceed the maximum allowable vibration levels listed in ANSI/HI 9.6.4.4-2000. Field vibration measurements shall be made in accordance with ANSI/HI 9.6.4.3-2000.

6. Operate each pump one at a time. Manually adjust the speed for each pump (one at a time) via the respective speed control unit such that the pump output is 30%, 40%, 50%, 60%, 80%, and 100% of the maximum capacity specified. The duration at each flow rate shall be at least 10 minutes after RPM and flow levels out.

7. Assure that in the automatic mode each pump responds to its level or pressure signal. Assure that each pump operates at a steady rate (±5% of set point) at any given level pressure for 30%, 40%, 50%, 60%, 80%, and 100% of the maximum capacity specified.

8. Assure that each motorized valve on the seal water supply line opens and closes when its respective pump starts and stops. Start and stop each pump twice and verify that the pump/solenoid interlock functions.

9. Assure that limit switches on the pumps' check valves indicate and transmit the signals for the valves in the open and closed positions.

10. Demonstrate that the pumping units, drivers, and control system meet the following requirements:

    a. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

    b. Automatic and manual controls function in accordance with the specified requirements.

    c. Drive equipment operates without being overloaded.

H. Field Measurement of Coating Thickness on Columns

Field measure coating thickness on pump columns per Section 15201.

I. Contract Closeout

Provide in accordance with Section 01700.

J. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective individual pump.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

K. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

L. Certification

Provide a written certification from the equipment manufacturer that each pumping system has been properly installed according to the Contract Documents and the manufacturer's recommendations, and that the equipment is operating normally. Make all necessary corrections and adjustments including but not limited to parts, labor, or freight at no additional cost to the County.

END OF SECTION

SECTION 11281 FABRICATED STAINLESS STEEL SLIDE GATES

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of fabricated stainless steel slide and weir gates, open channel or wall mounted conforming to AWWA C561 and as supplemented herein.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit dimensional drawings.

3. Submit manufacturer’s catalog data and detail drawings showing slide gate parts and described by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show coatings. Identify each slide gate by tag number to which the catalog data and detail sheets pertain.

4. Submit calculations to show that gates, stems, and lifts meet the specifications.

5. Submit manufacturer's installation instructions.

C. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Manufacturers and Models

1. Type 3 slide gates shall be of the self-contained upward-opening type with guides for embedding in concrete. Type 3 slide gates shall be Fontaine Series 25, Whipps Series 921, or WACO Environmental Products Series 8500.

2. Type 4 slide gates shall be of the self-contained upward opening type designed to mount on the face of concrete walls. Type 4 slide gates shall be Fontaine Series 20, Whipps Series 923, or WACO Environmental Products Series 8500.

B. Weir Gates

Weir gates shall be of the self-contained downward-opening type designed to mount on the face of concrete walls. Weir gates shall have rising stems. Weir gates more than 5 feet wide shall have double stems. Design the gate to be lowered for opening and to be raised for closing. Gate design and materials of construction shall conform to the descriptions of slide gates. Manufacturers: Fontaine, Whipps, or WACO.

C. Slide Gate Design

1. Slide gates and appurtenances shall comply with AWWA C561, except as modified herein.

2. Provide slide gates complete with gates, guides, frames, baseplates, seats, stems, stem guides, seals, actuators, and anchor bolts. Design slide gates for minimum seating and unseating heads of 10 feet. Measure the seating and unseating heads from the top surface of the water to the centerline of the disc.

3. Under the design seating and unseating heads, the leakage shall not exceed 0.05 gpm per foot of wetted seating perimeter.

4. Slide gates shall have rising stems.

5. Provide offset bevel box operating system for gates there the centerline elevation of handwheel or crank is greater than 48-inches from floor elevation. Centerline of offset bevel box operating system crank shall be 36-inches from floor elevation.

6. Provide extension for actuator to place handwheel interior to new guardrails where guardrail blocks access to actuator.

D. Frames for Self-Contained Slide Gates

Design frames to be suitable for bolting to concrete walls or for grouting into channel recesses as noted herein. Furnish flush inverts for wall-mounted gates and flush inverts for channel-mounted gates as noted herein.

E. Guides

1. The guides shall extend in one continuous piece from the gate invert to form posts for crank operated floor stand. The extended guides or posts shall require no additional reinforcing to support the operator. The guide frames shall be fabricated from plates and angles suitable for the loads imparted to it by the water head and operator in accordance with design guidelines and safety factors herein. All stainless steel frame components shall be a minimum of 1/4-inch thick.

2. Provide a flush invert at the bottom of the frame. Provide a rubber insert to function as a seating surface for the gate disc.

3. Provide rubber J-bulb seals or self-adjusting UHMWPE seals along the sides of the gates.

4. Provide replaceable polyethylene bearing strips in the guides. Provide strips along both sides of the guide channels containing the disc to insure no metal to metal surface contact. Alternatively, mount the replaceable polyethylene bearing strips on the disc.

5. Provide rubber or UHMWPE J-bulb seals or self-adjusting UHMWPE seals along the top of the gate for submerged applications.

6. All adjustable J-bulb seals shall be secured by stainless steel retainer bars of the same alloy as the frame.

7. Rubber J-bulb seals shall have a fluorocarbon film vulcanized and bonded to the sealing surface of the bulb. The film shall be minimum 0.060-inch thick Buckhorn Rubber abrasion-resistant Fluorocarbon Film No. 4508 or equal. Test fluorocarbon film for adhesion bond per ASTM D 413 using either the machine method or the

deadweight method. There shall be no separation between the fluorocarbon film and the rubber when subjected to a load of 30 lbs per inch of width.

F. Disc

1. Fabricate the disc using stainless steel flat plate with stainless steel structural or formed members welded to the plate. Provide disc components with a minimum material thickness of 1/4-inch.

2. The disc shall be a one-piece plate, reinforced with ribs so that the disc will not deflect more than 1/720 of the gate span or 1/16-inch, whichever is less, at design head. Attach reinforcing ribs to disc by welding; do not use bolting. Reinforcing ribs shall extend into the guides such that they overlap the seating surface of the guide. Vertical reinforcing ribs can also be provided adjacent to the guides to ensure deflection remains within the specified limits. Design the disc so that all surfaces are free of metal-to-metal contact with the frames.

G. Actuator Support Yoke for Self-Contained Slide Gates

Attach the actuator support yoke to the extensions of the guides. Provide two angles bolted to opposite sides of the guide extensions. Mount the actuator on a plate bolted to the support yoke. Maximum deflection of the yoke shall not exceed 1/4-inch when subjected to a load induced by an 80-pound pull on the actuator or 1/360 span when subjected to a load induced by a 40-pound pull on the actuator, whichever is less.

H. Stems and Stem Guides

1. Lifting stems shall be one piece, with a minimum diameter of 1-1/2 inches. The stem shall withstand an actuator effort of 80-pounds without buckling, assuming the critical buckling load as determined by using the Euler Column Formula with C = 2.0. The stem shall have a minimum diameter of 1-1/2 inches. The threaded portion shall have machine cut or machine rolled, full depth Acme threads, polished to a 16 microinch finish or better. Support the stems with stem guides such that the L/R ratio for the unsupported part of the stem does not exceed 200.

2. The stem connection to the disc shall be either the clevis type, with structural members welded to the slide and containing two bolts to secure the stem to the disc, or a threaded and bolted or keyed thrust nut supported in a welded nut pocket. The pocket shall be capable of withstanding a load of 80-pounds on the actuator.

3. Provide tandem stems and actuators when the gate width is more than twice the gate height and for weir gates 5 feet or more in width.

I. Materials of Construction

Materials of construction shall conform to the requirements listed below:

Component	Material	Specification
Guides	Stainless steel	ASTM A240 or A276, Type 316L
Disc, yoke	Stainless steel	ATSM A240 or A276, Type 316L
Stems, stem guides, bushings, pivot pin	Stainless steel	ASTM A276, Type 316
Bolts, fasteners (including anchor bolts)	Stainless steel	ASTM A193, F593 or F594; Grade B8M or ASTM A276, Type 316
Lift nut	Bronze	ASTM B62 or ASTM B584, Alloys C83600, C83800, or C86500
J-bulb seals, flush bottom seals	Rubber	ASTM D2000, Grades BC610, BC611, BC612, BC613, BC614, or BC615
Floor Stand	Stainless steel or Aluminum	ASTM A240, Type 316L; or Tenzaloy aluminum
Hand Wheel	Aluminum	ASTM B 209 or B 308, Alloy 6061-T6 or 6063-T6

J. Actuators

1. Provide manual actuators unless otherwise indicated in the drawings. Where possible provide Acme threaded handwheel lifts without gear reduction for gates having design seating heads 10-feet or less. Provide a flanged lift nut to engage the threaded portion of the stem. Support the lift nut on nonmetallic thrust washers or

ball or roller bearings. Provide manual crank-operated lift with gear reduction for gates having design seating heads greater than 10 feet. Maximum pull required to open the gate shall not exceed 40-pounds. Support crank-operated lift nuts only on ball or roller bearings. The crank handle shall be removable. Provide a 2-inch-square nut configured to allow the use of a portable electric actuator.

2. Provide a graduated clear plastic stem cover to show the gate position in increments of 1/4-inch. Provide vent holes to prevent condensation.

K. Floor Stands

1. Design crank-operated or handwheel-operated floor stand hoists to permit gate operation with 40-pounds of maximum effort under the head conditions noted in the drawings.

2. Provide floor stand hoists that can also accommodate a portable electric actuator.

3. Coat cast iron floor stands per Section 09900, System No. 10. All stainless steel weld burn and weld slag shall be mechanically passivated in accordance with ASTM A380 to provide a uniform finish.

L. Spare Parts

1. Provide the following spare parts for each size of slide or weir gate:

Quantity	Description
1	Standnut for each size
4	Stem guides of each type and size
1 set	self-adjusting seal and Flush bottom seals for each type and size gate
1	Stem Covers for each type and size gate
5	Tubes of Recommended Grease

2. Pack spare parts in a wooden box; label with the manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained within.

PART 3 - EXECUTION

A. Slide Gate Designations and Designs

1. Provide the following stainless steel slide gates:

Tag	Type	Opening Width (ft)	Opening Height (ft)	Bottom of Opening EL	Top of Opening EL	Deck EL
231-SG-1	Wall Mounted	3'-0"	3'-0"	86.00	89.00	96.50
335-SG-1	Wall Mounted	2'-6"(1)	2'-6"(1)	82.75	85.25	99.00
336-SG-1	Wall Mounted	2′-6"(1)	2'-6"(1)	82.75	85.25	99.00
360-SG-1	Wall Mounted	4'-0"	4'-10"	81.00	85.83	88.00
360-SG-2	Wall Mounted	4'-0"	4'-10"	81.00	85.83	88.00
360-SG-3	Wall Mounted	4'-0"	4'-10"	81.00	85.83	88.00
360-SG-4	Wall Mounted	4'-0"	4'-10"	81.00	85.83	88.00
360-SG-5	Wall Mounted	4'-0"	4'-10"	81.00	85.83	88.00
360-SG-6	Wall Mounted	4'-0"	4'-10"	81.00	85.83	88.00
360-SG-7	Wall Mounted	4'-0"	4'-10"	81.00	85.83	88.00
562-SG-1	Wall Mounted	3′-6″(1)	3′-6″(1)	74.05	77.55	95.00
563-SG-1	Wall Mounted	3′-0″(1)	3′-0″(1)	74.82	77.82	95.00
564-SG-1	Wall Mounted	2′-6″(1)	2′-6″(1)	75.20	77.70	95.00
564-SG-2	Wall Mounted	2′-6″(1)	2′-6″(1)	75.20	77.70	95.00
565-SG-1	Wall Mounted	3′-6″(1)	3′-6″(1)	81.50	85.00	94.00

(1) Dimension corresponds to the nominal size of a pipe.

B. Weir Gate Designations and Designs

1. Provide the following stainless steel weir gates:

Tag	Type	Opening Width (ft)	Opening Height (ft)	T/Wall EL	T/Weir Gate EL	Deck EL
221-WG-1	Wall Mounted	10'-6"	3'-0"	93.00	94.75	96.88
222-WG-2	Wall Mounted	10'-6"	3'-0"	93.00	94.75	96.88
223-WG-3	Wall Mounted	10'-6"	3'-0"	92.96	93.60	97.00
224-WG-4	Wall Mounted	10'-6"	2'-8"	93.13	93.60	97.00
231-WG-1	Wall Mounted	8'-0"	2’-8”	92.50	93.00	96.50
335-WG-1	Wall Mounted	10'-0"	4'-0"	95.00	95.33	99.00
335-WG-2	Wall Mounted	10'-0"	4'-0"	95.00	95.33	99.00
336-WG-1	Wall Mounted	10'-0"	4'-0"	95.00	95.33	99.00
336-WG-2	Wall Mounted	10'-0"	4'-0"	95.00	95.33	99.00
360-WG-1	Wall Mounted	8'-0"	3'-0"	85.00	86.53	88.00
360-WG-2	Wall Mounted	8'-0"	1'-8"	85.00	86.53	88.00
360-WG-3	Wall Mounted	8'-0"	3'-0"	85.00	86.53	88.00
561-WG-1	Wall Mounted	8’-0”	3’-0”	82.00	85.00	95.00
562-WG-1	Wall Mounted	9’-0”	1’-6”	86.00	87.50	95.00
563-WG-1	Wall Mounted	9’-0”	1’-6”	86.17	87.50	95.00
564-WG-1	Wall Mounted	7’-0”	2’-0”	86.37	88.37	95.00
564-WG-2	Wall Mounted	7’-0”	2’-0”	86.37	88.37	95.00

C. Welding

Welder qualification shall comply with AWS D1.6 Welding rod and electrodes shall comply with AWS A5.4.

D. Painting and Coating

Coat cast-iron and steel surfaces above deck level, including actuators and floor stands, per Section 09900,

System No. 10. Apply prime coat at factory. Color of finish coat shall be provided by the OWNER.

E. Installation

1. Install epoxy anchors for wall mounted gates using templates. Epoxy anchors shall be Type 316 stainless steel threaded rod adhesive anchors. Epoxy adhesive shall comply with ASTM C881, Type IV, Grade 3, Class B or C. Adhesive shall be Rawl Power-Fast, Hilti HIT RE 500, Simpson Epoxy-tie with SET epoxy, or equal. Epoxy anchor assemblies shall be ICBO approved.

2. Comply with AWWA C561, paragraph 4.6.

F. Field Testing

1. Operate each slide gate through two complete cycles. Gates shall operate without sticking or binding.

2. Determine the pulling force required to turn the handwheel with a torque wrench. Pulling force required shall be less than the limit specified.

3. Fill channels to which the gates are attached with water. Measure leakage through each slide gate. Measure the actual field seating and unseating heads. The allowable leakage shall be as specified above. If the leakage rate is exceeded, adjust or replace the gate and retest until it passes.

G. Contract Closeout

Provide in accordance with Section 01700.

H. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

3. Leakage shall be no more than that allowed by the AWWA C561 Standard during the guarantee period.

4. Door (disc) shall be free of sticking or binding as judged by the Engineer (move freely via operator provided) with no exercising required. Gate operators are to be warranted by the operator manufacturer.

I. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

J. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

SECTION 11284 HIGH-DENSITY POLYMER SLIDE GATES

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of fabricated high-density polymer slide gates, open channel or wall mounted conforming to AWWA C563 and as supplemented herein.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit dimensional drawings.

3. Submit manufacturer’s catalog data and detail drawings showing slide gate parts and described by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show coatings. Identify each slide gate by tag number to which the catalog data and detail sheets pertain.

4. Submit calculations to show that gates, stems, and lifts meet the specifications.

5. Submit manufacturer's installation instructions.

C. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Manufacturers and Models

High-density polymer slide gates shall be Coplastix® as manufactured by Ashbrook Simon-Hartley, Inc.; Composite2 Series 50 – 40 as manufactured by Ham Baker; or acceptable equal.

B. Gate Design

1. Provide slide gates as shown in the drawings complete with gates, guides, frames, baseplates, seats, stems, stem guides, actuators, and anchor bolts. Design gates for minimum seating and unseating heads of 15 feet. Measure the seating and unseating heads from the top surface of the water to the center of the disc.

2. Channel-mounted slide gates shall be of the self-contained upward-opening type with guides for embedding in concrete. Wall-mounted slide gates shall be of the self-contained upward-opening type designed to mount on the face of concrete walls. Slide gates shall have rising stems.

3. Under the design seating head, the leakage shall not exceed 0.05 gpm per foot of wetted seating perimeter for gates having design heads less than 15 feet. Under the design unseating head, the leakage shall not exceed 0.05 gpm per foot of wetted seating perimeter.

4. Provide offset bevel box operating system for gates there the centerline elevation of handwheel or crank is greater than 48-inches from floor elevation. Centerline of offset bevel box operating system crank shall be 36-inches from floor elevation.

5. Provide extension for actuator to place handwheel interior to new guardrails where guardrail blocks access to actuator.

C. Gate Construction

1. Fabricate the frame using minimum of 5/16 inch thick Type 316 stainless steel complying with Type I per AWWA C563. Use Type 316 stainless steel fasteners (including anchor bolts, machined bolts, cap screws, and fittings for the gate proper and stem guides). Gate frames shall be of sufficient length to completely support the disc in the fully open position. Provide gates that are

suitable for flush invert embedded or wall mounted as noted in the drawings.

2. Construct the disc or slide using horizontal carbon steel internal reinforcements. The matrix is encapsulated using a composite synthetic material suitable for design head requirements. No external reinforcing is acceptable. Design the internal disc reinforcing members to limit deflection to 1/1,000 of the gate's span under design head conditions based upon horizontal support members only. The bottom of the disc shall be angled to provide a point seal. The outer skin material of the gates shall have a minimum thickness of 1/8 inch and be nontoxic, ultraviolet stabilized and in accordance with Class One fire resistance.

3. Materials of construction for gate components shall be as follows:

Component	**Material per AWWA C563**
Slides	Reinforced composite thermoplastic skin with an internal matrix of carbon steel
Seats and seals	Ultra high molecular weight polyolefin and backing constructed of neoprene

4. The gate seals shall be continuous multi finger design, adjustable, and fitted with a sealing face that is fixed to the frame and surrounds the clear opening. Provide resiliently backed fixed side seals and a fixed top seal that are molecularly incompatible with the gate material. Securely embed fixed side seals in the invert seal to ensure watertightness at the seal corners. Provide adjustable side pressure pads that are molecularly incompatible with the gate material. Angle the bottom of the disc to form a knife-edge. The frame invert shall be a resilient material that gives watertight sides-to-invert seal. When required top claw wedges or Horizontal pressure pads will be fitted.

D. Stems and Stem Guides

1. Lifting stems shall be one piece, with a minimum diameter of 1-1/4 inches. The stem shall withstand an actuator effort of 80 pounds without buckling, assuming the critical buckling load as determined by using the Euler Column Formula with C=2.0. Support the stems with

stem guides such that the L/R ratio for the unsupported part of the stem does not exceed 200.

2. Threaded stems shall be solid bar, Type 316 stainless steel. Stem couplings shall be Type 316 stainless steel and shall be threaded and bolted or keyed. Manganese bronze stop nuts with setscrews shall be accurately installed to prevent over-travel in closing. Stems shall be of sufficient length such that the stem end is visible in the clear plastic stem covers.

3. The stem connection to the disc shall be a threaded and bolted or keyed thrust nut supported in a welded nut pocket. The pocket shall be capable of withstanding a load of 80 pounds on the actuator.

4. Stem guides shall be Type 316 stainless steel split collar, adjustable in two directions to provide full adjustment for proper alignment with the stem and shall be Teflon bushed. Stem guides shall be provided in sufficient quantity that the slenderness or L/R (length/radius of gyration) ratio of the stem does not exceed 200. A sufficient number of stem guides shall be installed to prevent buckling of the stem. For self-contained gates, the manufacturer shall provide a stem with the diameter required to provide an L/R ratio that does not exceed 200.

5. Provide tandem stems and actuators when the gate width is more than twice the gate height and for weir gates 5 feet or more in width.

E. Anchor Bolts

Stainless steel bolts shall be ASTM A193, Grade B8 or ASTM F593, Type 316. Nuts shall be ASTM A194, Grade 8 or ASTM F594, Type 316. Use ASTM A194 nuts with ASTM A193 bolts; use ASTM F594 nuts with ASTM F593 bolts. Provide washer for each nut and bolthead. Washers shall be of the same material as the nuts.

F. Actuators

1. Provide manual actuators unless otherwise indicated in the drawings. Where possible provide Acme threaded handwheel lifts without gear reduction for gates having design seating heads 10-feet or less. Provide a flanged lift nut to engage the threaded portion of the stem. Support the lift nut on nonmetallic thrust washers or

ball or roller bearings. Provide manual crank-operated lift with gear reduction for gates having design seating heads greater than 10 feet. Maximum pull required to open the gate shall not exceed 40-pounds. Support crank-operated lift nuts only on ball or roller bearings. The crank handle shall be removable. Provide a 2-inch-square nut configured to allow the use of a portable electric actuator.

2. Materials of construction for manual lift components shall be as follows:

Component	Material per AWWA C563
Covers, baseplates, pedestals	Type 316 stainless steel
Lift blocks (in lift brackets)	Type 316 stainless steel
Lift Nuts in Handwheel or gearbox or electric actuator	Stainless Steel or UHMWPE, Bronze grades per gearbox/actuator manufacturer
Handwheels and handcranks	Galvanized steel
Input shafts	Type 304 stainless steel
Fabricated pedestals	Type 316 stainless steel

3. Provide a graduated clear plastic stem cover to show the gate position in increments of 1/4-inch. Provide vent holes to prevent condensation.

4. Provide motor actuators where shown in the drawings, as specified in Section 15119.

G. Spare Parts

1. Provide the following spare parts for each size of slide gate:

Quantity	Description
2	Lift nuts (threaded for handwheel or gearbox, or electric actuators
4	Stem guides of each type and size

2. Pack spare parts in a wooden box; label with the manufacturer's name and local representative's name,

address, and telephone number; and attach list of materials contained within.

PART 3 - EXECUTION

A. Slide Gate Designations and Designs

1. Provide the following copolymer slide gates:

Tag	Type	Gate Width (ft)	Gate Height (ft)	Bottom of Opening EL	Top of Opening EL	Deck EL
500-SG-1	Channel Mounted	5'-0"	8'-0"	102.83	112.00	112.00
500-SG-2	Wall Mounted	5'-0"	8'-0"	102.83	112.00	112.00
500-SG-3	Wall Mounted	5'-0"	8'-0"	102.83	112.00	112.00
500-SG-4	Wall Mounted	5'-0"	8'-0"	102.83	112.00	112.00
500-SG-5	Wall Mounted	5'-0"	8'-0"	102.83	112.00	112.00
500-SG-6	Channel Mounted	5'-0"	8'-0"	102.83	112.00	112.00
500-SG-7	Channel Mounted	5′-0″	8′-0″	102.83	112.00	112.00
500-SG-8	Wall Mounted	5′-0″	8′-0″	102.83	112.00	112.00
500-SG-9	Wall Mounted	5′-0″	8′-0″	102.83	112.00	112.00
500-SG-10	Wall Mounted	5′-0″	8′-0″	102.83	112.00	112.00
500-SG-11	Wall Mounted	5′-0″	8′-0″	102.83	112.00	112.00
500-SG-12	Channel Mounted	5′-3″	8′-0″	102.25	112.00	112.00
500-SG-13	Channel Mounted	5'-0"	8'-0"	102.25	112.00	112.00
500-SG-14	Channel Mounted	5'-0"	8'-0"	102.25	112.00	112.00
500-SG-15	Channel Mounted	5'-0"	8'-0"	102.25	112.00	112.00
500-SG-16	Channel Mounted	5'-0"	8'-0"	102.25	112.00	112.00
500-SG-17	Channel Mounted	5'-3"	8'-0"	102.25	112.00	112.00
580-SG-1	Wall Mounted	4′-0″(1)	4′-0″(1)	69.62	73.62	87.00
580-SG-2	Wall Mounted	2′-0″(1)	2′-0″(1)	76.00	78.00	87.00
580-SG-3	Wall Mounted	4′-0″(1)	4′-0″(1)	72.00	76.00	87.00

(1) Dimension corresponds to the nominal size of a pipe.

B. Weir Gate Designations and Designs

Provide the following copolymer weir gates:

Tag	Type	Gate Width (ft)	Gate Height (ft)	T/Wall EL	T/Weir Gate EL	Deck EL
500-WG-1	Wall Mounted	10'-0"	3'-0"	104.75	104.75	112.00
500-WG-2	Wall Mounted	10'-0"	3'-0"	104.75	104.75	112.00
500-WG-3	Wall Mounted	10'-0"	3'-0"	104.75	104.75	112.00
500-WG-4	Wall Mounted	10'-0"	3'-0"	104.75	104.75	112.00

C. Welding

Welder qualification shall comply with AWS D1.6. Welding rod and electrodes shall comply with AWS A5.4. In addition to structural welds, seal weld interfaces between mating parts to prevent moisture intrusion.

D. Painting and Coating

Surfaces above deck level, including Cast-iron, steel, actuators and floor stands, per Section 09900, System No. 10. Apply prime coat at factory. Color of finish coat shall be as selected by the owner.

E. Installation of Wall-Mounted Gates

1. Install the anchor bolts into the wall using frame as the template.

2. Comply with AWWA C563, Section 4.6.

F. Field Testing

1. Operate each slide gate through two complete cycles. Gates shall operate without sticking or binding.

2. Determine the effort required to turn the handwheel. Effort required shall be less than the limit specified.

3. Fill channels to which the gates are attached with water. Measure leakage through each slide gate. Measure the actual field seating and unseating heads. The allowable leakage shall be as specified above. If the leakage rate is exceeded, adjust or replace the gate and retest until it passes.

G. Contract Closeout

Provide in accordance with Section 01700.

H. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

3. Leakage shall be no more than that allowed by the AWWA C563 Standard during the guarantee period.

4. Door (disc) shall be free of sticking or binding as judged by the Engineer (move freely via operator provided) with no exercising required. Gate operators are to be warranted by the operator manufacturer.

I. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

J. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County

END OF SECTION

SECTION 11308 SUBMERSIBLE RAW SEWAGE PUMPS

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of submersible raw sewage pumps designed to operate in a wet well under submerged conditions.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit dimensional drawings.

3. Submit manufacturer's catalog data and detail drawings showing all pump parts and describe by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show linings and coatings. Show outline dimensions and weights of pumps, bases, and motors. Identify each pump by tag number to which the catalog data and detail sheets pertain.

4. Submit electrical drawings. Show wiring, controls, interlocks, terminals, and disconnects. Label each terminal, showing which control or electrical power wire connects to each terminal.

5. Submit pump curves from manufacturer's catalog data on which the specified operating points are marked. Show efficiency, brake horsepower, and NPSH required for the selected pump curve for each specified operating point. Show maximum operating speed.

6. Show impeller diameter, eye area, sphere size, and number of vanes.

7. Submit setting drawings. Show anchor bolt layout and anchor bolt dimensions.

8. Submit manufacturer's reports on hydrostatic tests and performance tests.

9. Submit manufacturer's sample form for reporting the performance test results. Submit at least two weeks before the tests. The test form should contain the data

presented in the sample form in Section 6 of ASME PTC 8.2.

10. Submit manufacturer's certified performance curves for review at least two weeks prior to shipping the units from the factory.

C. Definitions

Terms shall be as defined in the ASME PTC 8.2 for centrifugal pumps.

D. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Pump Design

1. The Contractor shall assign unit responsibility to the pump supplier for the complete pump system, including but not limited to the following: motors, discharge connection elbow, guiderails, lifting chain and cooling system control assembly.

2. Each pump shall be of the vertical, nonclog, single-suction, centrifugal type and shall be suitable for pumping unscreened raw sewage.

3. The pump, with its appurtenances and electric cable, shall be capable of continuous submergence under water without loss of watertight integrity to a minimum depth of 65 feet.

4. Design the casing to withstand a hydrostatic test of at least 150% of the pump discharge pressure (suction pressure plus pump differential pressure) at shutoff.

5. Each pump shall be capable of at least a 10% head increase at normal operating conditions by installing a larger impeller or an impeller of different hydraulic design.

6. Pump curve shall be continuously rising and shall be free of dips and valleys from the design point to the shutoff head. The shutoff head shall be at least 110% of the head that occurs at the design point.

7. The NPSH required shall be at least 5 feet less than the minimum NPSH available at all points on the pump curve up to 120% of the flow at the BEP.

8. Design the pump and its components to operate continuously over a flow range of 70% to 120% of the flow at the BEP.

B. Discharge Connections

The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection or service. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pump utilizing a machined metal to metal water-tight contact. A sliding guide bracket shall be an integral part of the pump unit. The entire weight of the pump unit shall be guided by no less than two stainless steel guide bars or stainless steel guide wire pressed tightly against the discharge connection elbow. No portion of pump shall bear directly on the floor of the sump.

C. Power Supply

Power supply will be 480 volts, 60 Hz, 3 phase.

D. Vibration

1. The pumping unit shall operate without surging or cavitating throughout the entire range of pump operation.

2. The maximum vibration level measured on the pump bearing housing at the rated pump speed (±10%) and at any flow for which efficiencies are shown on the manufacturer's

published performance curve shall not exceed that shown in Figure 11.16B in ANSI/HI 11.6-2001.

3. Maximum residual unbalance in impellers shall not exceed that shown in Figure 1.106 in ANSI/HI 1.1-1.5.

E. Volute Casing

Volute casing shall be of a single piece, nonconcentric design with smooth fluid passages at all points to pass any size solids which can pass through the impeller. Casing shall be accurately machined to fit the mechanical seal and suction cover assemblies. Fit the bottom of the volute with a Type 316 or 420 stainless steel or rubber-lined carbon steel replacement wear ring. Provide a 3/4-inch drain with plug in the volute.

F. Impeller

1. Impeller shall be enclosed type with a maximum of three vanes. Each impeller shall be cast in one piece and shall be statically and dynamically balanced, double-shrouded thrulet with smooth water passage to prevent clogging by stringy or fibrous materials and other matter found in normal sewage applications.

2. Each impeller shall be keyed to the shaft, and the fastening of the impeller to the shaft shall be made by a locking device. They shall be sealed from the liquid by means of an O-ring and covered and secured to the end face of the shaft by a single bolt.

3. Fit each impeller with a replaceable wear ring to provide sealing between the volute and impeller.

G. Shafts

1. Pump shaft diameter shall be such that it will not deflect more than 0.002-inch at the mechanical seal face with the largest impeller installed while operating at the maximum pump speed. Tolerance on the shaft diameter shall not exceed 0.002 inch. Dynamic shaft deflection at the stuffing box face shall not exceed 0.002 inch.

2. The first lateral critical speed of the rotating assembly shall be at least 120% of the maximum pump operating speed.

3. Surface finish of the shafts or sleeves through the mechanical seal and at the rubbing contact-bearing housing seals shall not exceed a roughness of 32 microinches.

4. If a carbon steel shaft is used, provide Type 420 stainless steel shaft sleeves having a minimum hardness of 450 Brinell.

H. Pump Seal

1. Provide each pump with a tandem mechanical shaft seal system. The upper of the tandem set of seals shall operate in an oil chamber located just below the stator housing. This set shall contain one stationary tungsten carbide ring and one positively driven rotating tungsten carbide ring functioning as an independent secondary barrier between the pumped liquid and the stator housing. The lower of the tandem set of seals shall function as the primary barrier between the pumped liquid and the stator housing. This set shall consist of a stationary ring and a positively driven rotating ring, both of which shall be tungsten carbide.

2. Each interface shall be held in contact by its own spring system supplemented by external liquid pressures. The seals shall require neither maintenance nor adjustment but shall be easily inspected and replaceable.

3. Shaft seals without positively driven rotating members or conventional double mechanical seals with a common single or double spring acting between the upper and lower units requiring a substantial pressure differential to offset external pressure and effect sealing shall not be considered acceptable or equal to the dual independent seal system specified.

4. The shaft sealing system shall be capable of operating submerged to depths of or pressures equivalent to a minimum of 65 feet. No seal damage shall result from operating the pumping unit out of its liquid environment. The seal system shall not rely upon the pumped media for lubrication.

I. Oil Chamber

Provide each pump with an oil chamber for the shaft sealing system. Design the oil chamber to assure that air is left in the oil chamber to absorb the expansion of the oil due to temperature variations. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside.

J. Bearings

1. Each pump shaft shall rotate on two permanently lubricated bearings. The upper bearing, providing for radial thrust, shall be a single row, roller bearing. The lower bearing shall consist of one double row angular contact bearing(s) for combined axial and radial loads.

2. Pump bearings shall be of the antifriction type designed to give 40,000 hours minimum life by L-10 calculations at maximum speed and operating load in continuous operation.

K. Cable Entry

Each cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by stainless steel washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry system shall utilize one of the two designs specified below.

1. The cable entry junction chamber and motor shall be separated by two terminal boards, which shall isolate the motor interior from foreign material gaining access through the pump top. Both the terminal boards shall be bolted to the interior of the motor housing and sealed by O-rings.

2. Provide cast-iron, pressure-tight cable entry gland, which shall be sealed by a nitrile rubber ring and compression gland. Design the compression gland to conform to the allowable bending radius of the power cable. In addition, cast each individual conductor wire in resin in such a manner to avoid any water leakage into the motor through capillary action, because of external cable damage or other causes.

L. Mating Surfaces

1. Machine and fit mating surfaces of major parts with nitrile O-rings where watertight sealing is required. Machining and fitting shall be such that sealing is accomplished by automatic compression in two planes and O-ring contact made on four surfaces, without the requirement of a specific torque limit. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered adequate or equal.

2. Tolerances of parts shall be such that they allow replacement of any part without additional machining required to ensure sealing as described above. No secondary sealing compounds, greases, or other devices shall be used.

M. Cooling System

1. The motor cooling system shall consist of ambient cooling by radiation and convection to the surrounding space and conduction through the pump volute to the pumped fluid.

2. Pumps equipped with water-cooling system consisting of a water jacket are also acceptable. The water-cooling jacket system shall encircle the stator housing. Provide the water jacket with a separate circulation of the pumped liquid. Cooling water shall enter the cooling jacket by way of the pumping vanes, integral with the impeller design, and exit with the pumping media. Cooling media channels and ports shall be nonclogging by virtue of their dimensions. Provide a separate, clear, external water source for motor cooling as well as lower seal flushing. Alternatively, ambient cooling of the motor may be utilized.

N. Electric Motors

1. Motors shall be provided in accordance with Section 16150 and the following.

2. Each pump shall be driven by a vertical, submersible squirrel cage induction motor, shell type design, housed in an air-filled, watertight chamber. The stator winding and stator leads shall be insulated with moisture-resistant Class H insulation which will resist a temperature of 180°C, 40°C ambient plus 115°C rise, and

designed for continuous duty, capable of sustaining a minimum of 15 starts per hour.

3. The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%.

4. The motor shall be sized to be nonoverloading when the pump is operated at any point on the pump performance characteristic curve drawn through the design point and shall have a minimum service factor of 1.15. Motor service factor shall not be used in satisfying pumping requirement.

5. Equip the stator with three sensors or thermistors embedded in the end coils of the stator winding to monitor stator temperature. Provide one sensor or thermistor in each stator phase, to switch off the unit if a winding temperature of 285°F is exceeded.

6. If the pump manufacturer uses thermistors in the motor windings, the pump manufacturer shall provide the motor winding thermistor relay and any motor bearing thermistor relays and shall arrange for their installation in the pump motor starter. Both relays shall operate in a 120-volt control circuit and have contacts as shown in the electrical drawings. Adjust and arrange relays to properly respond to the thermistors mounted within the pump-motor housing.

7. Connect sensors and thermistor relays to the pump motor starter in such a manner that their signal can actuate an alarm or provide for immediate shutdown or both.

8. Each pump motor shall have a sensor to monitor moisture in the stator cavity. Provide a conductivity-sensitive relay for installation in the pump motor starter to trip an alarm if moisture content indicates a failure of the outer mechanical seal.

O. Motor Cables

Pump motor power cables installed shall be made of a Hypalon or Protolon synthetic rubber-jacketed, Type SPC multiconductor cable, suitable for submersible pump applications and heavy mechanical stresses. The power cable shall also be sized according to NEC and ICEA standards and also meet with P-MSHA approval or equivalent. Use a separate

Hypalon or Protolon synthetic rubber-jacketed, Type SPC cable for temperature and moisture pilot protection signals. The total length of each cable shall be a minimum of 40 feet.

P. Materials of Construction

1. Materials of construction shall be as listed below:

Component	Material	Specification
Casing, volute, suction and discharge elbows	Cast iron	ASTM A48, Class 35B (minimum)
Impeller	Cast iron	ASTM A48, Class 35B (minimum)
Shaft	Stainless steel	ASTM A479, Grade CF8M
Impeller wear ring	Brass	ASTM A197
Drain and vent plugs	Stainless steel	AISI 316
Cap screws, bolts, and nuts	Stainless steel	AISI 316
Any bronze components in contact with water	--	See paragraph 3 below

2. Do not construct the impeller wear ring and case wear ring of the same material. Impeller and bowl wear ring materials shall have a minimum Brinell hardness difference of 50 unless both the stationary and the rotating wear surfaces have Brinell hardness numbers of at least 50.

3. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

Q. Factory Hydrostatic Testing

Hydrostatically test casing and volute for 10 minutes minimum with water at one and one-half times the maximum design operating pressure.

R. Anchor Bolts, Nuts, and Washers

Anchor bolts, nuts, and washers for pumps installed in wet wells shall be stainless steel per Section 05050.

S. Control Panel

1. The Manufacturer shall provide a NEMA 4X, 316 stainless steel, 480VAC control panel meeting the requirements of Section 16191, PART 2, paragraph B and as modified herein.

2. Solid state motor control or variable frequency drive is acceptable. If this is provided, single phase protection is inherent and the phase monitor is not required.

3. PLC control is allowed rather than the relay control specified in 16191, but the PLC must conform to the Division 13 requirements (Siemens) and an internal UPS in accordance with Division 13 shall be required. Internal PLC wiring shall be allowed to be 18 AWG but shall be rated 600 volts. Internal dividers or barriers shall be provided to allow instrumentation technicians to access the PLC components without being exposed to 480 volts.

T. Spare Parts

1. Provide the following spare parts for each model or size of pump:

Quantity	Description
1	Set of wear rings for impeller and volute
1	Complete set of seals, primary and secondary
2	Sets of radial bearings
2	Sets of thrust bearings
1	Complete set of O-rings or gaskets, whichever applies to the supplied pump unit
1	Pump w/Accessories

Quantity	Description
5	Gallons of Seal Cavity Oil
5	Tube of Recommended Grease

2. Pack spare parts in a wooden box; label with the manufacturer’s name and local representative’s name, address, and telephone number; and attach list of materials contained within.

PART 3 - EXECUTION

A. Factory Performance Testing

1. Each pumping unit shall be subjected to a nonwitnessed laboratory performance test using the actual job driver. Conduct tests in accordance with the Hydraulic Institute Standards.

2. No motor overload above nameplate rating will be allowed.

3. Deviations and fluctuations of test readings shall conform to ASME PTC 8.2, Table 2.

4. Measure flow by the "Capacity Measurement by Weight," the "Capacity Measurement by Volume," or the "Capacity Measurement by Venturi Meter, Nozzle, or Thin Plate Orifice" methods in ASME PTC 8.2.

B. Painting and Coating

1. Factory to coat pump with manufacturer recommended epoxy coating for submerged sewage service.

2. Line volute and interior wetted surfaces and coat impeller per Section 09900, System No. 6.

C. Service Conditions

1. Pump hydraulic performance conditions and design data shall be as shown below.

a. Pump Tag Numbers: 360-P-1 and 360-P-2

Location:	Flocculation Tank (Process 360)
Liquid Pumped:	Clarified Effluent
Service:	Outdoors Environmental temperature range of 20°F to 110°F
Altitude:	66 feet above mean sea level
Relative Humidity:	Up to 100%
Fluid Temperature Range:	50°F to 90°F

Pump Data

Capacity (gpm)	**Pump Total Head (feet)**	**Minimum Pump Efficiency (%)**
3,300	23	60
3,920*	17	79
4,700	8.5	45
*Design point.		

Maximum Pump Speed:	1200 rpm
Minimum NPSH Available:	40 feet
Motor Horsepower (Maximum):	30-Hp
Variable Speed Drive Required per Section 16260:	No
Suction Elbow Size:	N/A
Discharge Nozzle Size:	12 inches
Manufacturers and Models:	ABS Model XFP 300J-CB3 or Flygt Model NP3171 LT3/613

(1) The specified impeller shall be capable of passing a 3-inch sphere or equivalently a 2-inch by 2-inch rectangular shape.

b. Pump Tag Numbers: 495-P-3

Location:	In Plant Lift Station (Process 495)
Liquid Pumped:	Raw Sewage, Mixed Liquor, drainage from process tanks, Filtrate
Service:	Outdoors Environmental temperature range of 20°F to

	110°F
Altitude:	66 feet above mean sea level
Relative Humidity:	Up to 100%
Fluid Temperature Range:	50°F to 90°F

Pump Data

Capacity (gpm)	**Pump Total Head (feet)**	**Minimum Pump Efficiency (%)**
800	72	65
*1200	60	72
1600	48	70
*Design point.		

Maximum Pump Speed:	1800 rpm
Minimum NPSH Available:	34 feet
Motor Horsepower (Maximum):	30-Hp
Variable Speed Drive Required per Section 16260:	No
Suction Elbow Size:	N/A
Discharge Nozzle Size:	6 inches
Manufacturers and Models:	ABS Model XFP150J-CH2 or Flygt Model NP3171 MT

(1) The specified impeller shall be capable of passing a 3-inch sphere or equivalently a 2-inch by 2-inch rectangular shape.

c. Pump Tag Numbers: 560-P-1, 560-P-2, 560-P-3, and 560-P-4

Location:	Secondary Effluent Reject Pump Station (Process 560)
Liquid Pumped:	Secondary Effluent
Service:	Outdoors Environmental temperature range of 20°F to 110°F
Altitude:	66 feet above mean sea level
Relative Humidity:	Up to 100%
Fluid Temperature Range:	50°F to 90°F

Pump Data

Capacity (gpm)	Pump Total Head (feet)	Minimum Pump Efficiency (%)
6250	46	80
7600*	37	80
9200	25	70
*Design point.		

Maximum Pump Speed:	1200 rpm
Minimum NPSH Available:	34 feet
Motor Horsepower (Maximum):	85-Hp
Variable Speed Drive Required per Section 16260:	Yes
Suction Elbow Size:	N/A
Discharge Nozzle Size:	12 inches
Manufacturers and Models:	ABS Model XFP 300J-CB3 or Flygt Model NP3315 LT3/813

d. The specified impeller shall be capable of passing a 3-inch sphere or equivalently a 2-inch by 2-inch rectangular shape.

D. Installing Tensioning System

1. Attach cable bracket to the lip of the equipment opening. Use cast-in stainless steel bolts.

2. Attach the flange discharge elbow to the floor of the wet well using cast-in stainless steel anchor bolts.

3. Install the guide cable/rail per manufacturer's recommendations.

4. Provide and attach the stainless steel lift chain or cable.

E. Field Testing

1. Bump motor to ensure that motor has been connected for proper rotation.

2. Perform field tests for 24 consecutive hours on each pump. Measure flows at the following head points:

   a. Tag Numbers: 360-P-1 and 360-P-2

   b. Location: Flocculation Tank (Process 360)

   c. Service: Outdoors Environmental temperature range of 20°F to 110°F

   d. Maximum rpm: 1200 rpm

   e. Test Points (Feet): At data points listed above, Section 3.C.1.a

3. Perform field tests for 24 consecutive hours on each pump. Measure flows at the following head points:

   a. Tag Numbers: 495-P-3

   b. Location: In Plant Lift Station (Process 495)

   c. Service: Outdoors Environmental temperature range of 20°F to 110°F

   d. Maximum rpm: 1800 rpm

   e. Test Points (Feet): At data points listed above, Section 3.C.1.b

4. Perform field tests for 24 consecutive hours on each pump. Measure flows at the following head points:

   a. Tag Numbers: 560-P-1, 560-P-2, 560-P-3, and 560-P-4

   b. Location: Secondary Effluent Reject Pump Station (Process 560)

   c. Service: Outdoors Environmental temperature range of 20°F to 110°F

   d. Maximum rpm: 1885 rpm

   e. Test Points (Feet): At data points listed above, Section 3.C.1.c

5. If the measured flows at the above tabulated pump heads are more than 5% below the flows obtained on the laboratory or factory test, adjust the impellers or provide new impellers or otherwise repair or replace the pumps or calibrate meters or pressure gauges.

6. Assure that in the automatic mode each pump responds to its water level signal. Assure that each pump operates at a steady rate (±5% of set point) at any given water level for 30%, 40%, 50%, 60%, 80%, and 100% of the maximum capacity specified.

7. Assure that limit switches on the pumps' check valves indicate and transmit the signals for the valves in the open and closed positions.

8. Demonstrate that the pumping units, motors, and control system meet the following requirements:

   a. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

   b. Automatic and manual controls function in accordance with the specified requirements.

   c. Drive equipment operates without being overloaded.

F. Contract Closeout

Provide in accordance with Section 01700.

G. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

H. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

I. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County.

END OF SECTION

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SECTION 11311A NONCLOG CENTRIFUGAL PUMPS(WAS)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials and equipment, and incidentals required and install, complete and ready for operation variable speed, horizontal non-clog waste activated sludge (WAS) pumps, as shown on the Contract Drawings and as specified herein.

B. General Design:

1. Equipment specified herein is intended to be standard equipment for pumping return and waste activated sewage sludge and aeration tank mixed liquor.

2. Specific design information is provided in Table 11311A-A.

1.02 QUALITY ASSURANCE

A. Material Service Requirements: The pumps, motors and all related equipment shall be suitably constructed of materials to withstand the operating conditions which will be experienced during the pump's performance and outdoor environment.

B. Balancing: Pump impellers shall be statically and dynamically balanced. The vibration allowance in the units shall not exceed the upper limits as established by the Hydraulic Institute Standards.

C. Unit Responsibility: The entire pump assembly (pump, motor, coupling, guard, and equipment base) shall be supplied by the supplier to insure unit responsibility.

D. Qualification: The Pump supplier is required to demonstrate successful experience in the design and manufacturing of non-clog centrifugal pumps. The pump assembly shall be manufactured and tested within the United States of America. As of the date in which Bids are submitted, the manufacturer shall have a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than

four (4) consecutive years from final completion of the respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be non-clog centrifugal, mixed liquor applications in a similar service to the specified pumps.

E. Pumps furnished for RAS and WAS service shall be the product of a single manufacturer. The pumps shall be manufactured by Chicago, Morris, or Aurora.

1.03 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

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, 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.

2. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes

required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years.The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be non-clog centrifugal, mixed liquor application in a similar service to the specified pumps.

   a) Current Owner Reference Contact Information

   b) Installation Service Conditions

   c) Equipment Model Numbers

   d) Date of Final Completion of the Project

4. Manufacturer's literature, illustrations and applicable data for the pumps.

5. The shop drawings shall include details of pump assembly; installation layout and procedures; piping and electrical connections and requirements; types of materials used in pump construction; details on all pump accessories; dimensions of major components; weights, structural and operating features, space required, clearances, type of finish or shop coat, and other pertinent data.

6. A list of manufacturer's recommended spare parts to be supplied, with the manufacturer's current price for each item. List bearings by the bearing manufacturer's numbers only.

7. The following data shall be provided on the drive motor: materials of construction, dimensions, rpm at full load, frequency, voltage, full load current, code and design letter, efficiency, horsepower, number of phases, time rating, temperature rise, service factor and bearing life rating. The submittal shall include motor manufacturer's recommended lubrication requirements.

8. Submit motor data per Section 16150.

B. Performance Curves: The Contractor shall submit the following to the Engineer for review, prior to shipment from the factory.

1. Factory Testing: Factory testing in accordance with the standards of the Hydraulic Institute shall be required for all pumps. Certified pump performance curves shall be submitted, including head, capacity, brake horsepower and pump efficiency for each pump supplied.

2. Curves shall be submitted on 8 1/2-inch by 11 inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at shut off head to maximum pump runout head and capacity allowed by the manufacturer.

3. Points of operation which cause bearing stress or shaft deflection in excess of the manufacturer's tolerances for continuous operation shall be indicated on the submitted curves.

C. Operating and Maintenance Instructions: Submit operation and maintenance manuals in accordance with Section 01300. The operation and maintenance manuals shall have been prepared specifically for the model and type of pump furnished and shall not refer to other models and types of similar equipment. The operation and maintenance manuals shall include but not be limited to the following:

1. Equipment function.

2. Description.

3. Normal and limiting operating characteristics.

4. Installation instructions (assembly, alignment and adjustment procedures).

5. Operation instructions (normal start-up and shutdown procedures, normal operating conditions and emergency situations).

6. Lubrication and maintenance instructions.

7. Troubleshooting guide.

8. Parts list with catalog numbers and predicted life of parts subject to wear.

9. Drawings - cross sectional view, assembly and wiring diagrams.

10. Performance curves.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. 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 complete.

B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

C. Finished surfaces of all exposed pump openings shall be protected by wooden blanks.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.

F. Each box or package shall be properly marked to show its net weight in addition to its contents.

G. Pump shall be shipped and handled in such manner as to prevent damage. At the job site, pumps and motors shall be stored in clean, dry, and protected locations.

1.05 WARRANTY AND GUARANTEES

A. The equipment shall be warranted against defects in material and workmanship for three (3) years from date of substantial completion of the respective unit process in which the pumps are installed.

B. An additional two (2) year warranty period, extending the warranty period for a total of five (5) years, shall be provided for consideration by the Owner. Refer to Division 1 for additional information and requirements.

C. The equipment shall be under warranty to be free from defects in workmanship, design and materials. If any part of

the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

D. The replacement or repair (including cost of parts and labor) of those items normally consumed in service, such as mechanical seals, oil, grease, and the like, shall be considered as part of routine preventive maintenance by the Owner.

E. Certifications: Furnish the Engineer with a written certification signed by the manufacturer's representative, that the installed equipment:

1. Has been installed per manufacturer's requirements.

2. Has been lubricated per manufacturer's instructions.

3. Has been accurately aligned and proper running clearances set.

4. Is free from undue stress imposed by piping or mounting bolts.

5. Is ready to be operated on a continuous basis, and is free from any known defects.

6. Suction piping and seal water piping has been flushed and all debris removed prior to startup.

1.06 TOOLS AND SPARE PARTS

A. One (1) set of all special tools required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys.

B. Spare Parts: One (1) complete set of mechanical seals for the pumps supplied for each Process Area (total of 4 sets).

C. All spare parts shall be protected for long periods of storage and packed in containers, which are clearly identified with indelible markings as to the contents.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General:

1. The equipment covered by these Specifications is intended to be similar in quality to the existing WAS pumps already in service and to be standard pumping equipment of proven ability as manufactured by reputable concerns having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practice and methods and shall operate satisfactorily when installed as shown on the Contract Drawings.

2. Equipment shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation and without excessive vibration or strain.

3. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustments.

4. The pump base shall be rigidly and accurately anchored into position, precisely leveled and aligned, so that the completed installation is free from stress or distortion. All necessary foundation bolts, plates, nuts and washers shall be furnished and installed by the Contractor to conform to the recommendations and instructions of the manufacturers. Anchor bolts, nuts and washers shall be Type 316 stainless steel. Grouting under bases after the equipment is set is included as work under this section.

5. Stainless steel nameplate giving the name of manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to the pump.

6. Stainless steel nameplate giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes an all other pertinent data shall be attached to the motor.

7. The nameplate ratings of the motor shall not be exceeded, nor shall the design factor be reduced when its pump is operating at any point on its characteristic curve at maximum speed.

2.02 PUMPS

A. General:

1. The pumps shall be of the centrifugal, non-clog, solids handling type for outdoor installation.

2. The pumps shall be of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.

3. The pumps shall conform to all requirements stipulated in Table 11311A-A.

B. Pump Construction:

1. Pump Casings:

a) The pump casings shall be constructed of close-grained cast iron, ASTM-A-48, Class 30 of sufficient thickness to withstand all stresses and strains of service at full operating pressure. The pump casings shall be equipped with double radial type replaceable 420 stainless steel HT with minimum 50BHN difference wear rings.

b) Suction and discharge connections shall be 125 lb. ANSI Standard flat-face flanges positioned as indicated on the Contract Drawings.

c) Casings for the pumps shall be given a certified hydrostatic test to 125 psi minimum for at least five minutes with no evidence of leakage. Test results shall be sealed by a registered Engineer or certified by a factory test engineer and shall be submitted prior to approval.

d) Large volute clean out port shall be provided.

2. Suction and Back Heads:

a) The volute casings shall be provided with cast suction and back heads of the same material as the volute, cast separately from the volute, and shall be built to allow for complete removal of the bearings, shaft and impeller by simply unbolting the back head. The back head and suction head shall shoulder fit to the volute casing to assure accurate alignment. The back head shall be designed to support the head frame and shall be designed to support the seal box or contain an integral seal box.

b) Seal Box:

1) The seal box shall be engineered for the specified mechanical seals. The seal box shall be designed for the compressed seal length and shall not require any adjustments. The seal housing shall be extra large to provide excellent circulation of clear sealing liquid. The mechanical seal shall be provided with a flushing tap on the gland to permit a clear water flush to the pump seal at a rate of ½ gpm, dead-end flow, into the seal cavity.

2) The seal box shall have a bronze Chesterton, Spiral Trac, Series 4, throat bushing installed in the bottom of the seal box for the exclusion of solids and provide for operation if flush water fails..

3) The manufacturer shall provide a shaft sleeve in 316 series, stainless steel material for the cartridge seal to be mounted over.

c) Seals: Provide a split style, cartridge type, single, inside mechanical seal with silicon carbide rotating and silicon carbide stationary sealing faces, and EPDM elastomers. Provide all metal parts in 316 series or hasteloy- C materials. Seals shall be Chesterton Model 442.

3. Pump Impellers:

a) The pump impeller shall be of the non-clogging type and shall be of the same material as the casing and shall be statically and dynamically balanced. The pump manufacturer shall be fully responsible for the vibration-free operation of the pumping unit throughout the entire operating range.

b) The impeller shall be of the enclosed type. The impeller shall be of cast iron, ASTM A-48, Class 30, and shall be securely fastened to the shaft by means of a stainless steel key and impeller locknut or bolt. The impeller shall be equipped with a replaceable stainless steel wear ring. Axial adjustment of the impeller shall be external

through integral jackscrews or radial wear rings made be provided in lieu of jackscrews.

4. Pump Shaft: Each pump shaft shall be ANSI 1144 or equal, accurately machined and ground to size. Where shafts pass through stuffing boxes or where exposed directly to sewage, they shall be protected by readily renewable, snug fitting 420 Series stainless steel wearing sleeves internally ground to approved tolerances and positively secured to the shaft so as to prevent relative rotation. Passage of water from pump casing between shaft and sleeve shall be prevented by "O-Ring" packing or other approved means. The shaft sleeve shall extend from the impeller hub through the seal box. Factory certified calculations showing deflection of less than or equal to 0.002 mils will be provided in the submittal. Shafts with greater deflection will not be accepted.

5. Bearings:

   a) The pump bearing frame shall be equipped with a bearing system designed to provide a separate bearing to accept all thrust loadings imposed by the pump impeller and a minimum of two separate bearings for the radial loads imposed by the pump impeller. All bearings shall be designed for a 20-year average life for any point within the pump operating conditions as defined by Table 11311A. The pump manufacturer shall submit certified calculations showing at least 290,000 hours of life at design conditions.

   b) The minimum bearing span of the pumps shall be no less than 70 percent of the maximum impeller diameter that can be placed in the pump casing. The cantilever portion of the pump shaft between the inboard radial bearing and the impeller shall not be greater than the span between the radial bearings. The diameter of the pump shaft between the span of the radial bearings shall be no less than 20 percent of the diameter of the maximum impeller that can be placed in the pump casing.

   c) All bearing grease fittings shall be accessible while the pump is in operation. The bearings shall be grease lubricated, and a relief shall be provided so that excessive grease pressure will not damage the bearings. Each pump bearing housing

will be fitted with a lubrication system, Lube Site model 500 with 2-ounce capacity, or equal.

d) For protection of bearings during shipment and installation, the bearings shall be properly processed with a high quality rust preventative. Each bearing frame shall be designed so that the complete rotating element can be removed from the casing without disconnecting the suction and discharge piping.

e) The bearing support frame shall be of cast-iron construction and shall be designed to provide a self-centering and self-indexing fit with the wetted end of the pump to ensure proper alignment of the bearings and stuffing box.

6. Pump Support:

a) Each pump shall be mounted on a fabricated steel pump support base of sufficient size and strength to support all loads to which it may be subjected. Each frame shall be designed to mount on the concrete pads as shown on the Contract Drawings. Bases shall be reinforced and shall have large, readily accessible openings for installation of grout. The bases will have air escape holes at each end to insure proper grout filling. Open channel bases will not be acceptable. The bases will have drip rim with NPT connections. The OSHA coupling guard will be a non-metallic hinged lockable type. All pump case and mounting fasteners shall be 316 series stainless steel.

b) Pump shall be designed for connection to the motor and shall be furnished complete with coupling guards and shall be furnished complete with a 1.20 service factor coupling. The coupling will be a spacer type T.B. Woods or Martin spacer coupling with a Neoprene or rubber split ring sleeve.

7. Pump Suction and Discharge Gauges: The contractor shall furnish and install for each pump tapped holes in the suction and discharge piping complete with pipe nipples and isolation valves for use in connecting pressure gauges. Nipples shall be of such length and provided with elbows if necessary so that a pressure gauge may be easily installed and read. The suction and pressure gauges will be diaphragm type with upper and lower stainless steel seal housing and bolts. The diaphragm

will be for sludge applications. The housing will be 4-1/2 inch face with non-metallic body. The nipple and valves will be stainless steel construction.

8. Pump Coatings: Provide the pump assembly with a minimum coating of 6 mils DFT, high solids epoxy factory prime coating for finish coating by the contractor. Factory prime shall be compatible with finish coating.

9. The pump manufacturer shall provide a seal flush piping system which shall take plant process water and meter it to each pump on a continuous basis at 0.5 GPM and have an incoming isolation ball valve, pressure regulating valve, upstream and downstream pressure gauges, stainless steel needle valve, Dwyer 0 to 1.0 gpm rotameter, bronze check valve and outflow connection isolation ball valve. Mount all piping arrangement on an aluminum, power coated sub panel for the contractor to mount near the pump unit. Connect the seal water from the metering panel to the seal gland with a poly tubing fitting the connections on the gland.

2.03 MOTORS

A. General:

1. The motors for the pumps shall be of the horizontal or vertical TEFC design as required by the pump arrangement.

2. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA Standards where applicable.

3. The pump motors shall also be suitable for use with variable speed drives utilizing PWM technology as specified and shall be inverter duty.

4. Motors shall be as manufactured by Reliance Electric, Westinghouse, U.S. Electrical Motors or approved equal.

5. Refer to Electrical Section 16150 for additional requirements.

B. Performance Requirements:

1. Motors shall be rated for operation on a 480 volt, three-phase, 60 Hz power supply.

2. Each motor shall have a 1.15 service factor.

3. Motors shall be premium efficiency type.

4. Motors shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level not to exceed 90 dBA as measured 5 feet from any surface.

5. Maximum temperature rise of motor windings shall not exceed 80°C, as measured by resistance, when motor is operated continuously at service factor horsepower, rated voltage and frequency in ambient air temperature of 40°C.

6. Nameplate horsepower shall not be exceeded during pump operation at any point on characteristic curve for impeller furnished.

C. Construction:

1. Motors shall be Corro-Duty suitable for operation in moist air with hydrogen sulfide gas present.

2. Motor frames and end shields shall be of cast-iron construction of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.

3. The motors shall be of totally enclosed fan cooled construction. Motors shall have Class F non-hygroscopic epoxy sealed insulation but shall be limited to Class B temperature rise. The motor shall be suitable for outdoor weather conditions.

4. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibration.

5. The shaft shall be made of high-grade machine steel or steel forgoing of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.

6. Stator and rotor cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be random wound and of size, shape, insulation and number of turns required. Coils shall be epoxy sealed after fabrication.

7. Motors shall be equipped with bearings made of AFBMA Standards, and be of ample capacity of the motor rating. Bearings shall be grease lubricated and shall have a minimum B_{10} bearing life of 100,000 hours.

8. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all motors. Enclosures shall have stainless steel screen and shall be protected from corrosion, fungus and insects.

9. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.

10. All motors greater than 7.5 HP shall be supplied with space heaters to prevent accumulation of moisture. Space heaters shall be rated 120 volt single phase.

11. All motors to have a normally open internal thermal switch.

12. Provide grounding lug in Conduit box.

2.04 CONTROLS

A. The speed of the WAS pumps will be controlled by variable frequency drives that receive a signal from the SCADA system.

B. Controls are specified in Division 13.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Installation of pumping equipment shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the Contract Drawings. Equipment shall be installed by experienced and mechanically skilled workmen with previous experience in similar installations. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

B. All necessary piping, fittings, valves, air relief valves, vents, concrete foundation, anchor bolts, grouting, etc. shall be provided to insure a complete and satisfactory

installation of the pumping equipment including pump, electric motor, electrical connections and piping connections.

C. Install pressure gauges on the pump suction and discharge piping as shown on the Contract Drawings, including an isolation valve and pressure gauge at each location.

D. Hardware: All anchor bolts, nuts and washers shall be Type 316 stainless steel. All brackets and the hardware items shall be Type 316 stainless steel.

E. Install piping, fittings, valves and other appurtenances to the pump installation in accordance with the manufacturer's installation instructions, the requirements of referenced sections included with these specifications and as shown on the Contract Drawings. Equipment shall be installed in a workmanlike manner so that individual equipment will function properly and freely and no individual parts shall be strained.

F. Noise and Vibrations: All equipment containing moving parts shall be installed level and plumb, unless otherwise indicated, and shall be anchored securely in order that noise be suppressed to a minimum and that vibrations do not cause damage while in operation.

3.02 FIELD PAINTING

A. Field surface preparation and painting shall be as specified in Section 09900.

3.03 FACTORY SERVICE REPRESENTATIVE

A. For each pump supplied, the Contractor shall arrange for the services of a qualified factory service representative. The period of service shall be one day for each type or model pump supplied.

B. The duties of the service representative shall be as follows: After the equipment has been installed but before it is operated by others, the representative shall inspect the completed installation for soundness (no damaged or cracked components), completeness, and correctness of setting and alignment, and for the adequacy and correctness of mechanical seal alignment and lubricants. The service representatives shall start-up the equipment and instruct the Owner's personnel in proper operation and maintenance procedures. The responsibility of the Contractor with regard to start-up shall be fulfilled when the start-up is

completed, the equipment is functioning properly and has been accepted by the Owner.

C. The service representative shall submit to the Engineer six (6) copies of a signed report of the result of his inspection, adjustments and start-up. The report shall include descriptions of the inspection, adjustments made, and the start-up. The report shall also include a statement that the equipment is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void. Final payment shall not be made to the Contractor until this report has been submitted to and approved by the Engineer.

3.04 INSPECTION AND TESTING

A. After pump has been completely installed, the Contractor shall conduct, in the presence of the Engineer, testing of all mechanical equipment and piping to demonstrate capacity, correct alignment, smooth operation, proper adjustment, and freedom from noise, vibration, over-heating and leaking, and to ensure satisfactory compliance with the specifications. All defects shall be corrected. The Contractor shall supply all oil, grease, electric power, water and all other material necessary to complete the field tests.

B. If the pump performance does not meet the Specifications, corrective measures shall be taken by the Contractor, or pump shall be removed and replaced with a pump which satisfies the conditions specified.

C. Motor Field Testing: Motor shall be disconnected from the pump and run for four (4) hours. Following the run-in test, reconnect the motor to the pumping equipment and reinstall all coupling guards.

D. Pump Field Testing:

1. Upon completion of all the mechanical work, the Contractor shall conduct testing as specified herein to demonstrate that the equipment performs in accordance with all specifications.

2. The Contractor shall perform initial testing of the equipment to insure himself that the tests listed in the Demonstration Test paragraph below can be completed.

3. Demonstration Test shall demonstrate that all items of these Specifications have been met by the equipment, as installed, and shall include the following tests:

a) That the pump controls perform satisfactorily.

b) That the pump has been successfully field Laser aligned with report from a certified testing firm.

b) The pump has been vibration tested in compliance with the Hydraulic institute standards for horizontal rotating assemblies.

c) A dba sound test.

4. In the event that the equipment does not meet the Demonstration Test, the Contractor shall, at his own expense, make such changes and adjustments in the equipment which he deems necessary and shall conduct further tests until written certification is received from the Engineer.

5. See Section 01664 (System Start-up and Testing) for additional requirements.

Table 11311A-A

Item	Clarifiers 1&2 (Process 251)	Clarifiers 3&4 (Process 252)	Clarifiers 7&8 (Process 253)	Clarifier 9 (Process 352)
Tag Number(s)	251-P4 and P5	252-P4 and P5	253-P4 and P5	352-P3 and P4
Name	WAS Pumps	WAS Pumps	WAS Pumps	WAS Pumps
No. of units	2	2	2	2
Maximum motor full load speed (rpm)	1150	1150	1150	1150
Minimum Motor to be supplied (hp)	5	5	5	5
Rated pumping temperature	85degF	85degF	85degF	85degF
Minimum sphere size passed (inches)	3	3	3	3
At Maximum Pump Speed:				34
Minimum pump shut-off head (ft.)	32	32	30	55
Rated total dynamic head (ft.)	27	27	26	25
Rated capacity (gpm)	150	150	150	220
Minimum pump efficiency (%)	46	46	48	50
NPSHR (ft)	12 or less	12 or less	12 or less	12 or less
At Minimum Pump Speed:				
Rated total dynamic head (ft.)	18	18	15	17
Rated capacity (gpm)	100	100	100	150
Speed	Variable (VFD)	Variable (VFD)	Variable (VFD)	Variable (VFD)

Manufacturers: Chicago, Morris, r Aurora.

END OF SECTION

SECTION 11311B NONCLOG CENTRIFUGAL PUMPS (RAS)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work:

1. Furnish all labor, materials and equipment, and incidentals required and install, complete and ready for operation variable speed, horizontal non-clog return activated sludge (RAS) pumps, as shown on the Contract Drawings and as specified herein.

B. General Design:

1. Equipment specified herein is intended to be standard equipment for pumping return and waste activated sewage sludge and aeration tank mixed liquor.

2. Specific design information is provided in Table 11311B-A.

1.02 QUALITY ASSURANCE

A. Material Service Requirements: The pumps, motors and all related equipment shall be suitably constructed of materials to withstand the operating conditions which will be experienced during the pump's performance and outdoor environment.

B. Balancing: Pump impellers shall be statically and dynamically balanced. The vibration allowance in the units shall not exceed the upper limits as established by the Hydraulic Institute Standards.

C. Unit Responsibility: The entire pump assembly (pump, motor, coupling, guard, and equipment base) shall be supplied by the supplier to insure unit responsibility.

D. Qualification: The Pump supplier is required to demonstrate successful experience in the design and manufacturing of non-clog centrifugal pumps. The pump assembly shall be manufactured and tested within the United States of America. As of the date in which Bids are submitted, the manufacturer shall have a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than

four (4) consecutive years from final completion of the respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be non-clog centrifugal, mixed liquor applications in a similar service to the specified pumps.

E. Pumps furnished for RAS and WAS service shall be the product of a single manufacturer. The pumps shall be manufactured by Chicago, Morris, or Aurora.

1.03 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

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, 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.

2. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant

drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years.The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be non-clog centrifugal, mixed liquor application in a similar service to the specified pumps.
   a)Current Owner Reference Contact Information
   b)Installation Service Conditions
   c)Equipment Model Numbers
   d)Date of Final Completion of the Project

4. Manufacturer's literature, illustrations and applicable data for the pumps.

5. The shop drawings shall include details of pump assembly; installation layout and procedures; piping and electrical connections and requirements; types of materials used in pump construction; details on all pump accessories; dimensions of major components; weights, structural and operating features, space required, clearances, type of finish or shop coat, and other pertinent data.

6. A list of manufacturer's recommended spare parts to be supplied, with the manufacturer's current price for each item. List bearings by the bearing manufacturer's numbers only.

7. The following data shall be provided on the drive motor: materials of construction, dimensions, rpm at full load, frequency, voltage, full load current, code and design letter, efficiency, horsepower, number of phases, time rating, temperature rise, service factor and bearing life rating. The submittal shall include motor manufacturer's recommended lubrication requirements.

8. Submit motor data per Section 16150.

B. Performance Curves: The Contractor shall submit the following to the Engineer for review, prior to shipment from the factory.

1. Factory Testing: Factory testing in accordance with the standards of the Hydraulic Institute shall be required for all pumps. Certified pump performance curves shall be submitted, including head, capacity, brake horsepower and pump efficiency for each pump supplied.

2. Curves shall be submitted on 8 1/2-inch by 11 inch sheets, at as large a scale as is practical. Curves shall be plotted from no flow at shut off head to maximum pump runout head and capacity allowed by the manufacturer.

3. Points of operation which cause bearing stress or shaft deflection in excess of the manufacturer's tolerances for continuous operation shall be indicated on the submitted curves.

C. Operating and Maintenance Instructions: Submit operation and maintenance manuals in accordance with Section 01300. The operation and maintenance manuals shall have been prepared specifically for the model and type of pump furnished and shall not refer to other models and types of similar equipment. The operation and maintenance manuals shall include but not be limited to the following:

1. Equipment function.

2. Description.

3. Normal and limiting operating characteristics.

4. Installation instructions (assembly, alignment and adjustment procedures).

5. Operation instructions (normal start-up and shutdown procedures, normal operating conditions and emergency situations).

6. Lubrication and maintenance instructions.

7. Troubleshooting guide.

8. Parts list with catalog numbers and predicted life of parts subject to wear.

9. Drawings - cross sectional view, assembly and wiring diagrams.

10. Performance curves.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. 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 complete.

B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

C. Finished surfaces of all exposed pump openings shall be protected by wooden blanks.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment, and proper care shall be taken to protect parts from the entrance of water during shipment, storage, and handling.

F. Each box or package shall be properly marked to show its net weight in addition to its contents.

G. Pump shall be shipped and handled in such manner as to prevent damage. At the job site, pumps and motors shall be stored in clean, dry, and protected locations.

1.05 WARRANTY AND GUARANTEES

A. The equipment shall be warranted against defects in material and workmanship for three (3) years from date of substantial completion of the respective unit process in which the pumps are installed.

B. An additional two (2) year warranty period, extending the warranty period for a total of five (5) years, shall be provided for consideration by the Owner. Refer to Division 1 for additional information and requirements.

B. The equipment shall be under warranty to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. The replacement or repair (including cost of parts and labor) of those items normally consumed in service, such as mechanical seals, oil, grease, and the like, shall be considered as part of routine preventive maintenance by the Owner.

D. Certifications: Furnish the Engineer with a written certification signed by the manufacturer's representative, that the installed equipment:

1. Has been installed per manufacturer's requirements.

2. Has been lubricated per manufacturer's instructions.

3. Has been accurately aligned and proper running clearances set.

4. Is free from undue stress imposed by piping or mounting bolts.

5. Is ready to be operated on a continuous basis, and is free from any known defects.

6. Suction piping and seal water piping has been flushed and all debris removed prior to startup.

1.06 TOOLS AND SPARE PARTS

A. One (1) set of all special tools required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys.

B. Spare Parts: One (1) complete set of mechanical seals for the pumps supplied for each Process Area (total of 3 sets).

C. All spare parts shall be protected for long periods of storage and packed in containers, which are clearly identified with indelible markings as to the contents.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General:

1. The equipment covered by these Specifications is intended to be similar in quality to the existing RAS pumps already in service and standard pumping equipment of proven ability as manufactured by reputable concerns

having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practice and methods and shall operate satisfactorily when installed as shown on the Contract Drawings.

2. Equipment shall be designed and built for 24-hour continuous service at any and all points within the specified range of operation, without overheating, without cavitation and without excessive vibration or strain.

3. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustments.

4. The pump base shall be rigidly and accurately anchored into position, precisely leveled and aligned, so that the completed installation is free from stress or distortion. All necessary foundation bolts, plates, nuts and washers shall be furnished and installed by the Contractor to conform to the recommendations and instructions of the manufacturers. Anchor bolts, nuts and washers shall be Type 316 stainless steel. Grouting under bases after the equipment is set is included as work under this section.

5. Stainless steel nameplate giving the name of manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to the pump.

6. Stainless steel nameplate giving the name of the manufacturer, serial number, model number, horsepower, speed, voltage, amperes an all other pertinent data shall be attached to the motor.

7. The nameplate ratings of the motor shall not be exceeded, nor shall the design factor be reduced when its pump is operating at any point on its characteristic curve at maximum speed.

2.02 PUMPS

A. General:

1. The pumps shall be of the centrifugal, non-clog, solids handling type for outdoor installation.

2. The pumps shall be of standard dimensions, built to limit gauges or formed to templates, such that parts will be interchangeable between like units.

3. The pumps shall conform to all requirements stipulated in Table 11311-A.

B. Pump Construction:

1. Pump Casings:

a) The pump casings shall be constructed of close-grained cast iron, ASTM-A-48, Class 30/3% Ni of sufficient thickness to withstand all stresses and strains of service at full operating pressure. The pump casings and impellers shall be equipped with replaceable stainless steel wear rings.

b) Suction and discharge connections shall be 125 lb. ANSI Standard flat-face flanges positioned as indicated on the Contract Drawings.

c) Casings for the pumps shall be given a certified hydrostatic test to 125 psi minimum for at least five minutes with no evidence of leakage. Test results shall be sealed by a registered Engineer or certified by a factory test engineer and shall be submitted prior to approval.

d) Large volute clean out port shall be provided.

2. Suction and Back Heads:

a) The volute casings shall be provided with cast suction and back heads of the same material as the volute, cast separately from the volute, and shall be built to allow for complete removal of the bearings, shaft and impeller by simply unbolting the back head. The back head and suction head shall shoulder fit to the volute casing to assure accurate alignment. The back head shall be designed to support the head frame and shall be designed to support the seal box or contain an integral seal box.

b) Seal Box:

1) The seal box shall be engineered for the specified mechanical seals. The seal box shall be designed for the compressed seal

length and shall not require any adjustments. The seal housing shall be extra large to provide excellent circulation of clear sealing liquid. The mechanical seal shall be provided with a flushing tap on the gland to permit a clear water flush to the pump seal at a rate of ½ gpm, dead-end flow, into the seal cavity.

2) The seal box shall have a bronze Chesterton, Spiral Trac, Series 4, throat bushing installed in the bottom of the seal box for the exclusion of solids and provide for operation if flush water fails..

3) The manufacturer shall provide a shaft sleeve in 316 series, stainless steel material for the cartridge seal to be mounted over.

c) Seals: Provide a split style, cartridge type, single, inside mechanical seal with silicon carbide rotating and silicon carbide stationary sealing faces, and EPDM elastomers. Provide all metal parts in 316 series or hasteloy- C materials. Seals shall be Chesterton Model 442.

3. Pump Impellers:

a) The pump impeller shall be of the non-clogging type and shall be of the same material as the casing and shall be statically and dynamically balanced. The pump manufacturer shall be fully responsible for the vibration-free operation of the pumping unit throughout the entire operating range.

b) The impeller shall be of the enclosed type. The impeller shall be of cast iron, ASTM A-48, Class 30/3% Ni, and shall be securely fastened to the shaft by means of a stainless steel key and impeller locknut. The impeller shall be equipped with a replaceable stainless steel wear ring. Axial adjustment of the impeller shall be external through integral jackscrews or radial wear rings made be provided in lieu of jackscrews.

4. Pump Shaft: Each pump shaft shall be ANSI 1144 or equal, accurately machined and ground to size. Where shafts pass through stuffing boxes or where exposed

directly to sewage, they shall be protected by readily renewable, snug fitting 316 Series stainless steel wearing sleeves internally ground to approved tolerances and positively secured to the shaft so as to prevent relative rotation. Passage of water from pump casing between shaft and sleeve shall be prevented by "O-Ring" EPDM material. The shaft sleeve shall extend from the impeller hub through the seal box. The pump shaft shall have a tapered end for fit into the impeller.

5. Bearings:

a) The pump bearing frame shall be equipped with a bearing system designed to provide a separate bearing to accept all thrust loadings imposed by the pump impeller and a minimum of two separate bearings for the radial loads imposed by the pump impeller. All bearings shall be designed for a 20-year average life for any point within the pump operating conditions as defined by Table 11311B-A.

b) The minimum bearing span of the pumps shall be no less than 70 percent of the maximum impeller diameter that can be placed in the pump casing. The cantilever portion of the pump shaft between the inboard radial bearing and the impeller shall not be greater than the span between the radial bearings. The diameter of the pump shaft between the span of the radial bearings shall be no less than 20 percent of the diameter of the maximum impeller that can be placed in the pump casing.

c) All bearing grease fittings shall be accessible while the pump is in operation. The bearings shall be grease lubricated, and a relief shall be provided so that excessive grease pressure will not damage the bearings.

d) For protection of bearings during shipment and installation, the bearings shall completely lubricated from the full load, factory performance test, requiring no additional lubrication at start-up. Each bearing frame shall be designed so that the complete rotating element can be removed from the casing without disconnecting the suction and discharge piping.

e) The bearing support frame shall be of cast-iron construction and shall be designed to provide a self-centering and self-indexing fit with the wetted end of the pump to ensure proper alignment of the bearings and stuffing box.

f) Radial impeller wear rings are to be provided. The bearing frame shall contain external provision for axial adjustment of the rotating element to provide proper clearance between the impeller and suction cover over the life of the pump. Adjustment shall be accomplished with integral jacking screws and stationary shims.

6. Pump Support:

a) Each pump shall be mounted on a fabricated steel pump support base of sufficient size and strength to support all loads to which it may be subjected. Each frame shall be designed to mount on the concrete pads as shown on the Contract Drawings. Drain ports and NPT threads shall be provided so that seal water discharged from the pump can be piped to a floor drain. Bases shall be reinforced and shall have large, readily accessible openings for installation of grout. All pump case and mounting fasteners shall be 316 series stainless steel.

b) Pump shall be designed for use of a spacer coupling connection to the motor and shall be furnished complete with non-metallic coupling guards. Pump and base design shall permit the removal of the spacer coupling and the pump rotating assembly without disturbing the motor mounting.

7. Pump Suction and Discharge Gauges: The contractor shall furnish and install for each pump tapped holes in the suction and discharge piping complete with pipe nipples and isolation valves for use in connecting pressure gauges. Nipples shall be of such length and provided with elbows if necessary so that a pressure gauge may be easily installed and read. All pump gauges shall provided with stainless steel diaphragm seals, oil filled, 4 inch stainless steel cases and internal movements, and be supplied with non-corroding pipe nipples and isolation shut off valves for each pump suction and discharge connection.

8. Pump Coatings: Provide the pump assembly with a minimum coating of 6 mils DFT, high solids epoxy factory prime coating for finish coating by the contractor. Factory prime shall be compatible with finish coating.

9. The pump manufacturer shall provide a seal flush piping system which shall take plant process water and meter it to each pump on a continuous basis at 0.5 GPM and have an incoming isolation ball valve, pressure regulating valve, upstream and downstream pressure gauges, stainless steel needle valve, Dwyer 0 to 1.0 gpm rotameter, bronze check valve and outflow connection isolation ball valve. Mount all piping arrangement on an aluminum, power coated sub panel for the contractor to mount near the pump unit. Connect the seal water from the metering panel to the seal gland with a poly tubing fitting the connections on the gland.

2.03 MOTORS

A. General:

1. The motors for the pumps shall be of the horizontal TEFC design as required by the pump arrangement.

2. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA Standards where applicable.

3. The pump motors shall also be suitable for use with variable speed drives utilizing PWM technology as specified and shall be inverter duty.

4. Motors shall be as manufactured by Reliance Electric, Westinghouse, U.S. Electrical Motors or approved equal.

5. Refer to Electrical Section 16150 for additional requirements.

B. Performance Requirements:

1. Motors shall be rated for operation on a 480 volt, three-phase, 60 Hz power supply.

2. Each motor shall have a 1.15 service factor.

3. Motors shall be premium efficiency type.

4. Motors shall be free of objectionable noise and vibration. Units shall operate with a maximum sound level not to exceed 90 dBA as measured 5 feet from any surface.

5. Maximum temperature rise of motor windings shall not exceed 80°C, as measured by resistance, when motor is operated continuously at service factor horsepower, rated voltage and frequency in ambient air temperature of 40°C.

6. Nameplate horsepower shall not be exceeded during pump operation at any point on characteristic curve for impeller furnished.

C. Construction:

1. Motors shall be Corro-Duty suitable for operation in moist air with hydrogen sulfide gas present.

2. Motor frames and end shields shall be of cast-iron construction of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.

3. The motors shall be of totally enclosed fan cooled construction. Motors shall have Class F non-hygroscopic epoxy sealed insulation but shall be limited to Class B temperature rise. The motor shall be suitable for outdoor weather conditions.

4. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibration.

5. The shaft shall be made of high-grade machine steel or steel forgoing of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating.

6. Stator and rotor cores shall be made of low loss, non-aging electrical sheet steel with insulated laminations. Stator coils shall be random wound and of size, shape, insulation and number of turns required. Coils shall be epoxy sealed after fabrication.

7. Motors shall be equipped with bearings made of AFBMA Standards, and be of ample capacity of the motor

rating. Bearings shall be grease lubricated and shall have a minimum B_{10} bearing life of 100,000 hours.

8. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all motors. Enclosures shall have stainless steel screen and shall be protected from corrosion, fungus and insects.

9. All fittings, bolts, nuts and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.

10. All motors greater than 7.5 HP shall be supplied with space heaters to prevent accumulation of moisture. Space heaters shall be rated 120 volt single phase.

11. All motors to have a normally open internal thermal switch.

2.04 CONTROLS

A. The speed of the RAS pumps will be controlled by variable frequency drives that receive a signal from the SCADA system.

B. Controls are specified in Division 13.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Installation of pumping equipment shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the Contract Drawings. Equipment shall be installed by experienced and mechanically skilled workmen with previous experience in similar installations. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

B. All necessary piping, fittings, valves, air relief valves, vents, concrete foundation, anchor bolts, grouting, etc. shall be provided to insure a complete and satisfactory installation of the pumping equipment including pump, electric motor, electrical connections and piping connections.

C. Install pressure gauges on the pump suction and discharge piping as shown on the Contract Drawings, including an isolation valve and pressure gauge at each location.

D. Hardware: All anchor bolts, nuts and washers shall be Type 316 stainless steel. All brackets and the hardware items shall be Type 316 stainless steel.

E. Install piping, fittings, valves and other appurtenances to the pump installation in accordance with the manufacturer's installation instructions, the requirements of referenced sections included with these specifications and as shown on the Contract Drawings. Equipment shall be installed in a workmanlike manner so that individual equipment will function properly and freely and no individual parts shall be strained.

F. Noise and Vibrations: All equipment containing moving parts shall be installed level and plumb, unless otherwise indicated, and shall be anchored securely in order that noise be suppressed to a minimum and that vibrations do not cause damage while in operation.

3.02 FIELD PAINTING

A. Field surface preparation and painting shall be as specified in Section 09900.

3.03 FACTORY SERVICE REPRESENTATIVE

A. For each pump supplied, the Contractor shall arrange for the services of a qualified factory service representative. The period of service shall be one day for each type or model pump supplied.

B. The duties of the service representative shall be as follows: After the equipment has been installed but before it is operated by others, the representative shall inspect the completed installation for soundness (no damaged or cracked components), completeness, and correctness of setting and alignment, and for the adequacy and correctness of mechanical seal alignment and lubricants. The service representatives shall start-up the equipment and instruct the Owner's personnel in proper operation and maintenance procedures. The responsibility of the Contractor with regard to start-up shall be fulfilled when the start-up is completed, the equipment is functioning properly and has been accepted by the Owner.

C. The service representative shall submit to the Engineer six (6) copies of a signed report of the result of his inspection, adjustments and start-up. The report shall include descriptions of the inspection, adjustments made, and the start-up. The report shall also include a statement that the equipment is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void. Final payment shall not be made to the Contractor until this report has been submitted to and approved by the Engineer.

3.04 INSPECTION AND TESTING

A. After pump has been completely installed, the Contractor shall conduct, in the presence of the Engineer, testing of all mechanical equipment and piping to demonstrate capacity, correct alignment, smooth operation, proper adjustment, and freedom from noise, vibration, over-heating and leaking, and to ensure satisfactory compliance with the specifications. All defects shall be corrected. The Contractor shall supply all oil, grease, electric power, water and all other material necessary to complete the field tests.

B. If the pump performance does not meet the Specifications, corrective measures shall be taken by the Contractor, or pump shall be removed and replaced with a pump which satisfies the conditions specified.

C. Motor Field Testing: Motor shall be disconnected from the pump and run for four (4) hours. Following the run-in test, reconnect the motor to the pumping equipment and reinstall all coupling guards.

D. Pump Field Testing:

1. Upon completion of all the mechanical work, the Contractor shall conduct testing as specified herein to demonstrate that the equipment performs in accordance with all specifications.

2. The Contractor shall perform initial testing of the equipment to insure himself that the tests listed in the Demonstration Test paragraph below can be completed.

3. Demonstration Test shall demonstrate that all items of these Specifications have been met by the equipment, as installed, and shall include the following tests:

a) That the pump controls perform satisfactorily.

b) That the pump has been successfully field Laser aligned with report from a certified testing firm.

c) The pump has been vibration tested in compliance with the Hydraulic Institute Standards for horizontal rotating assemblies.

d) A dba sound test.

4. In the event that the equipment does not meet the Demonstration Test, the Contractor shall, at his own expense, make such changes and adjustments in the equipment which he deems necessary and shall conduct further tests until written certification is received from the Engineer.

5. See Section 01664 (System Start-up and Testing) for additional requirements.

Table 11311B-A

Item	Clarifiers 1&2 (Process 251)	Clarifiers 3&4 (Process 252)	Clarifiers 10&11 (Process 450)
Tag Number(s)	251-P1, P2, P3	252-P1, P2, P3	450-P3
Name	RAS Pumps	RAS Pumps	RAS Pumps
No. of units	3	3	1
Maximum motor full load speed (rpm)	900	900	720
Minimum Motor to be supplied (hp)	20	20	20
Rated pumping temperature	85degF	85degF	85degF
Minimum sphere size passed (inches)	3	3	3
At Maximum Pump Speed:			
Minimum pump shut-off head (ft.)	50	50	19
Rated total dynamic head (ft.)	34	32	14
Rated capacity (gpm)	1300	1300	3500
Minimum pump efficiency (%)	75	75	77
NPSHR (ft)	10 or less	10 or less	12 or less
At Minimum Pump Speed:			
Rated total dynamic head (ft.)	16	16	10
Rated capacity (gpm)	800	800	2500
Speed	Variable (VFD)	Variable (VFD)	Variable (VFD)

Manufacturers: Chicago, Morris, or Aurora.

END OF SECTION

SECTION 11314 RECESSED IMPELLER GRIT PUMPS

PART 1 - GENERAL

A. Description

This section describes materials, installation, and testing of horizontal, belt driven, recessed impeller vortex-type slurry pumps specifically designed to pump slurries of grit, debris and organic solids without clogging. Pumps shall be provided by the Grit Collecting Equipment Supplier (See Section 11320) and shall be provided as a one complete operating system.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit dimensional drawings.

3. Submit manufacturer's catalog data. Show materials of construction by ASTM reference and grade.

4. Submit pump curves from manufacturer's catalog data on which the specified operating points are marked. Show efficiency and brake horsepower for the selected pump curve. Show NPSH required.

5. Submit manufacturer's drawings and calculations for intermediate shafting for vertically driven pumps. Show shaft lengths, locations of intermediate bearing supports, and shaft critical speed.

6. Submit motor data per Section 16150.

7. Submit manufacturer’s catalog data and detail drawings showing packing type and material and mechanical seal design and parts. Describe material of construction by specification (such as AISI, ASTM, SAE, or CDA) and grade or type. Identify each mechanical seal and type of packing by the tag number of the associated pump to which the catalog data and detail sheets pertain.

8. A list of spare parts that are to be supplied with the project in accordance with this specification.

9. Submit manufacturer's reports on hydrostatic tests and performance tests.

10. Submit manufacturer's sample form for reporting the performance test results at least two weeks before the tests. The test form should contain the data presented in the sample form in Section 6 of the ASME PTC 8.2 or ANSI/HI 1.6.

11. Submit manufacturer's certified performance curves for review at least two weeks prior to shipping the units from the factory. Show pump total head, torque, brake horsepower, pump efficiency, and required NPSH. Provide copies of the data recorded during the test and methods of data reduction for determining certified test results.

12. Submit factory certified hardness test report on actual parts supplied. Failure to meet the specified requirements shall be cause for rejection.

13. Operation and Maintenance Manuals per Section 01300 with installation instructions, operation and start-up procedures including lubrication requirements and a complete bill of materials for all equipment.

14. Submit six copies of a written report prepared by the manufacturer certifying that the equipment has been properly installed, lubricated, and test run.

C. Definitions

1. Terms shall be as defined in ANSI/HI 1.1-1.2 for horizontal pumps and 2.1-2.2 for vertical pumps. If there is a discrepancy in definitions between the two publications, the definitions given in ANSI/HI 1.1-1.2 and 2.1-2.2 shall govern.

2. Additional terms are defined below:

   Submergence: Vertical distance in feet between the pumping water level and the bottom of the suction bell.

D. Manufacturer's Services

1. See Section 11320.

PART 2 - MATERIALS

A. Pump Design

1. Equipment for the pumps, including motors, v-belt drives, OSHA approved belt guards and common pump/motor baseplates, shall be provided as a complete unit by the pump manufacturer.

2. The design pressure of the casing, including the stuffing box and gland, shall be at least 60 psig. Design casing to withstand a hydrostatic test pressure of 150% of the maximum design pressure for the pump or 125% of the shutoff head, whichever is greater.

3. Pump curve shall be continuously rising and shall be free of dips and valleys from the design point to the shutoff head.

4. The NPSH required shall be at least 5 feet less than the minimum NPSH available at all points on the pump curve up to 120% of the flow at the BEP.

5. Design the pumps and its components to operate continuously over a flow range of 70% to 120% of the flow at the BEP.

B. Suction and Discharge Connections

Pump(s) shall be equipped with slotted raised-face flanges to receive 125 lb. standard bolting. Special case slots shall be cast in to retain bolts and to fasten the case to the bearing housing and to the intake for easy case removal.

C. Casing

1. Pump casing shall be foot mounted or 2-piece, radially split and shall be completely open from suction to discharge. Provide internal case clearances equal to the discharge size. Provide rounded internal passages within the casing; do not use square passages.

2. Minimum casing thickness shall be:

Suction Size (inches)	**Casing Thickness (inches)**
4	3/4

3. Provide threaded drain connections (minimum 1/2-inch size) in the gland housing. Alternatively, provide a self-draining design with a large (minimum 1-inch) opening.

4. Two-piece radially split type casing shall be provided with a separate and removable suction piece designed so that the impeller can be withdrawn without the need to remove the discharge casing or disturb the discharge piping. Alternatively, where radial vane impellers are used, the pump casing shall consist of a one piece casting with integral suction and discharge nozzles and a back plate with integral wear element.

5. The casing shall be constructed so that it can be reversed for opposite rotation, and shall be of Hi-Chrome Iron or Ni-Hard Iron.

D. Impellers

1. Provide open, completely recessed impellers mounted completely out of the flow path between the pump inlet and outlet so that solids are not required to pass through the impeller. Fasten the impeller to the shaft by a key or lockplate, capscrew and washer or impeller nut threaded to tighten with the rotation of the shaft.

2. All flow path clearances within the pump(s) shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.

3. The impeller shall be constructed of 650 Brinell Hi-Chrome Iron or Ni-Hard Iron and specifically designed to maintain hydraulic pumping performance as wear occurs.

4. The impeller shall be of the radial vane design with radial wear element in casing or cup design such that the deepest portion of the vane is not located at the vane tips and the tips are surrounded by a thick-sectioned rim of the following thickness:

Pump Size	Minimum Impeller Dia. @ Outside Rim	Minimum Rim Thickness @ Wear Area	Minimum Vane Thickness @ Wear Area
4 in.	16 in.	1-5/8 in.	7/8 in.

E. Suction Pieces

Provide a separate and replaceable suction piece attached to the pump casing or provide wear plate with radial element. Design suction piece so that it can be unbolted and the impeller can be removed without disturbing the casing or discharge piping. Suction piece shall be of the same material as the casing. Minimum thickness of suction piece at the point of highest wear shall be at least one and one-half times the casing thickness. Provide neoprene gasket between the suction piece and casing. To insure a liberal wear allowance, the casing and suction piece shall be constructed as follows:

Discharge Diameter	Casing Minimum	Suction Piece at Wear Area
4 In.	3/4 In.	1-1/4 in.

F. Pump Shaft

1. Tolerance on the shaft diameter through the stuffing box shall not exceed 0.002 inch. Shaft runout on the stuffing box face and at the impeller shall not exceed 0.002-inch full indication movement. Dynamic shaft deflection at the stuffing box face shall not exceed 0.002 inch.

2. The first lateral critical speed of the rotating assembly shall be at least 120% of the maximum pump operating speed.

3. Surface finish of the shafts or sleeves through the stuffing box and at the rubbing contact-bearing housing seals shall not exceed a roughness of 32 microinches.

4. The shaft shall be of ASTM A108, Grade 1141 (or equal) steel, and shall be protected throughout the packing area by a removable, hardened stainless steel shaft sleeve conforming to ASTM A582 Type 416.

G. Packing Sealing System

1. Provide five rings (minimum) of packing plus a lantern ring and repacking space. Provide external clear water lubrication. Packing shall be one of the following nonasbestos materials:

a. Regular braid, square cross-section graphite-lubricated, and impregnated nonasbestos packing, such as Garlock Style 8909, Phelps Style 2075, or equal.

b. Teflon-impregnated nonasbestos packing with lubricant, such as Phelps Style 2072, Garlock Style 8922, or equal.

H. Motors

Motors shall be provided in accordance with Section 16150 and as specified in the “Service Conditions”.

I. Bearings

1. Bearings shall be oil bath lubricated. The oil reservoir shall be sealed at both ends to prevent entrance of foreign matter. The thrust bearings shall consist of three angular contact ball bearings for maximum protection from all thrust loads. The bearing housing will be equipped with a pressure venting device and oil fill and drain taps. A built-in sight glass shall be furnished to check proper oil level. The bearings shall be rated for a minimum B10 life of 100,000 hours, without credit for any rear pump-out vanes to balance hydraulic thrust.

J. Vibration

1. The maximum vibration level measured on the pump bearing housing at the rated pump speed (±10%) and at the rated flow (±10%) shall not exceed that shown in Figure 9.6.4.10 in ANSI/HI 9.6.4.

2. Maximum residual unbalance in impellers shall not exceed that shown in Figure 9.6.4.15B in ANSI/HI 9.6.4.

K. Materials of Construction

1. Material of construction for the various pump duties shall be as listed below:

Component	Material
Casing	Ni-hard (ASTM A532, Class I, Type A) or High Chrome Iron (ASTM A532, Class III, Type A)
Impeller	Ni-hard (ASTM A532, Class I, Type A) or High Chrome Iron (ASTM A532, Class III, Type A)
Shaft	Steel (ASTM A108)
Shaft Sleeve	Hardened Stainless Steel (Type 416 ASTM A582)
Case wear ring or plate	Ni-hard (ASTM A532, Class I, Type A) or High Chrome Iron (ASTM A532, Class III, Type A)
Casing capscrews	Stainless Steel (AISI Type 316)
Gland eyebolts and nuts	Stainless Steel (AISI Type 316)
Lantern rings	Teflon

2. Minimum Brinell hardness of high chrome iron shall be 650.

3. Test bars shall be cast integrally with the case and suction piece and shall remain attached to the casting upon final delivery to the Owner. Test bars shall be of sufficient thickness to represent the average thickness of the cast part. After receipt of final delivery, the Owner may at any time prior to the final acceptance, remove the test bar and independently verify compliance to the material and hardness specification. Failure of the tested bars to meet the specified requirements shall be cause for rejection. Alternatively, submit factory certified hardness test report on actual parts supplied.

L. Baseplates for Horizontal Pumps

1. The pump manufacturer shall provide a common pump and motor base, constructed of minimum 3/8 inch thick fabricated steel, ASTM A36, suitably reinforced to support the full weight of the pump, motor, belt drive and guards.

2. The pump manufacturer shall furnish and install a separate, adjustable motor base with handwheel adjustment so that the motor can be easily moved for V-belt tensioning and adjustment, TB Woods type MC 3B, modified with a welded steel gusset, or equal.

3. The pump manufacturer shall supply and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions.

4. The drive shall be of the stationary control variable speed TB Woods type ‘SVS’ or equal, which allows a speed change by means of an adjustment to the motor sheave when the drive is not in operation.

5. An OSHA approved fiberglass or thermoplastic belt guard shall be provided to safely enclose the belt drive. If metal guards are furnished, they shall be of all 316 stainless steel construction with suitable lifting eyes and handles to aid in removal.

M. Factory Hydrostatic Testing

Hydrostatically test casings and covers for 10 minutes minimum with water at the test pressure described above in subsection on “Pump Design.” Testing shall be done in accordance with (ANSI/HI 12.1-12.6).

N. Controls

See Section 11320.

O. Spare Parts

Provide the following spare parts for each model or size pump:

Quantity	Description
2	Sets packing
1	Lantern ring
1	Impeller wear ring
2	Sets radial bearings
2	Sets thrust bearings
1	Shaft sleeve

PART 3 - EXECUTION

A. Pump Installation

1. Provide the manufacturer's recommended lubricants in the pumps, bearings and other mechanical equipment.

2. Install in accordance with Manufacturer’s instructions and recommendations.

3. Prepare foundation, mount driver, level the base, align pumps, and install couplings per ANSI/HI 1.4. Install baseplates with epoxy grout in accordance with API 686, Chapter 5.

B. Performance Testing HI Standards, latest edition

1. Each pumping unit shall be subjected to a non-witnessed laboratory performance test. Conduct tests in accordance with the Hydraulic Institute Standards, using the actual job driver. Take a minimum of six points from shutoff head to 150% of maximum design flow to plot the pump curve. Take points at approximately equal intervals between shutoff head and 150% of maximum design flow.

2. No motor overload above motor nameplate horsepower rating will be allowed at any flow up to 120% of the flow at the BEP.

3. Deviations and fluctuations of test readings shall conform to ASME PTC 8.2, 1.11 (Type A), or ANSI/HI 1.6, paragraph 1.6.5.4.2.

4. Measure flow by the “Capacity Measurement by Weight,” the “Capacity Measurement by Volume,” or the “Capacity Measurement by Venturi Meter, Nozzle, or Thin Plate Orifice” method in ASME PTC 8.2 or ANSI/HI 1.6.

C. Painting and Coating

Coat exposed surfaces of pump and motor the same as the adjacent piping. If the adjacent piping is not coated, then coat per Section 09900, System No. 10. Apply the specified prime and intermediate coats at the place of manufacture. Apply finish coat in the field.

D. Service Conditions

1. Pump hydraulic performance conditions and design data shall be as shown below.

2. Pump Tag Numbers: 500-P-1, 500-P-2, 500-P-3, 500-P-4 and 500-P-5.

Liquid Pumped:	Grit slurry
Service:	Indoors environmental temperature range of 20°F to 110°F
Elevation:	90 feet above mean sea level
Relative Humidity:	Up to 100%
Fluid Temperature Range:	50°F to 90°F

Pump Data

Capacity (gpm)	**Pump Total Head (ft)**
300	46

Maximum Pump Speed:	1225
NPSH Available:	41
Motor type:	Horizontal, heavy duty, TEFC per Section 16150. Motor shall be rated for continuous duty at an ambient temperature of 40º Celsius.
Motor Horsepower:	15
Manufacturer's and Models:	Hayward Gordon TORUS XR Severe Duty Series XR3-11, Wemco 3” Model C, or acceptable equal.

E. Field Testing

1. Bump motor to ensure that motor has been connected for proper rotation.

2. Perform field tests for 24 consecutive hours on each pump. Measure flows at the following head points:

   a. Tag Numbers: 500-P-1, 500-P-2, 500-P-3, 500-P-4 and 500-P-5

   b. Location: Preliminary Treatment Structure (indoors, lower level of structure)

   c. Service: Severe

d. Maximum rpm: 875

e. Test Points (ft): 22, 25, 30

3. If the measured flows at the above-tabulated pump heads are more than 5% below the flows obtained on the laboratory or factory test, adjust the impellers or provide new impellers or otherwise repair or replace the pumps or calibrate meters or pressure gauges.

4. Conduct vibration-level tests with pumps operating at their rated capacity. Adjust or replace pumps that exceed the maximum vibration levels.

5. Assure that limit switches on the pumps' check valves indicate and transmit the signals for the valves in the open and closed positions in accordance with Section 15100.

6. Assure that each solenoid valve on the seal water supply line opens and closes when its respective pump starts and stops. Start and stop each pump twice and verify that the pump/solenoid interlock functions.

7. Demonstrate that the pumping units, motors, and control system meet the following requirements:

   a. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

   b. All automatic and manual controls function in accordance with the specified requirements.

   c. All drive equipment operates without being overloaded.

F. Contract Closeout

See Section 11320.

G. Warranty

See Section 11320.

H. Additive Warranty

See Section 11320.

I. Certification

See Section 11320.

END OF SECTION

SECTION 11319 SUBMERSIBLE PUMPS (SCUM PUMPS)

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals to install submersible pumps suitable for pumping wastewater treatment plant scum, and control panels tested and ready for operation and with all accessories as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Concrete work is included in Division 3.

B. Field painting is included in Section 09900.

C. Instrumentation unless specified herein is included in Division 13.

D. Mechanical piping, valves, pipe hangers and supports are included in the respective Sections of Division 15.

E. Electrical work is included under Division 16.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

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, 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.

2. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be a submersible, raw wastewater or scum application in a similar service to the specified pumps.

   a)Current Owner Reference Contact Information
   b)Installation Service Conditions
   c)Equipment Model Numbers
   d)Date of Final Completion of the Project

4. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

5. Descriptive literature, bulletins and/or catalogs of the equipment.

6. Data on the characteristics and performance of the pumps: Data shall include guaranteed performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2-in by 11-in sheets. Curves for variable speed pumps shall be provided with at least five curves plotted from maximum rpm to minimum rpm.

7. The total weight of the equipment including weight of the single largest item.

8. A complete total bill of materials for all equipment.

9. A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item. List bearings by the bearing manufacturer's numbers only.

10. A statement indicating bearing life.

11. Motor data (and power factor correction capacitors, if required) per Section 16150.

12. Complete description of surface preparation and shop prime painting.

B. Operation and Maintenance Data

1. Copies of an operating and maintenance manual for each size pump shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc, which are required to instruct operating and maintenance personnel unfamiliar with such equipment.

2. A technical representative, from the respective pump manufacturer, who has complete knowledge of proper operation and maintenance shall be provided for 1 day to instruct representatives of the Owner and the Design-Builder on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and test run as provided under Paragraph 3.02 below. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no additional cost.

1.04 REFERENCE STANDARDS

A. American National Standard Institute (ANSI)

B. Anti-Friction Bearing Manufacturers Association (AFBMA)

C. National Electrical Manufacturers Association (NEMA)

D. National Electrical Code (NEC)

E. Factory Mutual (FM)

F. Underwriters Laboratories (UL)

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

1.05 QUALITY ASSURANCE

A. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc, required by such a change will be provided at no additional cost.

B. Qualification: The Pump supplier is required to demonstrate successful experience in the design and manufacturing of non-clog submersible pumps. As of the date in which Bids are submitted, the manufacturer shall have a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be non-clog centrifugal, mixed liquor applications in a similar service to the specified pumps.

C. Multiple pumps of the same type to be furnished under this Section shall be the product of a single manufacturer. The pumps shall be Flygt, ABS, or approved equal.

1.06 WARRANTY AND GUARANTEES

A. The equipment shall be warranted against defects in material and workmanship for two (2) years from date of substantial completion of the respective unit process in which the pumps are installed.

B. The equipment shall be under warranty to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced at no expense to the Owner.

C. The replacement or repair (including cost of parts and labor) of those items normally consumed in service, such as mechanical seals, oil, grease, and the like, shall be considered as part of routine preventive maintenance by the Owner.

D. Certifications: Furnish the Engineer with a written certification signed by the manufacturer's representative, that the installed equipment:

1. Has been installed per manufacturer's requirements.

2. Has been lubricated per manufacturer's instructions.

3. Has been accurately aligned and proper running clearances set.

4. Is free from undue stress imposed by piping or mounting bolts.

5. Is ready to be operated on a continuous basis, and is free from any known defects.

1.07 SYSTEM DESCRIPTION

A. All of the equipment included herein is intended to be standard for submersible use in wastewater treatment.

B. Submersible pumps shall be as follows:

1. Name: Scum Pumps
2. Location: Scum Wet Well
3. Number of Units: one per clarifier, total of 5
4. Tag Numbers: 251-P-6 & P -7, 252-P-6 & P-7; 450-P-7
5. Capacity and Head:
   a. Primary Point 100 gpm @ 40 feet TDH
   b. Minimum Shutoff Head 51 ft
6. Minimum Efficiency at Design Capacity: 40%
7. Motor Hp: 5 Hp
8. Motor Type: NEMA B
9. Maximum Pump Speed: 1750 rpm
9. Pump Discharge Size: 4 inches
10. Pump Suction Size: 4 inches
11. This pump will be operated to transport scum from the secondary clarifiers to the sludge handling system.
12. Pump operation shall be initiated by high level in the wetwell and pump shut off shall be initiated by check valve closure or high amp draw.
13. Pump Basis for Design: Flgyt NP3102/Impeller 463 (chopper).

1.08 TOOLS AND SPARE PARTS

A. No special tools are required.

B. Spare Parts: The recommended spare parts, properly boxed and labeled for each pump, which are to include, as a minimum, the following:

1. One complete pump ready for installation.

C. All spare parts shall be protected for long periods of storage and packed in containers which are clearly identified with indelible markings as to the contents.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

1. This Section is intended to give a general description of what is required, but does not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however intended to cover all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in this Section or not.

2. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in this Section or not and as required for an installation incorporating the highest standards for the type of service.

3. Pump bases or base elbows, as the case may be shall be rigidly and accurately anchored into position on concrete and all necessary foundation bolts, plates, nuts and washers shall be furnished and installed. Anchor bolts shall be Type 304 stainless steel.

4. Brass or stainless steel nameplates giving the name of manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump and each motor.

5. The manufacturer shall supply complete factory mounted equipment with sufficient power and signal cable, as required by the location.

6. Each pump and drive shall be designed to withstand the maximum turbining run-away speed of the pump due to backflow through the pump.

7. All electrical materials and equipment shall be UL listed or FM approved and NEMA rated, and shall otherwise be equal to that supplied under Division 16, where applicable.

8. Control panels as applicable shall be factory wired,

such that field wiring connections shall require connection of power and control/sensory wiring to the control panel and to the pumps and alarm wiring to the control panel and the pump failure alarm light. Field wiring connections shall be to numbered terminal strips. The entire control system shall be factory tested before shipment.

9. Pumps shall be capable of running dry without harm to the pump or motor.

10. A guiderail system shall be supplied by the pump manufacturer for raising and lower pump. Guide rails shall be 2-inch 316 stainless steel. Type 316 stainless steel lifting chain and cable holder shall be provided.

11. Aluminum access door and frame shall be supplied by the pump manufacturer and pump manufacturer shall certify that the size and location of the access is suitable for pump installation and removal.

12. Hoist/davit shall be provided for each pump by the pump manufacturer and pump manufacturer shall certify that the size and location of the hoist is suitable for pump installation and removal. Hoist shall be 316 SS and shall have a minimum capacity of 300 lbs. Manual winch shall be provided and have provisions for portable motor operation. Hoist shall be by Halliday Products or approved equal.

13. System features shall be comply with OCU Standards Manual for submersible pumping stations.

2.02 PUMP CONSTRUCTION

A. The pump specified shall be submersible with pump discharge connection and metal to metal seal.

B. The stator casing, coil casing and volute shall be constructed of gray cast iron with all components in contact with liquid protected by a coat of rubber-asphalt paint. All external bolts and nuts shall be AISI type 304 stainless steel.

C. The impeller shall be of gray cast iron, Class 35 B, dynamically balanced, double shrouded non-clogging design having a long throughlet without acute turns. The impellers shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in wastewater. Whenever possible, a full-vaned, not vortex, impeller shall be used for maximum hydraulic efficiency to reduce operating costs. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. Impellers shall be retained with an Allen head bolt and

shall be capable of passing a minimum 3-inch diameter solid. All impellers should be coated with an acrylic dispersion zinc phosphate primer.

D. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be ANSI type 431 stainless steel.

E. If a shaft material of lower quality than 431 stainless steel is used, a shaft sleeve of 431 stainless steel is used to protect the shaft material. However, shaft sleeves only protect the shaft around the lower mechanical seal. No protection is provided for the oil housing and above. Therefore, the use of stainless steel sleeves will not be considered equal to stainless steel shafts.

F. Pump and motor bearings shall be anti-friction type with a B-10 life of 20,000 hours minimum. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces. Single row lower bearings are not acceptable.

G. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a nitrile rubber coated steel ring insert that is drive fitted to the volute inlet.

H. Pump volutes shall be single-piece gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. The pump shall be supplied with a cast iron suction elbow and stand.

I. Pump motors shall be housed in an air-filled or oil-filled watertight submersible casing and shall have Class F insulated windings, which shall be moisture resistant. Pump motors shall be 460 Volt, 3 Phase, and 60 Hz. Motors shall be NEMA Design B. Motor characteristics are specified above. Pump motors shall have cooling characteristics suitable to permit continuous operation in a non-submerged condition. The pump motor shall be capable of running without damage, for extended periods.

2.03 PUMP CONTROLS

A. Provide an automatic pump control system for each wet well.

1. The control system shall utilize liquid level to operate at preset liquid levels in the wet well to control the

pumps and both check valve closure and high amp draw to stop pump operation.

2. Pump on and high level floats mounted on stainless steel pole shall be provided.

3. A complete control panel shall be provided for mounting and shall be completely wired and ready for field connection of power, control/sensory and alarm wiring. The control panel shall be NEMA 4X, 316 stainless steel, designed for outdoor mounting. The panel shall be mounted near the pumps or in the location shown on the Drawings.

4. Power supply to the control panel will be 480 Volt, 3 Phase, 60 Hz, and 3 Wire. For each pump motor provide an individual thermal magnetic circuit breaker/disconnect switch interlocked with the door handle, three phase overload protection with manual reset, and a magnetic motor starter with NEMA Class 10 overload relays. 120 and/or 24-Volt control circuit transformer with disconnect and overload protection shall be included. Control design shall provide for automatic and manual operation. Level switches and control shall be UL approved as intrinsically safe. Control leads to and from the wet well shall be low voltage, microwatt type designed such that if system components fail, voltage and current will not exceed their normal values. All of the low voltage intrinsically safe components shall be isolated by and mounted through a grounded metal barrier. All field connections shall be by means of terminals. Panel shall have Hand/Off/Automatic selector switch, pump run light, pump running time meter, a thermostatically (adjustable) controlled condensate heater and lightning protection. Provide panel mounted lights for indication of each of the following: High Water Level, and High Motor Temperature. Provide a common contact for a panel powered external alarm. Side mounted alarm light and audio alarm shall be provided.

5. The control panel shall automatically stop the pumps on a loss of flow condition. Loss of flow shall be detected from a limit switch installed on a check valve downstream of the pump or high amp draw (operator selectable). If the pump is called to start and no flow is detected for a 1-60 second (adjustable) time delay; the pump shall stop and the station shall go into alarm. An intrinsically safe isolation relay shall be provided for the check valve limit switch.

6. Contacts shall be provided for pump run, pump fail and high level (alarm).

2.04 SURFACE PREPARATION AND PRIME PAINTING

A. All equipment furnished under this Section shall be shop primed and finish painted.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

B. Provide minimum 4-foot power cable to motor to allow removal without disconnection.

3.02 INSPECTION AND TESTING

A. Factory Test

1. The pumps shall be factory tested as follows: Manufacturer shall submit written report with the details and results of the tests.
2. Controls shall be factory tested and documentation of the test shall be submitted.
3. No equipment shall be shipped until the above test results are received.

B. After all pumps have been completely installed, conduct in the presence of the Design-Builder, and plant operator such tests as are necessary to indicate that pump efficiency and discharge conform requirements specified. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water or wastewater and auxiliary equipment required to complete the field tests.

C. If the pump performance does not meet the specified requirements, corrective measures shall be taken, or pumps shall be removed and replaced with pumps that satisfy the conditions specified. A 24-hour operating period of the pumps will be required before acceptance. During this 24-hour operating period, supply all power necessary.

D. The pumps and motors shall be designed and constructed to avoid the generation of objectionable noise or vibration. The sound pressure level at full load shall not exceed 90 (A Scale) decibels above 300 cycles, when measured at a point not exceeding 5-ft from the motor. Mufflers or

external baffles will not be accepted. When operating at any point between no-load and full-load, the vibration measured in a horizontal plane at the top of the motor shall not exceed the limits recommended by the Hydraulic Institute Standards.

E. Any component parts which are damaged as a result of testing or which fail to meet the requirements specified shall be replaced, reinstalled and re-tested at no additional cost.

END OF SECTION

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SECTION 11320 GRIT REMOVAL, WASHING, AND DEWATERING SYSTEMS

PART 1 - GENERAL

A. System Description

1. This section includes materials and installation of grit removal, washing and dewatering equipment.

2. The Grit Removal, Washing, and Dewatering Systems shall include three (3) Grit Concentrator units (HEADCELLS), four (4) Grit Washing/Classification units (SLURRYCUPS), two (2) Grit Dewatering Escalator units (GRIT SNAILS), five (5) grit pumps (see Section 11314), two (2) control panels and accessories as shown in the drawings and specified herein.

3. Each HEADCELL unit shall be placed in a concrete tank and receive the incoming screened flow. Each HEADCELL shall provide sufficient surface area to remove the specified grit particles from the specified peak flow as stated in the “Service Conditions” while concentrating the grit in a sump at the bottom of the unit. Effluent from each HEADCELL unit shall be weir discharged as shown on the drawings.

4. The Grit Removal, Washing, and Dewatering System manufacturer shall coordinate with Section 11314 to ensure that supplied grit pumps remove the grit from the underflow of the HEADCELL unit and transport the grit slurry from each HEADCELL unit to each SLURRYCUP for proper separation of organics.

5. Each SLURRYCUP unit shall receive the underflow of the HEADCELL and shall be mounted above the GRIT SNAIL and discharge concentrated and washed grit slurry to the GRIT SNAIL unit. The degritted overflow shall discharge by gravity upstream of the HEADCELL.

6. Each GRIT SNAIL unit shall receive the underflow from the SLURRYCUP and allow the washed grit to settle in its integral clarifier. A slow moving belt shall carry the grit to the point of discharge allowing it to dewater during transport. The washed and dewatered grit shall be discharged to a dewatered grit receptacle. The degritted overflow shall discharge by gravity upstream of the HEADCELL.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's catalog data and descriptive literature and detail drawings showing all grit collective equipment, parts and describe by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Identify each piece of equipment by tag number to which the catalog data and drawings pertain. Mark out inapplicable options.

3. Submit dimensional sketches of all equipment supplied. Show arrangement of equipment components including drive and motor, weirs, piping connections, and supports.

4. Submit weight of equipment mounted on base and weights of all components.

5. Submit performance data as specified below.

6. Submit motor data as specified in Section 16150.

7. Submit electrical drawings. Show wiring, controls, interlocks, terminals, and disconnects. Label each terminal, showing which control or electrical power wire connects to each terminal.

8. Submit calculations for equipment anchorage stamped by a registered civil or structural engineer in the State of Florida.

9. Submit list of spare parts to be supplied with the project in accordance with this specification.

10. Operation and Maintenance Manuals per Section 01300 with installation instructions, operation and start-up procedures including lubrication requirements and a complete bill of materials for all equipment.

11. Submit six copies of a written report prepared by the manufacturer certifying that the equipment has been properly installed, lubricated, and test run.

C. Manufacturer's Services

Provide equipment manufacturer’s services at the job site for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days to check the installation and advise during start-up, testing, and adjustment of all equipment supplied.

2. Two (2) labor days to instruct the Owner’s personnel in the operation and maintenance of each piece of equipment supplied.

3. The grit collecting equipment start-up representative shall insure that all control functions are properly carried out by the control panel as part of the start-up procedure.

4. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Manufacturer Requirements

1. Grit Removal, Washing, and Dewatering System shall be as manufactured by Hydro International – Wastewater, Hillsboro, OR 97124.

2. All components, of the Grit Removal, Washing, and Dewatering System shall be provided by one supplier. The supplier of the Grit Removal, Washing, and Dewatering system shall have overall system responsibility for coordination of all major components of the system including startup training, calibration and overall successful operation of the equipment, including the grit pumps (see Section 11314).

B. Equipment Performance

The Grit Removal, Washing, and Dewatering Systems shall be designed to remove, classify, wash, and dewater grit from screened raw wastewater in accordance with the “Service Conditions”.

C. Grit Concentrator (HEADCELL)

1. The HEADCELL shall be characterized by a controlled boundary layer flow to enhance settleable solids

concentration and removal. The unit shall be all-hydraulic consisting of self cleaning corrosion resistant, non-metallic trays with no moving parts within the unit.

2. The HEADCELL shall be fabricated such that all flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.

3. The HEADCELL trays shall be constructed with a minimum ¼ inch thick LDPE material on the pans and sidewalls and the stack of trays shall securely fit into a 316 Stainless Steel support frame. The support frame will fit and secure to the bottom of the concrete support structure as shown in the drawings.

4. A 316 stainless steel grit collector shall be provided with the HEADCELL for collection and removal of settled solids. The grit sump shall be installed in a concrete tank as shown in the drawings. The grit collector shall incorporate the flanged underflow and threaded fluidizing pipe connections as shown in the drawings. All pipe flanges shall conform to ASNI B16.1 bolt pattern.

5. Each unit shall have 1-inch NPT pipe stub for connection of the system water. Water shall be continuously supplied to the solids underflow sump. Provide one (1) manually actuated 1-inch Type 304 SST globe valve and one (1) 1-inch, 8-40 gpm 316 stainless steel flow meter for each HEADCELL to regulate the system water flow rate, Blue-White Series F-420N, or acceptable equal. Provide 1-inch 304 SST spring actuated pressure reducing valve. Minimum 20 gpm at 50 psig shall be supplied to the grit sump. Provide one (1) manually actuated 1-inch stainless steel ball valve, Type 320 per Section 15100, for shut off for each HEADCELL.

D. Grit Washing/Classification Unit (SLURRYCUP)

1. The SLURRYCUP shall be characterized by a dominant, strong free vortex which utilizes centrifugal and gravitational forces and secondary boundary layer velocities to effect the separation, collection and classification of grit from the unit's inflow.

2. Defining characteristics of the dominant free vortex / secondary boundary layer velocity type units are as follows:

   a. Dominating increasing tangential velocity profile toward the center of the unit with the ability to handle increasing flows with no loss of the specified grit removal efficiency and with increasing headloss requirements.

   b. The ability to classify (wash) the grit from lighter organic material to meet the specified organic solids content.

   c. No requirements for electrical or mechanical components, flow deflecting/guiding weirs or baffles, or compressed air lines within the unit to meet the specified performance in addition to the continuous removal of washed, clean grit.

3. The SLURRYCUP unit shall be all-hydraulic with no moving parts within the unit. The grit underflow from the SLURRYCUP unit shall be transported by gravity to the GRIT SNAIL.

4. Each SLURRYCUP shall be designed to handle grit slurry underflow from one HEADCELL and shall be designed to operate continuously. Each unit shall handle a range of flow as specified under the “Service Conditions”.

5. The SLURRYCUP shall be fabricated from 316 stainless steel. Welding shall conform to the most current standards of the American Welding Society. The dished and flanged heads shall be 1/4 inch thick. The vessel walls shall be 3/16 inch thick. The unit shall have flanged inlet connection and flanged outlet connections as specified in the “Service Conditions”. Flanges will be rotatable and conform to ANSI B16.1 bolt patterns.

6. The SLURRYCUP shall be designed to withstand a maximum working pressure of 14.7 psig and the actual maximum pressure at the inlet will be no more than 14.7 psig.

7. A minimum 18 inch diameter access shall be provided in the top of each unit and all internal elements shall be removable from inside the unit.

8. The SLURRYCUP shall be free standing on three legs and mounted above a GRIT SNAIL (two (2) SLURRYCUPS per Grit SNAIL). Clearance shall be provided between the bottom

of the grit underflow pipe and the Dewatering Unit clarifier surface.

9. Each unit shall include a Hydraulic Valve (HV) to deliver a continuous flow of “washed” grit slurry to the dewatering unit. The HV shall have no mechanical or moving parts.

10. Each unit shall have one (1) 1-1/2 inch grit underflow connection, one (1) 3 inch flanged drain connection with 3 inch eccentric cast iron flanged plug valve, Type 500 per Section 15100, installed at drain and one (1) 1-1/2 inch NPT fluidizing water connection for the Hydraulic Valve supply and Hydraulic Valve backwash.

11. Each unit shall be supplied with the following equipment to regulate and automate water supply:

    a. One (1) 1-1/2 inch stainless steel ball valve, Type 320 per Section 15100, for main water supply shut off.

    b. One (1) 1-1/2 inch stainless steel globe valve to regulate water flow to the Hydraulic Valve.

    c. One (1) 1-1/2 inch stainless steel solenoid valve to automate system water to the Hydraulic Valve.

    d. One (1) 1-1/2 inch stainless steel solenoid valve to automate system backwash water.

    e. One (1) 0-100 psig pressure gauge per Section 13315 to monitor the supply water delivery pressure.

    f. One (1) 0-30 psig pressure gauge per Section 13315, to monitor the pressure in the slurry discharge (underflow) line.

    g. One (1) 0-30 psig pressure gauge per Section 13315, to monitor wash water delivery pressure.

    h. Three (3) 1/4 inch stainless steel ball valves, Type 320 per Section 15100, to isolate the pressure gauges (one (1) at each pressure gauge).

    i. One (1) 0-35 gpm 316 stainless steel flow meter, King Series 7710 or acceptable equivalent.

12. Provide one (1) 1-1/2 inch stainless steel ball valve, Type 320 per Section 15100, one (1) 1-1/2 inch 316 SST WYE type strainer, and 1-1/2 inch pressure reducing valve, Type 1402 per Section 15111 for each water supply connection. Water shall be continuously supplied to each dual SLURRYCUP and the GRIT SNAIL combination at a regulated 50 psig ± 5 psi. Each unit shall have a single 1-1/2 inch NPT pipe stub for connection of the system water. The utility water requirements are as follows:

    a. A continuous supply of 30 gpm is required for normal operation of the SLURRYCUP.

    b. An intermittent supply of 47 gpm is required for a periodic short duration during backwash cycle for the SLURRY CUP.

    c. A continuous supply of 20 gpm for normal operation of the GRIT SNAIL.

    d. Integrated controls and instrumentation to allow automated operation of the SLURRYCUP shall be provided as described herein.

E. Grit Dewatering Escalator Unit (GRIT SNAIL)

1. Each GRIT SNAIL shall be designed to capture and dewater concentrated, washed grit slurry from two (2) SLURRYCUPS in accordance with the “Service Conditions” and as shown in the drawings.

2. The GRIT SNAIL shall capture and dewater all grit removed by the SLURRYCUPS and the dewatered grit shall, on a weighted average, contain no more than 20% (wt) unattached organic solids and a minimum 60% solids concentration.

3. The GRIT SNAIL shall be provided with an integral square clarifier manufactured of 316 Stainless Steel. The clarifier design shall be based on a settling rate not to exceed 3.2 gpm/ft^2. The clarifier shall have minimum of free water surface area as specified in the “Service Conditions” and walls sloping at least 45 degrees from the horizontal. The clarifier shall provide at least 3 inches of freeboard. The clarifier shall be fitted with an overflow weir with overflow discharge connection.

4. Each GRIT SNAIL shall be supplied with a belt made of 1/8 inch x 1/32 inch two-ply polyester reinforced continuous conductor belting. The belt cleats shall be

3-3/8 inch X 4-9/16 inch of molded 60 Durometer neoprene and aluminum reinforced and shall be vulcanized on the belt. The cleats shall attach to the belt with minimum 5/32 inch thick neoprene hinges.

5. The housing for the GRIT SNAIL belt shall be fitted under the clarifier and shall be 316 stainless steel with urethane bonded to the internal surfaces. The belt housing shall be inclined at 30 degrees and shall be fabricated from 0.135-inch thick 316 stainless steel. Welding shall conform to the most current standard of the American Welding Society. The belt housing shall be provided with clean out plates and (1) flanged 3 inch drain for each unit.

6. Each GRIT SNAIL shall be provided with a headroll manufactured of 316 stainless steel with a headroll scraper having 1/4 inch thick high density polyethylene (HDPE) contact surfaces with a 1/4 inch thick HDPE retainer plate. The headroll shall be 9-3/4 inch diameter and lagged. Both retainer plate and scraper shall be loaded to keep belt cleats closed tightly around the headroll during operation. The headroll shall be adjustable to allow take-up of slack in the GRIT SNAIL belt. Adjustment of the headroll shall not affect the headroll retainer plate, scraper, or drive unit.

7. Provide motion sensor on the side of each GRIT SNAIL to detect movement of the headroll scraper arm. Lack of motion of the headroll scraper arm shall indicate lack of belt movement, drive unit failure and/or scraper arm overload.

8. Each GRIT SNAIL shall be provided with a tailroll manufactured of 316 stainless steel and shall be designed to mount internal to the unit belt housing with external sealed bearings. The tailroll mechanism shall be self-cleaning. As the belt rotates with the tailroll at the bottom of the unit the belt cleats shall lift from the belt to provide a gap of at least 1-inch. The GRIT SNAIL belt shall be provided with 2-inch openings to allow transfer of fine solids internal to the belt to the underside of each cleat. The tailroll shall be fitted with a scraper, which shall also function as an internal belt scraper.

9. Each GRIT SNAIL shall be supplied with a rinse bar system. The rinse bar system shall be pre-piped and factory installed. The flow to the rinse bars shall be

manually adjustable with a flow indicator at the tailroll rinse. The system shall include:

a. One (1) 1 inch stainless steel ball valve, Type 320 per Section 15100, to manually shut off flow from the SLURRYCUP to the GRIT SNAIL water systems.

b. Two (2) spray bars located above the belt and below the clarifier liquid level to enhance grit washing. This section shall be isolated from the belt rinse water piping by 3/4 inch stainless steel ball valves, Type 320 per Section 15100, to shut off the top rinse bars for maintenance.

c. One spray bar located at the bottom of the clarifier as a tailroll area rinse. The tailroll rinse will include a 1 inch stainless steel globe valves, to manually regulate the flow of rinse water to the tailroll section.

d. One (1) 1-inch stainless steel solenoid valve to automate the water to the rinse bar system.

e. One (1) 1-inch stainless steel ball valve, Type 320 per Section 15100, to manually shut off flow to the rinse bar system.

f. One (1) 2-20 gpm 316 stainless steel flow meter, King Series 7710 or acceptable equivalent.

g. One (1) 1-inch stainless steel globe valves, to manually regulate the tailroll rinse water.

h. One (1) 3-inch plug valve, Type 500, per Section 15100 for drain line isolation.

10. Drive Unit.

a. Motor shall be provided in accordance with Section 16150 and the following.

b. The motor shall be 3 phase, 460 VAC, 60 Hz, Inverter Duty Motor with a 1.0 Service Factor and compliant with the Hazardous Area service factor illustrated within the Drawings. The motor shall have epoxy treated windings.

c. Each drive unit consisting of the motor and the helical gear reducer shall be mounted as a single integrated unit. Bearings shall be anti-friction,

ball or roller type. Heavy-duty bearings are required on the output shaft.

d. The helical gear reducer will have hardened alloy steel gears accurately cut to shape.

e. A mechanical torque-limiting clutch shall be mounted on the headroll gear assembly to prevent an accidental overload of the drive unit and belt.

f. The drive speed shall be adjusted by a variable speed drive that will be housed in the control enclosure. Belt speed shall be adjustable from 1-5 ft/min.

F. Grit Pumps

The grit pumps shall be designed for continuous operation. Grit pumps shall be provided by the Grit Removal, Washing and Dewatering System Supplier in accordance with Section 11314.

G. Local Control Station

For each Grit System, provide a NEMA 4X, 316 stainless steel local control station near the SLURRYCUP/GRITSNAIL. The local control station shall at a minimum include the following:

1. System Local/Remote Switch on LCS

2. Emergency Stop

3. Lock-out

4. Auto Initiate Blowdown button

H. Grit Equipment System Control Panels (CP-GS1, CP-GS2)

1. The Manufacturer shall provide NEMA 4X, 316 stainless steel, 480VAC control panels meeting the requirements of Section 16191, PART 2, paragraph B and as modified herein.

2. Solid state motor control or variable frequency drive is acceptable. If this is provided, single phase protection is inherent and the phase monitor is not required.

3. Two (2) Grit System control panels shall be supplied, each designed to operate, control and monitor two (2)

HEADCELL units, three (3) grit pumps, (two (2) active, one (1) standby), two (2) SLURRYCUPS, and one (1) grit snail in either fully automated or manual mode.

4. Panels shall be completely pre-wired and tested, requiring only mounting and connection to external wiring in the field.

5. The panels shall be relay logic based and contain all timers, starters, switches, a variable frequency drive, and indicator lights. The control panel shall be supplied with applicable control relays and time delay relays. The panels shall be provided with all dry contacts necessary for remote monitoring as shown in the drawings and specified herein.

6. Provide the following spare parts for the control panel:

   a. Fuses: 20 percent of each size and type used, but no less than ten of each size and type.

   b. Relays and relay sockets: One (1) spare unit for every ten (10) of each type installed, minimum one.

   c. Panel-Mounted Lights and Switches: One (1) spare mechanism for every ten (10) of each type installed, minimum one; plus 10 units or 20 percent of bulbs and colored lenses installed, whichever is more.

   d. Power Supplies: 20 percent of each size and type used, minimum one.

   e. Corrosion Inhibiting Vapor Capsules: Provide 10 of each type and size used.

7. Each Control Panel door layout shall include the following items:

   a. Front panel mounted combination main disconnect switch and circuit breaker.

   b. Backlit, push to test, power on indicating light.

   c. System three position HOA switch.

   d. System emergency stop push button.

   e. System alarm reset push button.

   f. Grit Pump Selector Switches (x2).

g. Grit Pump running light (x 3).

h. Grit Pump three position HOA switch (x 3).

i. Grit Pump fail indicating light (x 3).

j. Grit Pump manual START push button (x 3).

k. Grit Pump manual STOP push button (x 3).

l. SLURRYCUP three position HOA switch (x 2).

m. SLURRYCUP supply water three position HOA switch (x 2).

n. SLURRYCUP backwash water valve three position HOA switch (x 2).

o. SLURRYCUP auxiliary backwash push button (x 2).

p. SLURRYCUP RUNNING indicating light (x 2).

q. SLURRYCUP SUPPLY OPEN light (x 2).

r. SLURRYCUP BACKWASH OPEN light (x 2).

s. SLURRYCUP BLOWDOWN light (x 2).

t. SLURRYCUP WET/DRY/REMOTE three position switch (x 2).

u. GRIT SNAIL running light.

v. GRIT SNAIL three position HOA switch.

w. GRIT SNAIL fail indicating light.

x. GRIT SNAIL manual STOP push button.

y. GRIT SNAIL manual START push button.

z. GRIT SNAIL manual speed potentiometer.

aa. GRIT SNAIL rinse water valve three position HOA switch.

bb. GRIT SNAIL rinse water valve OPEN indicating light.

cc. GRIT SNAIL FAIL RESET push button.

dd. GRIT SNAIL LOCAL/REMOTE switch for escalator speed control.

8. Each control panel shall provide start / stop control via dry contacts for two grit pumps plus either of two swing pumps. CP-GS1 shall control grit pumps No. 1 and No. 2 and swing pumps No. 3 and No. 4. CP-GS2 shall control grit pumps No. 5 and No. 6 (future) and swing pumps No. 3 and No. 4.

9. SCADA system control and monitoring: Provide the following discrete I/O signals for each control panel.

   a. System ON/OFF/AUTO status.

   b. Grit Pump ON status.

   c. Grit Pump ON/OFF/AUTO status.

   d. Grit Pump FAIL alarm.

   e. SLURRYCUP ON/OFF/AUTO status.

   f. SLURRYCUP supply water ON/OFF/AUTO status.

   g. SLURRYCUP backwash water valve ON/OFF/AUTO status

   h. SLURRYCUP ON status.

   i. SLURRYCUP supply water OPEN status.

   j. SLURRYCUP backwash water valve OPEN status.

   k. SLURRYCUP blowdown ON status.

   l. SLURRYCUP WET/DRY/REMOTE status.

   m. GRIT SNAIL ON status.

   n. GRIT SNAIL HAND/OFF/AUTO status.

   o. GRIT SNAIL FAIL alarm.

   p. GRIT SNAIL speed.

   q. GRIT SNAIL rinse water valve HAND/OFF/AUTO status.

   r. GRIT SNAIL rinse water valve OPEN status.

   s. GRIT SNAIL LOCAL/REMOTE status.

10. Sequence of Operation.

a. The system shall be controlled to provide automatic or manual operation, manual starting and stopping and system shut down when a fault is detected.

b. Clarified plant water shall be supplied and distributed between the HEADCELL fluidizing line, the SLURRYCUP and the GRIT SNAIL.

c. Screened raw wastewater shall be gravity fed into the HEADCELL continuously.

d. GRIT PUMP

(1) Grit slurry from the HEADCELLS shall be pumped to the SLURRYCUP continuously.

(2) Each Grit System shall include a grit pump designated to deliver grit slurry to a dedicated SLURRYCUP and a common stand-by as shown in the Drawings.

(3) Under no circumstances shall the stand-by pump in a system be allowed to feed more than one SLURRYCUP. If both selector switches in a single system are set to the standby pump, one pump and corresponding SLURRYCUP shall stop and the failure light illuminate.

e. SLURRYCUP

(1) Grit slurry from the HEADCELLS shall be pumped to the SLURRYCUP continuously.

(2) During operation, a small volume of washed/classified grit slurry shall continuously underflow from the Grit Washing/Classification unit. Control of the grit slurry underflow rate is via the Hydraulic Valve mounted on the bottom of the unit. A portion of the system water is continuously introduced to the Hydraulic Valve.

(3) Periodically, (typically twice per hour during heavy grit loads and typically once per hour during light grit loads), a backwash sequence is initiated, by cycling

solenoid valves, which flushes the grit underflow gap inside the unit. Frequency and duration of backwash cycles is adjustable.

(4) Periodically, (typically once every 4 backwashes), a blowdown sequence is initiated to flush accumulations of debris inside the unit. Blowdown is accomplished by stopping the influent to the SLURRYCUP unit, cycling solenoid valves, and resuming operation. Frequency and duration of blowdown cycles is adjustable.

f. GRIT SNAIL

(1) The belt shall run whenever grit slurry is being transported to the unit.

(2) While the dewatering unit is running, water shall be directed to the tailroll self cleaning mechanism and grit rinse system.

(3) The belt speed shall be adjustable via a manual speed control potentiometer on the control panel or by remote signal (4-20ma) from the plant SCADA System.

(4) A motion sensor shall be installed on the side of the GRIT SNAL takeup frame and shall detect movement of the headroll scraper arm. Lack of motion of the headroll scraper arm shall indicate lack of belt movement, drive unit failure and/or scraper arm overload. Lack of belt movement or scraper arm overload shall interrupt signal from the motion sensor to the timer. If the motion sensor fails to reset the timer, the GRIT SNAL shall stop and the failure light illuminate.

(5) After a System Shut Down the GRIT SNAL shall continue to operate for a pre-determined amount of time to allow for the removal and dewatering of all grit accumulated in the clarifier. The off delay timer shall be adjustable from 0-60 minutes with a typically delay off time of 15 minutes.

I. Materials and Finishes

1. MATERIALS

316 Stainless Steel unless otherwise noted

Plate and Sheet	ASTM A 167
	ASTM A 240
Bar	ASTM A 276
	ASTM A 479
Tube	ASTM A 312

2. Exterior Surfaces Finishes

a. All surfaces shall be free of sharp edges, weld spatter and residue. All welds shall be ground smooth.

b. All stainless steel surfaces shall be acid washed

c. All non-submerged exterior surfaces shall be Glass Bead Blasted to a uniform finish.

J. Structural Design Grit Washing/Classification (SLURRY CUP) & Grit Dewatering Escalator (GRIT SNAIL) Units

1. Provide all equipment bases, anchorage, supports, and foundations designed in accordance with the following.

2. Design equipment, bases, anchorage, supports, and foundations per the 2010 Florida Building Code (FBC) requirements supplemented by ASCE 7-10 for wind loading requirements:

Basic Wind Speed, mph:	150
Risk Category:	3
Exposure:	B

3. An unreinforced concrete housekeeping pad above the reinforced concrete structural slab shall not be considered to have structural value in the design of the anchor bolts. Tension and shear values for drilled or epoxied anchor shall be FBC approved. Maximum hoop stress shall not exceed 1/10 of the ultimate hoop strength of the laminate.

4. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a structural engineer, registered in the State of Florida, stating that computations were performed and that all components have been sized for the wind load specified and indicated.

PART 3 - EXECUTION

A. Installation

Installation of the Grit Removal System shall be performed in accordance with instructions provided by the manufacturer.

B. Service Conditions

1. HEADCELL Tag Number: 500-HC-1, 500-HC-2, and 500-HC-3

Location	Preliminary Treatment Structure
Number of Units	3
Size	12-ft diameter
Number of Trays per Unit	13
Surface Area per Unit	1,469 ft 2
Peak Loading Rate	12.6 gpm/ft 2
Performance	95% removal of all grit (S.G. 2.65) ≥ 106 microns @ peak flow 95% removal of all grit (S.G. 2.65) ≥ 75 microns at average flow
Average Flow per unit	13.3 mgd
Headloss at average flow	3 inches
Peak flow per unit	26.7 mgd
Maximum headloss at peak flow	12 inches
Influent direct opening	See drawings
Discharge	Weir (see drawings)
Underflow connection	4 inches
NPW connection	1 inch NPT

2. SLURRYCUP Tag Number: 500-SC-1, 500-SC-2, 500-SC-3 and 500-SC-4

Location	Preliminary Treatment Structure (Top Deck)
Number of Units	4 (2 at each GRIT SNAIL)
Size	32-in diameter
Performance	95% removal of all grit (S.G. 2.65) ≥ 75 microns at peak flow
Influent Solids Concentration	≤ 1.0%
Design flow/unit	300 gpm with 15-ft headloss
Minimum Flow/unit	280 gpm with 13-ft headloss
Maximum Flow/unit	400 gpm with 27-ft headloss
Influent connection	6-inch, flanged
Effluent Connection	8-inch, flanged
Underflow connection	3-inch, NPT
NPW connection	1-1/2-inch, NPT

3. GRIT SNAIL Tag Numbers: 500-GS-1 and 500-GS-2.

Location	Preliminary Treatment Structure (Top Deck)
Number of Units	2
Maximum Grit Load	4.0 cy/hr.
Performance	95% removal of all grit (S.G. 2.65) ≥ 75 microns with less than 15% volatile solids and greater than 60% total solids
Belt Width	24 inches
Clarifier Size	72-inch square
Minimum Free Water Surface Area	26.7 ft 3
Motor	1/3 HP, TENV
Overflow Connection	6-inch, flanged
Drain Connection	3-inch, flanged
NPW connection	1-inch, NPT

C. Field Testing

1. Operate the grit removal system for 30 consecutive days, and perform adjustments to the equipment. Assure that automatic sequencing and control system interconnecting the grit pumps, dewatering screw, and solenoid valves functions. Assure that equipment operates without binding or sticking.

2. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

3. Repeat tests until specified results are obtained.

4. Make all adjustments necessary to place equipment in specified working order at time of above tests.

D. Contract Closeout

Provide in accordance with Section 01700.

E. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

F. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

G. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating

normally. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

SECTION 11328 MECHANICALLY CLEANED FINE SCREENS AND APPURTENANCES(BAND TYPE)

PART 1 - GENERAL

A. Description

1. This section includes all labor, equipment, materials, and incidentals required to completely install and place in to operation mechanically cleaned band screens, gear reducers, motors, controls and appurtenances as indicated and specified.

2. All components of the Influent Screening System including Fine Band Screen, Washing Compactors, Screenings Conveyance Sluice, Controls and accessories shall be the product of a single manufacturer/supplier who shall have sole responsibility for providing an integrated system, which is complete and operable in all aspects. The manufacturer shall have overall system responsibility for coordination of all major components of the system including startup training, calibration and overall successful operation of the equipment.

B. Submittals

1. Submit the following shop drawings in accordance with the General Conditions, Section 01300 and the following:

2. Certified shop and erection drawings. Drawings showing materials of construction, thicknesses, operating and maintenance envelope and assembly weight. Provide a scaled drawing showing the equipment and motors including equipment weights, lifting attachments, slings and clearances for equipment removal and maintenance.

3. 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, 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.

4. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

5. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of ten (10) operating units with five (5) consecutive years of successful operating experience, from final completion of the respective project of the installation, that are of equivalent to, or greater, size and type of band screen and compactors which are operating under equivalent service conditions specified and indicated herein. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. At a minimum the reference information shall include the following;

   a. Current Owner Reference Contact Information

   b. Installation Service Conditions

   c. Equipment Model Numbers

   d. Date of Final Completion of the Project

6. Certified setting plans, with tolerances, for anchor bolts.

7. Hydraulic calculations verifying compliance to the design criteria.

8. Strength calculation verifying compliance to the specified criteria.

9. Shop drawing data for accessory items.

10. Manufacturer's literature as needed to supplement certified data.

11. Submit motor data per Section 16150.

12. Bearing temperature operating range for the service conditions specified.

13. Bearing Life: Certified by the equipment manufacturer. Include design data.

14. Schematic control and power wiring diagrams including interconnecting and internal wiring diagrams

15. Control panel drawings

16. Shop and field testing procedures, set up and equipment to be used.

17. Shop and field inspection reports.

18. Equipment shop test results.

19. Qualifications of field service engineer.

20. Recommendations for short and long-term storage.

21. Special tools.

22. List of recommended spare parts other than those specified.

23. Manufacturer’s product data, specifications and color charts for shop painting.

24. Operation and Maintenance Manuals per Section 01300 with installation instructions, operation and start-up procedures including lubrication requirements and a complete bill of materials for all equipment.

25. Submit six copies of a written report prepared by the manufacturer certifying that the equipment has been properly installed, lubricated, and test run.

C. Quality Assurance

1. Equipment specified shall be the product of one manufacturer. All components of the influent screening system and appurtenances shall be supplied from the mechanically cleaned screen manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

2. Equipment specified shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

3. Welding: In accordance with latest applicable American Welding Society Code AWS 1.6 or equivalent.

4. Shop tests as specified.

5. If equipment proposed is heavier or taller, different width, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

6. Provide all components made of stainless steel passivated by full submergence in a pickling bath or a brush application of paste in compliance with ASTM A380 and/or ASTM A967.

7. Provide fabrication in compliance with all applicable ASTM standards or equivalent international standards.

8. Factory welding to use shielded arc, inert gas, MIG or TIG method.

   a. Filler wire: Add to all welds to provide for a cross section equal to or greater than the parent metal.

   b. Butt welds: Fully penetrate to the interior surface and gas shielding to interior and exterior of the joint.

9. Control panels shall be UL listed, FM approved.

D. Qualification

The band screen manufacturer is required to prove satisfactory experience in the design and manufacturing of mechanically cleaned fine screens of the band type. Prior to

submitting shop drawings, submit data, records, contact names and numbers for all appropriate references.

As of the date in which Bids are submitted, the Manufacturer of band screen equipment must have a minimum of ten (10) operating units with five (5) consecutive years of successful operating experience, from final completion of the respective project of the installation, that are of equivalent to, or greater, size and type of band screen and compactors which are operating under equivalent service conditions specified and indicated herein. The installations must be within the contiguous lower forty-eight (48) States of the United States of America.

E. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. Three (3) days prior to scheduled start-up to meet and coordinate with the systems integrator and provider of the Preliminary Treatment Process PLC to ensure that the TCP/IP protocol communication over the fiber.

4. The screenings equipment start-up representative shall insure that all control functions are properly carried out by the control panel as part of the start-up procedure.

5. Refer to Section 01010 for additional requirements.

PART 2 - PRODUCTS

A. System Description

1. Screening system capacities and operating data are indicated in the “Service Conditions”.

2. Each band screen shall be a self-contained, screening system to raise screenings mechanically on screen and automatically discharge to a trough provided by the screen manufacturer to sluice the wastewater debris to a custom screenings conveyance sluice trough for transport to a screenings washer/compactor. Screened material shall be cleaned from the screen face by water jets provided as part of the screen equipment.

3. Screen consists of screen installed in new channels, cleaning mechanism, driving unit and housing as specified and shown in the drawings.

4. Service: Raw wastewater.

5. Screens will discharge to a sluice as shown in the drawings.

6. Provide a screen capable of operating with the screen 50 percent blinded and structurally capable of 100 percent blinded.

7. Interface:

   a. Provide driving mechanism headworks and housing arranged in accordance with limitations imposed by space available.

   b. Provide room for inspection, adjustment and repair of equipment.

B. Manufacturers

Brackett Green Model CF200 Band Screen, JWCE Band Screen Monster, or acceptable equal.

C. Structural Design

1. Provide all equipment components; frames, anchorage, supports, sheet metal panels and foundations designed in accordance with the following;

2. Design equipment, bases, anchorage, supports, and foundations per the 2010 Florida Building Code (FBC) requirements supplemented by ASCE 7-10 for wind loading requirements:

Basic Wind Speed, mph: 150

Risk Category: 3

Exposure: B

3. An unreinforced concrete housekeeping pad above the reinforced concrete structural slab shall not be considered to have structural value in the design of the anchor bolts. Tension and shear values for drilled or epoxied anchor shall be FBC approved. Maximum hoop stress shall not exceed 1/10 of the ultimate hoop strength of the laminate.

4. Provide with the Certificate of Unit Responsibility, certification for all equipment signed by a structural engineer, registered in the State of Florida, stating that computations were performed and that all components have been sized for the wind load specified and indicated.

D. Screen Construction

1. General:

a. Provide band screens consisting of a continuous band of perforated panels mounted parallel to the flow with affixed debris elevating combs secured to the panels.

(1) Provide the drive sprockets secured to the main drive shaft driven by a shaft-mounted gearbox and motor.

(2) Flow Pattern: Provide screen to allow for the flow to enter into the center of the screen and exit to the outside of the screen, totally separating the influent and effluent.

(3) As the band of screen panels rotate, the debris collected on the inside of the screen will be lifted above deck level, where it will be washed into a debris trough within the head section. The debris trough will discharge via gravity flow to the screenings conveyance sluice trough. Screenings shall not be carried over back into the main process flow stream.

(4) Screens without this type of design shall not be acceptable.

(5) As the perforated panels reach the discharge section of the system, provide cleaning by means of a spray jet system.

b. Provide the band screens designed and proportioned to handle the screenings capacity for continuous operation with geometry as specified and indicated in the Band Screen Schedule and on the drawings.

c. Provide all structural parts sized for the loads encountered during operation.

d. Provide the washing of screenings by multiple spray nozzles located in the inlet band screen housing with the wash water flow controlled by a solenoid valve and control signal from the control panel.

e. Provide access and space for inspection, repair, replacement and adjustment.

f. Apply anti-seize compound to all bolts.

2. Frame:

a. Screen Frame: Rectangular structure built from Type 316L stainless steel sections and plate that are minimum 3/8-inch thick for submerged sections and minimum 1/4–inch thick for exposed sections. The screen shall be reinforced to handle all loads specified.

b. The screen frame shall be fitted with replaceable roller tracks and neoprene seal system to guide the screening band.

c. Provide the side frame connected together with the Type 316L stainless steel cross members. Cross Members shall be one of the following:

(1) Type 316L stainless steel bent plate and angle 3/8 inch thick and machined to maintain the correct distance between the side frames.

(2) Type 316L stainless steel pipe and minimum 1/2-inch Type 316L stainless steel plate and machined to maintain the correct distance between the side frames.

d. The tracking system in each frame shall be one of the following designs:

(1) 1/2 inch thick 316L stainless steel replaceable track that is bolted to 4-inch wide stainless steel plates continuously welded to the machine frame to form the upper and lower frames of the guide tracks.

(2) 2-3/8 x 3-5/8 inch minimum Ultra High Molecular Weight (UHMW) in the vertical and 1/2-inch minimum Type 316L stainless steel for the outer track and 2-3/4 x 4 inch minimum UHMW for the inner track at the bottom.

e. A flanged connection shall be provided on the frame as shown in the drawings to allow for odorous air control piping connections.

3. Screen Panels:

a. 9 mm thick polyurethane or 10 mm thick minimum UHMWPE with 5 mm diameter perforations.

b. The screen panel shall fit into the frame and attach to the stainless steel chain on each side.

c. Provide each panel with side seals and seals between each panel.

d. The seals between the panels shall be neoprene and shall be attached to each panel to ensure no bypassing of the main process flow stream.

e. Units that use hinges between the panels are not acceptable.

4. Chain and Sprockets:

a. The main carrier chains shall consist of links connected by pins and bushings, filled with rollers that shall run on the roller tracks of the main frame. Provide roller chain of 3/8 inch thick minimum stainless steel side bars. Alternatively, roller chain shall be 2 x 0.20-inch outer and 2 x 0.318-inch inter stainless steel side bars

b. Chain pins and bushings shall be ASTM A276 Grade 431 stainless steel hardened to Rc 48 minimium and tempered or 17-4 stainless steel per ASTM-A-564

Grade 630. Pins shall have a minimum 1 inch diameter.

c. Rollers: Nylon 6, cast nylon machined to size or molded nylon.

d. Provide the stainless steel roller chain with a 30,000 lbs minimum breaking load.

e. The roller chain shall be water lubricated and shall not require external lubrication.

f. Drive shaft: 1040 carbon steel, epoxy coated or Type 316 stainless steel.

g. Provide a horizontal shaft fitted with two (2) sprockets over which the main chain will pass. Provide cast iron Type A48, epoxy coated or Type 316 stainless steel sprockets that are keyed directly to the drive shaft. Sprockets shall have 10 teeth keyed to the drive shaft and shall be sized for 15 inch pitch chain with 5 inch diameter rollers. Alternatively, sprockets shall have 8 teeth keyed to the drive shaft and shall be sized for a 11.81 pitch chain with 3.94 inch diameter rollers.

h. The shaft shall be supported on each side by heavy duty roller bearings which are mounted within cast-iron housings for chain tensioning. The bearing housings will be retained in parallel slides and supported by the chain tensioning screws. The chain tensioning screws shall be 1.5 inch diameter minimum.

5. Discharge:

a. Provide spray wash water within the band screen housing designed to wash the screening band as it passes the discharge point above the debris trough. Provide the spray wash water system with nozzles to remove debris from the panels debris and spray wash water shall discharge to debris trough. The debris trough shall be 3/16 inch thick minimum, Type 316 stainless steel sluice that will take the debris out to the screen discharge. The debris trough shall discharge via gravity flow to the screenings conveyance sluice.

b. Provide the spray wash water system constructed of Type 316L stainless steel and consisting of a series

of spray nozzles maintained on a spray wash manifold, 2-inch pressure reducing valve, Type 1402 per Section 15111, 2-inch stainless steel flow meter, 2-inch electrically-actuated ball valve (refer to Paragraph 2.D.5.c herein) for spray wash water flow control, a manually operated ball valve Type 320 per Section 15100, for spray wash water flow control, and a Y-strainer with a 20 mesh screen and a removable end-cap for flushing purposes. The spray nozzles shall be attached to the spray pipe by quickly removable NPT connections.

c. Electrically-Actuated Ball Valve:

(1) Provide the electrically-actuated ball valve, Type 320 per Section 15100, automatically energized by the Control Panel allowing wash water to spray whenever the band screen is operational and continue to spray for a preset, but adjustable time period after the band screen stops.

(2) Enclosure: Class I, Division 1, Groups C and D.

(3) Normally closed.

(4) Pressure rating: 100 psig.

(5) Slow closing type.

(6) Provide valve actuator in accordance with Section 15119.

d. Coordinate spray wash water connection location with the drawings.

e. Provide a 0-100 psi pressure gauge and low pressure switch per Section 13315, attached to the spray wash manifold for visual confirmation of wash water pressure. The low pressure switch shall send a warning signal if the water pressure falls below the manufacturer’s required wash pressure.

6. Guards:

a. Provide the screen completely enclosed above the top of the channel. Provide removable access covers and splash guards incorporating an inspection door

designed to reduce aerosol from the spray nozzles and contain odors.

b. All guards shall be Type 316 stainless steel and removable.

c. Provide a 6 inch flanged odor control connection on each band screen, located on the top cover of the head section.

d. All equipment shall be electronically “locked out to prevent automatic starting when any covers or guards are open/removed.

E. Materials

1. Materials of construction shall conform to the requirements listed below.

Component	Material
Main Frame & Head Section	ASTM A240 Type 316 stainless steel
Straight Roller Tracks	ASTM A240 Type 316 stainless steel or Ultra High Molecular Weight Polyethylene (UHMWPE)
Outer Curved Roller Tracks	ASTM A240 Type 316 stainless steel
Inner Curved Roller Tracks	ASTM A240 Type 316 stainless steel or Ultra High Molecular Weight Polyethylene (UHMWPE)
Locating Strips	ASTM A240 Type 316 stainless steel
Sealing Angles	ASTM A240 Type 316 stainless steel
Head Shaft	AISI 1040 carbon steel, epoxy coated or ASTM A276 Type 316 stainless steel
Bearing Housings	ASTM A48 Cast Iron, painted
Main Chain Sprockets	ASTM A48 Cast Iron, painted
Main Chain Tensioning Screw	ASTM A193, Type 304 stainless steel
Main Chain Tensioning Nut	Bronze or ASTM A194, Type 304 stainless steel
Main Chain Links	ASTM A240 Type 316 stainless steel
Main Chain Pins & Bushings	ASTM A276 Gr. 431 Heat Treated SS (hardened to Rc 48 minimum and tempered) or 17-4 stainless steel

Component	Material
Main Chain Rollers	Nylon
Main Chain Sealing Plates	Ultra High Molecular Weight Polyethylene (UHMWPE)
Main Chain Seal	Neoprene or Ultra High Molecular Weight Polyethylene (UHMWPE)
Main Chain Fasteners/Nuts	ASTM A193/A194 Type 316 stainless steel
Basket Frames	ASTM A240 Type 316 stainless steel
Screen Panels	9 mm thick, molded, polyurethane or 10 mm thick Ultra High Molecular Weight Polyethylene (UHMWPE)
Basket to Basket Seals	Neoprene
Basket Seal Clamping Strips	ASTM A240 Type 316 stainless steel
Debris Elevators	ASTM A240 Type 316 stainless steel
Spray Pipes	ASTM A240 Type 316 stainless steel
Spray Nozzles	ASTM A240 Type 316 stainless steel
Splash Guards	ASTM A240 Type 316 stainless steel
Debris Trough	ASTM A240 Gr. 316 SS (3/16" min)
Fasteners and Nuts	ASTM A193/A194 Type 316 stainless steel
Anchor Bolts, Nuts, and Washers	ASTM A193/A194 Type 316 stainless steel
Channel Sealing Partition	ASTM A240 Type 316 stainless steel

2. All structural stainless steel components shall conform to the requirements of "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" published by the American Institute of Steel Construction.

3. Fabricate all parts and assemblies from sheets and plates of AISI Type 316 stainless steel conforming to AISI and ASTM A240.

4. Fabricate all rolled or extruded shapes to conform to ASTM A276. Fabricate all tubular products and fittings to conform to ASTM A269, A 312, A351 and A403.

5. Factory welding: Shielded arc, inert gas, MIG or TIG method. Add filler wire to all welds to provide for a cross section equal to or greater than the parent metal. Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of the joint.

6. Field welding of stainless steel will not be permitted.

7. All surfaces that are specified to be machined shall be designed and fabricated to provide a runout of not more than 0.005 inches and a concentricity to within 0.005 inches.

F. Discharge Chutes

1. Provide discharge chutes for receiving and discharging material, having the dimensions to suit the mechanically cleaned screens and screenings collection and conveyance sluice.

2. Discharge Chute:

   a. Structural Type 316L.

   b. Thickness: 1/4-inch.

   c. Provide all required supports.

3. Structural Design:

   a. Manufacturer is responsible to provide all components in compliance with the structural criteria of Part 2.C.

G. Screen Drive Systems

The screening band shall be driven by a shaft-mounted gear unit keyed directly to the shaft. The gear unit shall be fitted with a C-face or flange mounted electric motor. Coordinate location and orientation of the drive system with the drawings.

1. Motor:

   a. Provide in accordance with Section 16150 and as specified herein.

   b. Horsepower rating of motors: Not less than maximum brake horsepower requirements of equipment under any

condition of operation specified and indicated without operating in the motor service factor.

c. Motor enclosure and motor speed: Motor enclosure shall be explosion proof, Class I, Div. 2, Group D. Motor shall be VFD operated. VFDs shall be provided in accordance with 16370.

d. Provide motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust. Provide bearing with a minimum B-10 life of 100,000 hours.

e. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet from motor.

f. Operate without overheating at the speeds specified and indicated.

g. Service Factor: 1.15, with 1.0 inverter duty rating for screens equipped with variable frequency motor conditions.

h. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

i. Rating: 460V, 3-ph, 60 Hertz.

j. Insulation: Class F with Class B temperature rise, 40 degree C ambient.

k. Site Altitude: Less than 3,300 feet above sea level.

l. Integral gear reduction units are not acceptable.

m. Provide capacity sufficient to start and operate screen 50 percent blinded without exceeding nameplate ratings for current and power and without operating in the service factor.

n. Provide drive units, including the reduction gearbox, shaft-mounted and positioned to facilitate maintenance work.

2. Gear Reducer:

a. Provide parallel shaft arrangement classified for continuous, AGMA Class II, 24-hour duty.

b. Provide ASTM A48 Class 30 cast iron housing.

c. Gears: Case hardened alloy steel forgings with precision ground gear teeth minimum AGMA quality 12.

d. Provide horizontal parallel or bevel right angle shafting, arrangement or as indicated in the Mechanically Cleaned Screen Schedule.

e. Design reducer to match output speed requirements of screens.

f. Match torque-rating of driven equipment.

g. Minimum gear reducer service factor shall be 1.3 minimum, based on motor horse power rating.

H. Screw Compactor

1. Provide one (1) screw compactor for each screen provided.

2. Screen manufacturer shall provide washer screw compactors adequately sized to wash and compact screenings removed from influent raw wastewater at the peak rated capacity of the band screens specified herein. The washing system shall eradicate a substantial amount of the fecal solids so the final dewatered screenings will contain less than 50 G/L of BOD.

3. The screw compactor body shall be constructed from 316 stainless steel plate. Provide inlet flange to connect screenings conveyance sluice to body.

4. The screw(s) shall be a rotating, shafted, single flight design constructed of ASTM A36 Carbon Steel. Carbon steel screw shall be shop blasted to near white finish and coated with one coat of Tnemec coal tar epoxy or equal.

5. Each screw shall rotate within a 316 stainless steel, 5 mm perforated trough which collects screenings and allows water to pass and discharge by gravity to the plant sanitary collection system as shown in the drawings.

6. Provide brush(es) to prevent material from blocking the perforated trough. Brushes shall be hard wearing nylon or stainless steel with nylon bristles. Brush shall be affixed to the flights of each screw with adjustable clamps or for screws with groove, brushes shall seat into groove and be secured with set screws.

7. Each screw shall be supported at the drive end by an independent thrust and radial load bearing.

8. Each screw shall be supported by a thick walled UHMW sleeve at the de-watering end. This sleeve shall prevent oscillation of the screw, maintaining contact with the trough at all times and eliminating chances of trough wearing. The sleeve will also act to initiate the formation of the compacted plug of screenings.

9. Provide one of the following spray water system types:

   a. At the entrance to the de-watering cone there shall be a 1.0 inch NPT solenoid valve, Type 900 (NEMA 7) per Section 15100 and water connection to provide a internal machine wash system that requires 32 GPM of washwater @ 40 psi. Provide water supply line with 0-100 psi pressure gauge (per Section 13315), pressure reducing valve (Type 1402 per Section 15111), stainless steel flowmeter, bronze 80 mesh basket strainer, bronze Y-strainer, and manual ball valve (Type 320 per Section 15100). The washwater will be directed through a stainless steel pipe manifold into a series of injection points around the periphery of the compaction cone. The tubes shall be connected to the compaction cone by quick-connect couplings. A safety cable shall be provided to prevent the compactor from being opened without disconnecting the water injection tubes from the compaction cone.

   b. At the wash tank there shall be two (2) 3/4 inch integral spray manifolds to apply unobstructed washwater onto the section of the screw located above the wash tank’s perforated screen. At the compaction elbow there shall be two (2) 1/2 inch NPT ports for injection of water. Provide solenoid valve Type 900 (NEMA 7) per Section 15100, 0-100 psi pressure gauge (per Section 13315), pressure reducing valve (Type 1402 per Section 15111), stainless steel flowmeter, bronze 80 mesh basket strainer, bronze Y-strainer, and manual ball valve

(Type 320 per Section 15111) on the supply line to the water connection to the internal machine wash system. The wash system requires 45 GPM of washwater @ 40 psi. The piping to the washtank manifolds and compaction elbow shall be braided stainless steel hose.

10. The washed and compacted screenings shall be elevated to the discharge point by a 316 stainless steel tubular outlet chute angled at 45-50 degrees from the horizontal.

11. The outlet chute shall be larger in diameter than that of the screw to prevent the compacted screenings from becoming lodged in the chute.

12. Provide a 316 stainless steel drop box to direct the compacted screenings to the dumpster and/or truck bed as sown in the drawings. The drop box shall direct the screenings from the angled compactor tube into a larger diameter vertical tube with a flanged fitting. Provide a 16 inch diameter 316 stainless steel tube with a flexible hose attached to the end of the tube to direct the compacted screenings to the dumpster/truck bed. Provide a 3 inch flanged odor control connection at the top of the drop box as shown in the drawings.

13. Provide a minimum 8-inch drain or two (4) in drains as required by the manufacturer. Coordinate number, size and location with manufacturer.

14. The compactor shall be designed with a roll-out feature that will allow the screw, compaction cone, and other internal features to be rolled out the end of the machine. The feature shall allow full exposure and quick access to these components for maintenance and inspection without the need to remove the compactor covers.

15. Bolts shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M. Nuts shall be Type 316 stainless steel Type 716 stainless steel conforming to ASTM A194, Grade 8M.

I. Washer Screw Compactor Drive System

1. Each screw compactor shall be driven by a helical-bevel geared motor keyed directly to the screw shaft, with a torque arm to a bracket fitted on the main compactor

body. The gear motor shall be fitted with a flange or C-face mounted electric motor.

2. Provide motor in accordance with Section 16150 and the following.

3. Each motor shall be minimum of 3.0 Hp, 460Volt, 3 phase 60 Hz.

4. Motor enclosure shall be explosion proof, Class I, Div. 2, Group D.

5. Horsepower rating of motors: Not less than maximum brake horsepower requirements of equipment under any condition of operation specified and indicated without operating in the motor service factor.

6. Operate without overheating at maximum speed.

7. Service Factor: 1.15.

8. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

9. Rating: 460V, 3-ph, 60 Hertz.

10. Insulation: Class F with Class B temperature rise, 40 degree C ambient.

11. The screw compactor drive shall be a helical geared motor shaft mounted via a torque arm to a bracket fitted on the main compactor body.

12. Design reducer to match output speed requirements of screw.

13. Match torque-rating of driven equipment.

14. Minimum gear reducer service factor 1.3, based on motor horse power rating.

J. Controls

1. The Manufacturer shall provide a NEMA 4X, 316 stainless steel, 480VAC control panel meeting the requirements of Section 16191, PART 2, paragraph B and as modified herein.

2. Solid state motor control or variable frequency drive is acceptable. If this is provided, single phase protection is inherent and the phase monitor is not required.

3. Control shall be PLC based rather than the relay control specified in 16191.The PLC based panel must conform to all applicable Division 13 requirements, and include a Siemens S7-300 series PLC, Ethernet connectivity, operator touchscreen, fiber optic cable switch and patch panel, and an internal UPS. Internal PLC wiring shall be allowed to be 18 AWG but shall be rated 600 volts. Internal dividers or barriers shall be provided to allow instrumentation technicians to access the PLC components without being exposed to 480 volts.

4. Provide a control panel for each band screen. The controls for the washer screw compactor shall be supplied with the screening handling equipment within the corresponding band screen control panel. All control devices and switches required for equipment operation shall be supplied in the screenings control panel. Enclosure shall house the control devices, relays, terminal blocks and reversing motor starters.

5. For each Screen, provide a NEMA 4X, 316 stainless steel local control station. The local control station shall at a minimum include the following:

    a. Emergency Stop

    b. Run

    c. Stop

    d. Lock-out

6. Provide washwater electrically activated ball valve per Paragraph 2.D.5.c herein. Operation of the wash water solenoid valve for the Band Screen shall be controlled by a field adjustable cycle timer located in the control panel.

7. Provide normally closed solenoid valve(s), per Paragraph 2.H.9 herein, with each Washer Screw Compactor unit to allow a water rinse of the screenings prior to compaction.

8. Level Sensors:

    a. General:

(1) The Band Screen System shall be provided with ultrasonic level sensors. The level sensors shall initiate band screen operation based on channel head differential and the parameters set in the operator interface.

(a) The transmitter shall calculate the differential levels using signals from two separately-mounted ultrasonic transducers. Alternatively, the PLC logic shall determine differential levels using signals from two separately-mounted ultrasonic transmitters. If ultrasonic level instruments that utilize one or more remote transmitters are supplied, the transmitter(s) shall be mounted inside the control panel.

(b) The first transducer shall be installed upstream of the band screen and measure the band screen upstream head. The second transducer shall be installed downstream of the band screen and measures the screen's downstream head.

(c) The head in front (upstream) of the screen shall be compared to the head downstream of the screen to determine the head differential.

(2) Ultrasonic Level Transmitters shall be in accordance with Section 13315 and the following.

(a) The ultrasonic transmitters shall be rated for the installation environment, Class I, Division 2, Groups C and D.

9. Band Screen Operation:

a. The Control Panel shall be equipped with a BAND SCREEN ON-OFF/RESET-LEVEL three (3) position selector switch. In the OFF/RESET mode the band screen shall not run. In the ON mode the band screen shall run continuously. In the LEVEL position, band screen shall run, after a present, but adjustable time period, when initiated by the ultrasonic level sensors or the Level Sensors Backup Timer. The band

screen shall only be reset by switching the BAND SCREEN ON-OFF/RESET-LEVEL switch to the OFF/RESET position.

b. The Control Panel shall be equipped with a digital operator interface. The operator interface shall display band screen, elapsed times, reversals, jams, motor overloads and over-temperature occurrences. The operator interface shall display Fail, Service Reminder, and Operational Messages. Operator interface function keys shall select the following displays: Date and Time, Bandscreen Run Frequency, Real Time Data. Band screen Run Frequency and Level Sensors Backup Timer shall be programmable. Settings shall be entered at the operator interface using panel keys to initiate a desired run sequence.

c. Controls for setting the band screen Run Frequency as initiated by the ultrasonic level sensors shall be included in the PLC and accessed by the operator interface. The band screen Run Frequency settings for starting the band screen shall be adjustable based on head differential. The differential percentage shall be based on the head in front (upstream) of the screen as compared to the head downstream of screen.

d. The Control Panel shall be equipped with a programmable Level Sensors Backup Timer. The Level Sensors Backup Timer shall start the band screen if the ultrasonic sensors fail to start the band screen within a preset interval of 0 to 999 minutes. The Level Sensors Backup Timer shall be disabled when the timer is set to 0.

10. Washer Screw Compactor Operation

a. When the start signal is received by the screen and its motors are energized, a start signal shall be given to the screw compactor motor and solenoid valve.

b. When the stop signal is received by the screen, the screw compactor motor and the solenoid valve remain energized for a pre-set overrun period of between 0 and 5 minutes.

c. When the overrun time is completed , the motor and the solenoid valves shall be de-energized.

d. The following conditions shall be sensed by the control panel.

(1) Compactor drive tripped (Stop Screw Compactor)

(2) No Motion, Screw Compactor FAIL (Stop Screw Compactor).

(3) Wash water solenoid valve fail (alarm only).

11. Safety Features:

a. When a band screen jam condition occurs in the band screen ON or AUTO mode the Control Panel shall stop the band screen motors and activate the band screen fail indicator and relay.

b. If a power failure occurs while band screen is running, operation shall resume when power is restored.

c. If a power failure occurs while the band screen is in a fail condition, the fail indicator shall reactivate when power is restored.

d. Provide motion sensor to monitor rotation of Screw Compactor to provide indication that the screw is properly functioning during operatoion. If the sensor determines the screw is not turning during operation, the motor shall de-engergize and initiate Screw Compactor FAIL alarm. Enclosure shall be explosion proof, and be flange mounted to washer/compactor tank.

e. The Control Panel shall provide overload protection for the motors through an overload relay mounted directly on the motor starters.

f. Control Panel reset shall be from the local panel controls only.

12. Components:

a. Control Devices:

(1) Pilot devices shall be mounted on the enclosure front panel door.

(2) The Control Panel shall have indicator lights for BAND SCREEN RUN and FAIL.

(3) Indicator lights shall be of an integral-transformer type with 6 volt lamps. Lamps and the selector switches shall be heavy duty NEMA type.

(4) Control transformer shall be protected by two primary fuses and one secondary fuse. The 120 volt secondary shall have one leg grounded.

(5) Relay contacts shall be included for BAND SCREEN in LEVEL MODE, BAND SCREEN RUN and FAIL (common) signal outputs. The contacts shall be rated 10 ampere, 240 VAC, resistive load.

b. Motor Starters:

(1) Starters shall be a full-voltage reversing type with 120 volt operating coils.

(2) contactors on the starters shall have both mechanical and electrical interlocks.

(3) Overload relays (OL) shall be adjustable so that the range selected includes the full load amperes (FLA) rating and service factor.

13. Contacts shall be rated 10 ampere, 240 VAC, resistive load. Band screens shall not be allowed to operate if there is LOW WASHWATER FLOW or the Band Screen Influent and Effluent Gates are NOT OPEN. These conditions shall also generate common BAND SCREEN FAIL OUTPUT.

14. All field mounted control equipment shall be wired to intrinsically safe relays in the control panel.

15. External Interfaces:

Communication with the Preliminary Treatment PLC (PLC 02A) shall be using Ethernet TCP/IP protocol over fiber optic cable. Provide the following data exchange for each piece of equipment, as a minimum:

a. BAND SCREEN ON/OFF/LEVEL (HAND/OFF/AUTO)Command

b. BAND SCREEN RUN status & BAND SCREEN in LEVEL (AUTO) MODE Status

c. BAND SCREEN FAIL alarm

d. BAND SCREEN Washwater Valve Cycle Time Setting

e. BAND SCREEN Washwater Valve OPEN Status

f. BAND SCREEN Low Washwater Flow Alarm

g. BAND SCREEN RUN Frequency Setting (0-12 inches)

h. BAND SCREEN Back-up Timer Setting (0-999 minutes)

i. BAND SCREEN Motor OVERLOAD Alarm

j. BAND SCREEN Chamber Differential Level value

k. SCREW COMPACTOR ON Status

l. SCREW COMPACTOR FAIL alarm

m. SCREW COMPACTOR Overrun period (0-5 minutes)Setting

n. SCREW COMPACTOR RUN SCREW COMPACTOR Solenoid Valve OPEN Status

o. SCREW COMPACTOR Solenoid Valve FAIL alarm

p. SCREW COMPACTOR Motor OVERLOAD Alarm

K. Screenings Conveyance Sluice

1. Manufacturer is responsible to furnish all components for the screening conveyance system for conveying screenings to the compactor including but not limited to framing, paneling, sheet metal, anchor bolts, access covers, etc.

2. Provide a screenings conveyance sluice for each screen to collect screenings and wash water from the discharge hopper of each screen and transfer them by gravity directly into the selected washing screw compactor.

3. Screen manufacturer shall confirm that the screenings conveyance sluice supplied are adequately sized to convey screenings removed from influent raw wastewater at the peak rated capacity of the band screens specified herein.

4. The sluice system shall include trough, covers and supports. The sluice shall be constructed of minimum 14 gauge 316 stainless steel. The sluice shall be designed to transport screenings using water from the discharge point of the screens and connect directly to the washer/compactor. The overall length shall be made of

straight sections, no longer than 10 ft., that are connected with common pattern of flanges. Provide neoprene gasket at each connection.

5. The sluice shall be installed with a minimum constant gradient of 1%, sloping towards the discharge end of the trough. The upstream end of the trough shall be blanked off and have a 2 inch NPT Washwater connection at the invert.

6. The sluice shall be covered by a flat, 316 stainless steel covers. Covers shall attach to the sluice using either a spring-clamp or toggle-clamp quick release.

    a. Each cover section shall be approximately 5 feet in length to allow easy access to the trough. The cover length shall be arranged so that each edge rests on and is bolted to a trough stiffener.

    b. Provide two handles on each cover section for lifting.

    c. The cover shall prevent odors from escaping. Neoprene gaskets shall be installed along each trough cover flange and each stiffener to ensure a drip proof connection trough covers shall have turned down edges perpendicular to the trough cover flange.

    d. Hinged covers or hinged access ports shall be provided for maintenance and cleaning purposes. Provide hinged covers or access ports at the drop chute to each compactor and at a minimum every 20 feet. Hinge plates shall be welded to the cover sections and trough cover flanges.

7. Bolts shall be Type 316 stainless steel conforming to ASTM A193, Grade B8M. Nuts shall be Type 316 stainless steel Type 316 stainless steel conforming to ASTM A194, Grade 8M.

8. Provide support legs along the entire length of the sluice.

    a. All support legs and fixings shall be 316 SST.

    b. Coordinate support locations with the drawings.

    c. Provide support beams across screenings channels where required.

d. Field verify support height required prior to ordering and fabrication of the supports. Supports shall be field adjustable, capable of adjusting up and down 1-1/2 inches each way (total 3-inches) from installed height.

9. Submit calculations signed and sealed by a structural engineer registered in the State of Florida showing that the supports provided are adequate for the application. Include drawing showing locations of supports.

a. Structural Design:

(1) Manufacturer is responsible to provide all components in compliance with the structural criteria of Part 2.C.

10. Where panels and elbows are required, these should be supplied as separate sections. All bends shall be long radius to provide a smooth change in direction. Any vertical section of the flume shall be enclosed lengths of tube or pipe with all joints being fully with neoprene gaskets to prevent leakage.

L. Shop Painting

1. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, per System 10 in accordance with Section 09900.

2. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

3. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

M. Shop Testing

1. Provide motor shop testing.

2. Screen Testing:

a. All shop tests will be unwitnessed.

b. Control Panel Tests:

(1) Test all functions and alarms of each control panel. After acceptance and prior to shipping

apply dielectric grease and install corrosion inhibitors as specified.

c. Screen Tests:

(1) Fully factory assemble each mechanically cleaned screen and operate the screens in a vertical or as designed position.

(2) Operate each screen for 30 minutes and record results.

(3) Conduct testing using job motors control panels.

d. Verify functionality of over torque switch.

1. Repeat tests until specified results are obtained.

2. In event that specified tests indicate that equipment will not meet the specifications, the Owner and/or Owner’s Representative has the right to require complete witnessed tests for all equipment at no additional cost.

3. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to Owner.

4. Provide a 30 day minimum notice prior to testing.

PART 3 - EXECUTION

B. Installation

1. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.

2. After alignment is correct, grout using high grade non-shrink grout.

a. Do not imbed leveling nuts in grout.

C. Mechanically Cleaned Screen Schedule

1. Band screens shall remove 100 percent of solids greater than 5.0 mm for the full range of flows from no flow up to the rated capacity.

2. Service:

Band Screen Schedule	
Number of Band Screens	3
Bank Screen Tag Numbers	500-MS-1, 500-MS-2 and 500-MS-3
Number of Operating Band Screens	2
Number of Standby Band Screens	1
Screen Perforation Size, mm	5
Rated Capacity Each Unit, mgd	13.3 mgd-ADF 35.6 mgd-PHF
Screening Band Nominal Speeds	30-15 ft/min
Downstream Water Depth at Peak Rated Capacity, ft	6
Channel Size and Configuration	As indicated in drawings
Screen Panel Width (minimum), ft	60 inches
Velocity through Inlet Opening (maximum), fps	2.5
Velocity through Mesh Panels (maximum), fps	2.1
Velocity through Side Outlets (maximum), fps	2.6
Head Loss at Rated Peak Capacity, ft	<15 inches at 50% blinding <7 inches (clean screen)
Maximum Screen Loading, cf/hr/MGD	5.34
Motor Type	Squirrel cage inclusion
Gear Type	Shaft mounted, helical-bevel
Drive Motor	3 HP, 480 volt, 3 phase, 60 HZ
Washwater Flow Rate, gpm	per MFR
Washwater Pressure, psi	per MFR
Washwater Connection Size, inch	2
Electrical Classification	Explosion proof, Class 1, Div. 2, Group D
Insulation	Class F
Space Heater	Band heater, 120 v, single phase
Odor Control Vent Connection, in	6, ANSI B16.5

D. Washer Compactor Schedule

1. Service:

Washer Screw Compactor Schedule	
Number of Washer Compactors	3 (one per band screen)
Compactor Tag Numbers	500-CM-1, 500-CM-2 and 500-CM-3
Rated Capacity Each Unit, cf/hr	Per Screen MFR(1), minimum 150 cf/hr
Feed Concentration, % dry solids	1-2.5%
Screenings Discharge, % solids	45%
Minimum Drainage Capacity, gpm	Per Screen MFR(1)
Minimum Screw Diameter, in	12
Minimum Shaft Diameter, in	4
Maximum Screen Length, in	59
Discharge Height Above Operating Floor, in	See Drawings
Maximum Screw Rotational Speed, rpm	17 RPM
Drive Motor	3.0 HP (min), 480 volt, 3 phase, 60 HZ
Washwater Flow Rate, gpm	per MFR
Washwater Pressure, psi	per MFR
Washwater Connection Size, inch	per MFR
Electrical Classification	Explosion proof, Class 1, Div. 2, Group D

(1) Band Screen Manufacturer shall determine required compactor capacity and provide washer screw compactors adequately sized to wash and compact screenings removed from influent raw wastewater at the peak rated capacity of the band screens specified herein.

E. Field Testing

1. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, and a completed and signed pretesting check list.

2. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by

the manufacturer's field service technician, conduct a dry running test and a performance test for each unit in presence of the Owner or Owner's Representative to determine its ability to deliver its rated capacity under specified conditions.

a. Dry Testing:

(1) Make all necessary adjustments and settings to the drive mechanism and tripping device at the time of the test to ensure that the mechanical bar screen rakes will stop at the appropriate trip setting and then resume forward travel three times when the blockage is encountered, and will stop the screen at the fourth attempt and generate an alarm.

(2) Perform a dry test on each screen to demonstrate the correct alignment, smooth operation, proper and equal spacing of screen bars, freedom from vibration, excessive noise and overheating of the moving parts and bearings.

(3) Perform a dry test on each screen to demonstrate the ability of the screen to successfully handle large objects of the size and weight occasionally encountered in unscreened raw wastewater from a combined sewer system.

(4) All defects recorded during the above field tests and all defects and failures occurring within the first year of operation shall be corrected at no additional cost to the Owner.

(5) Dry tests on each screen shall be witnessed by Owner or Owner's Representative.

b. Performance Test:

(1) During tests, observe and record flow rates, channel water depths, headloss, and motor inputs.

(2) Test Duration: Not less than ten cycles.

(3) Each screen must demonstrate thirty (30) days of continuous, defect-free operation prior to final acceptance.

(4) Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

c. Repeat tests until specified results are obtained.

3. Make all adjustments necessary to place equipment in specified working order at time of above tests.

F. Field Touch-Up Painting

1. After installation and accepted testing by the Owner or Owner's Representative apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

G. Contract Closeout

1. Provide in accordance with Section 01700.

H. Spare Parts

1. Provide spare parts that are identical to and interchangeable with similar parts installed.

a. Furnish following spare parts for mechanically cleaned screens:

(1) Three (3) screening panels.

(2) Six (6)seal fins

(3) One (1) set main chain seals.

(4) One (1) set spray nozzles.

(5) One (1) complete gasket set.

(6) Three (3) fuses.

(7) Three (3) 6-volt, long life lamps.

b. Furnish following spare parts for washer screw compactor:

(1) One (1) screw brush set

c. One set of all special tools required.

I. Contract Closeout

Provide in accordance with Section 01700.

J. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for all equipment and materials furnished for a period of three (3) years. The warranty period shall begin at the date of substantial completion, for the process per Section 01664.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

3. The Manufacturer shall furnish, deliver, and install new parts to replace the defective parts at the Manufacturer’s expense.

4. Failures include, but are not limited to the following:

   a. Structural failures

   b. Mechanical failures

   c. Bearing failures

   d. Deterioration of metals, metal finishes, and other materials, and seals beyond normal wear.

5. The Manufacturer shall inspect the equipment at the end of each six (6) month period for the first two (2) years following equipment start-up, and each twelve (12) month period for the remaining duration of the warranty period.

6. At the time of each inspection, the manufacturer’s representation shall provide two (2) separate 4-hour training sessions to instruct the Owner’s personnel in the operation and maintenance of each piece of equipment supplied.

K. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above. The Manufacturer shall include manufacturer inspection of the equipment at the end of each twelve (12) month period for the remaining duration of the warranty period.

L. Maintenance Service Contract

Provide to the Owner, at the date of substantial completion of the process and commencement of the Manufacturer’s warranty period, a written three (3) year Manufacturer's Standard Service Contract for the all equipment as provided by the Manufacturer. The Service Contract shall include all preventive maintenance services and inspections as recommended by the Manufacturer to assure the safe and dependable operation of the system. The preventive maintenance inspections shall be in addition to the site visits aforementioned. This service contract does not supersede or replace the manufacturer's three (3) year equipment warranty aforementioned.

M. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer’s specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

SECTION 11336 SECONDARY CLARIFIER EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Contractor shall furnish, install and place into operation one (1) secondary clarifier mechanism in Clarifier No 11. The installations shall be in complete conformity with the drawings and specifications and the instructions and recommendations of the equipment manufacturer, as approved by the Engineer.

B. The equipment furnished for each clarifier mechanism shall include, but not be limited to, the following:

1. Walkway with aluminum grating.

2. Center assembly with drive unit.

3. Overload protection system.

4. Center column with inlet openings.

5. Flocculating feedwell with inner dispersion inlet well (EDI)

6. Center cage.

7. Sludge collection arms with spiral rake blades.

8. Scum skimmers and scum boxes.

9. Weirs and baffles.

10. Local control panel

11. Brush Cleaning System

12. All fasteners and anchor bolts.

C. General Design: Performance conditions and design data are as follows:

1. Average daily flow (ADF) per clarifier: 5 mgd

2. Influent suspended solids concentration: 3,500 mg/l

3. Return activated sludge (RAS) per clarifier:

a)	Minimum:	1,750 gpm
b)	Maximum:	3,375 gpm
c)	Density of sludge, %:	0.5% to 1.0%

4. Circular concrete tank measurements:

a)	Diameter:	125 ft. (inside)
b)	Side water depth (SWD):	14 ft.
c)	Bottom slope:	¾ inch in 12 inches
d)	Freeboard:	2 ft.

5. Mechanism type:

a)	Drive:	column supported
b)	Collector:	Spiral blade
c)	Nominal Tip Speed	14 fpm
d)	Continuous Design Torque	42,000 ft-lbs (min.)
e)	Momentary Peak Torque	2x Continuous
f)	Motor horsepower (min.):	3/4

D. The clarifier units shall include mechanisms and scum removal systems designed for extra-heavy duty service. Each mechanism shall be complete in all respects and ready for installation in the basin by the Contractor. Included with the equipment shall be all material and piping within the basins.

E. The Contractor shall be responsible for coordinating all activities between the concrete tank construction and the clarifier equipment manufacturer required for a complete installation. Activities requiring extensive coordination include but not be limited to shop drawing submittals, embedded items required to be installed during

construction of the concrete tank and, fabrication and installation of the clarifier equipment. Construction of the tank or fabrication of the clarifier equipment shall not commence until all key dimensions, equipment and pipe locations, and any other interdependent items are approved by the Engineer and any conflicts or ambiguities are resolved. It shall remain the Contractor's sole responsibility to resolve any errors or conflicts arising during construction due to improper coordination between the tank construction and the clarifier equipment manufacturer and installer.

F. Clarifier manufacturer shall be responsible for modifications to the existing clarifier walkways for Clarifiers 1, 2, 3 and 4. Manufacturer shall submit drawings and calculations, and a letter certifying that the modifications will not impact the existing warranty of the walkways or clarifier mechanisms. Manufacturer shall inspect the modifications and provide certifications in accordance with Part 3 (Execution).

1.02 QUALITY ASSURANCE

A. Qualifications

1. All of the equipment specified herein shall be furnished by a single manufacturer who regularly engages in the production of this type of equipment and who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. Each component and ancillary equipment item furnished shall be new and unused, of the type, size, design, and efficiency installed in previous projects. The manufacturer shall be required to modify their equipment, if necessary, to fully comply with the specifications.

2. The Equipment supplier is required to demonstrate successful experience in the design and manufacturing of secondary clarifier equipment. The equipment shall be manufactured and tested within the United States of America. As of the date in which Bids are submitted, the manufacturer shall have a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the

respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be units with a center drive and spiral type clarifier mechanism and for clarifiers with a minimum diameter of 125-ft. in domestic wastewater service.

B. Standards:

1. All fabricated structural steel shall conform to the requirements of "Standard Specification for Steel for Bridges and Buildings", ASTM Designation A36. All shop welding shall conform to the latest standards of the American Welding Society. All galvanized steel shall conform to the requirements of ASTM A123, ASTM A143, ASTM A384 and ASTM A385. All structural steel shall conform to the requirements of AISC "Specifications for Design, Fabrication and Erection of Structural Steel for Buildings".

2. Except where specifically indicated otherwise, all plates and structural members designated for submerged service shall have a minimum thickness of one-fourth inch. Stainless steel Type 316 anchor bolts, with necessary hex nuts and washers, shall be provided for all parts of the clarifier mechanism to be secured to the tank.

3. Fabricated assemblies shall be galvanized and shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection. The units shall be erected and lubricated in strict accordance with the instructions of the manufacturer's field engineer.

4. The complete machine shall be of sufficient strength to sweep the tank bottom under its own power. Grouting shall be done in strict accordance with the manufacturer's instructions.

5. Welding:

a) The equipment manufacturer's shop welding procedures, welders and welding operators shall be qualified and certified in accordance with

the requirements of AWS D1.1 "WELDING IN BUILDING CONSTRUCTION" of the American Welding Society.

b) Clearly show complete information regarding location, type, size, and length of all field welds in accordance with "STANDARD WELDING SYMBOLS" AWS A2.0 of the American Welding Society, and fully explain special conditions by notes or details on the equipment manufacturer's shop drawings.

c) The General Contractor's welding procedures, welders and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "WELDING IN BUILDING CONSTRUCTION" of the American Welding Society.

d) Perform all field welding in conformance with the information shown on the equipment manufacturer's drawings regarding location, type, size and length of all welds in accordance with "STANDARD WELDING SYMBOLS" AWS A2.0 of the American Welding Society, and special conditions as shown by notes and details.

e) All shop welds on galvanized steel items shall be seal welds. Stitch welding or partial welding will not be allowed.

C. The equipment shall comply with these referenced standards:

1. Anti-Friction Bearing Manufacturer's Association (AFBMA)

2. American Gear Manufacturer's Association (AGMA)

3. American National Standards Institute (ANSI)

4. American Society for Testing and Materials (ASTM)

5. National Electrical Manufacturers Association (NEMA)

6. American Welding Society (AWS)

7. American Institute of Steel Construction (AISC)

D. Equipment Manufacturer: Equipment shall be designed, fabricated and installed in accordance with the manufacturer's recommendations and shall be manufactured by: Ovivo USA (formerly EIMCO Water Technologies), Siemens (formerly Envirex), WesTech Engineering or Walker Process.

1.03 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

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, referenced to a detailed written explanation of the reasons for requesting the deviation. Non-compliance or exceptions to the specifications shall be grounds to disqualify a manufacturer and exclude them from supplying equipment for the Project. If a manufacturer is disqualified, the Contractor shall be required to submit equipment from another named manufacturer that complies with the specifications. 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.

2. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section,

marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the respective project of the installation. At least ten (10) of the projects shall have been completed within the past ten (10) years. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall be units with a center drive and spiral type clarifier mechanism and for clarifiers with a minimum diameter of 125-ft. in domestic wastewater service.

    a) Current Owner Reference Contact Information

    b) Installation Service Conditions

    c) Equipment Model Numbers

    d) Date of Final Completion of the Project

4. Certified shop drawings showing all important details and materials of construction, dimensions, and anchor bolt locations.

5. Descriptive literature, bulletins, and/or catalog data for the equipment.

6. Total weight of all equipment and the single largest item or component..

7. A list of manufacturer's recommended spare parts to be supplied, with the manufacturer's current price for each item. Include gaskets, packing and other parts.

8. Submit motor data per Section 16150.

9. The recommended grades of lubricants along with at least two (2) alternative references.

10. Piping details of connections to Contractor supplied piping.

11. Shop painting specification(s) for ferrous surfaces.

12. Letters from both the Clarifier and the Algae Sweeping Cleaning System manufacturers stating that they have reviewed the design, construction features and shop drawings and that the Clarifier and Algae Sweeping Cleaning System will operate as intended. The Clarifier manufacturer shall certify that the clarifier design, including torque calculations have accounted for the installation of the cleaning system.

B. Operating Instructions:

1. Copies of an operating and maintenance manual shall be furnished in accordance with Section 01300. The manual shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, descriptions, and information necessary to instruct operating and maintenance personnel unfamiliar with such equipment.

2. A factory representative with complete knowledge of proper operation and maintenance shall be provided for at least three (3) days to certify proper installation, test the equipment and to instruct representatives of the Owner on proper operation and maintenance (One day shall be dedicated to training.). The latter work may be conducted in conjunction with the inspection of the installation and test run as provided under PART 3. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

C. Certifications: The Contractor shall furnish the Engineer with a written certification signed by the manufacturer's representative that the equipment has been properly installed and lubricated, is in accurate alignment, is free from undue stress imposed by mounting bolts, and has been operated under full load conditions and that

satisfactory operation has been obtained. Refer to Section 01650 for more details.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All fabricated steel assemblies shall be shipped in convenient sections permitted by carrier regulations, properly match-marked and identified for ease of field erection.

B. All equipment shall be handled during delivery, storage and installation in a manner to prevent damage of any nature in accordance with the manufacturer's approved instructions.

C. All electrical controls and equipment shall be stored in a clean, dry, weather tight building.

1.05 WARRANTY AND GUARANTEES

A. The equipment shall be warranted against defects in material, design and workmanship for three (3) years from date of substantial completion of the respective unit process in which the equipment is installed.

B. An additional two (2) year warranty period, extending the warranty period for a total of five (5) years, shall be provided for consideration by the Owner. Refer to Division 1 for additional information and requirements.

C. If any part of the equipment should fail during warranty period, it shall be replaced at no expense to the Owner.

C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish one(1) center column supported spiral type circular clarifier mechanisms to be comprised as a complete unit including above water center drive, overload protection system, access bridge, controlled energy inlet diffusion feedwell, drive cage, sludge collector arms,

flights, center inlet, support column, skimmer assemblies and all necessary anchorage and mounting parts. Support the vertical thrust loads and torques from the top of the center columns without underwater bearings. Oil lubricate all gearing.

2.02 MATERIALS AND EQUIPMENT

A. Center Assembly Option 1: The center assembly shall consist of the drive unit with main bearing, suitable lubrication fittings, support points for the drive platform and attachment points for the rotating center cage.

1. The drive unit shall consist of a main spur gear, pinion, worm gear and worm.

a) The worm gear assembly shall be driven by a minimum 3/4-horsepower totally enclosed gear motor with a 1.15 service factor through roller chain and sprockets enclosed in a fabricated steel guard. The motor shall be suitable for 230/460 V, 60 Hz, 3-phase service. Planetary arrangements will not be allowed.

b) The main gear shall be designed for a Momentary Peak Torque of 2 times the specified continuous design torque (output torque at which the drive indicator will register 100% load).

2. The drive shall be rated to operate continuous for 24 hours a day for twenty (20) years at the specified output speed. The design basis for the rating is defined under Gear Design and Rating Criteria herein.

3. The main gear and worm assembly shall be enclosed in a housing and provided with adequate seals to protect the interior of the housing.

a) The housings shall be designed so that all gears and bearings are oil bath lubricated.

b) For spur gear teeth which are not fully submerged in oil, the tooth mesh shall be designed to force lubricant to the upper portion of the tooth face.

c) The housings shall be provided with oil level sight gauges, oil fill and drain connections and condensate drain connections from the low points of the oil reservoir.

d) The main gear housing shall be bolted to the top of the stationary influent column and shall be capable of transmitting the Mechanism Design Strength. There shall be no parts below the liquid level or in contact with the liquid in the clarifier.

e) The main gear with minimum pitch diameter of 40 inches shall be supported by and rotated on the main bearing. The rotating center cage to which the rake arms are attached shall be bolted to the main gear.

f) The main gear and worm assembly shall be enclosed in an ASTM A48 cast iron housing and provided with adequate seals to protect the interior of the housing. Fabricated housing of steel is not considered equal.

g) The secondary reducer unit shall be constructed using an ASTM A48 cast iron housing. The worm shall be minimum of AISI 4142 heat treated steel, ground and polished, driving a centrifugally cast Herculoy bronze worm gear. The worm and worm gear shall be designed based upon AGMA 6034-A87 for the torque specified. Planetary gear units are not considered equal in design.

h) The pinion shall be constructed of steel heat treated and precision cut to provide adequate tooth mesh for the values used in the calculations. The pinion must rotate in a lower taper roller bearing assembly and similar upper bearing encasement machined into the worm gear housing. The lower bearing pocket shall not be the collection point for condensation. Pinion shafts shall be one piece extending through the worm gear without immediate couplings.

i) All gear housings shall be constructed using proper wall thickness to resist full peak load

without any deflections. All oil dams shall be full sidewall constructed integral with the base. Before assembly, the base shall be thoroughly inspected for seep holes or inclusions and given a full hydrostatic test to insure no leaks in the oil containment area. These shop inspections shall be available to the Engineer upon request.

4. The main bearing shall be a radial thrust type ball bearing with renewable strip liner races.

   a) The strip liner design shall be such that the B_{10} life of the liner is a minimum of 20 years based on the specified mechanism speed and a uniformly distributed load due to the rotating mechanism.

   b) The bearing life shall be based on the life to initial pitting of the liner element and have a minimum diameter of 45 inches.

5. The complete drive shall be assembled in the manufacturer's shop and tested to assure the drive is running properly and to calibrate the drive control. Completed test report shall be sent to the Engineer verifying the drive meets the quality assurance of the manufacturer and Engineer.

6. The main gear shall be one or two piece construction. For two piece construction, the gear shall be shouldered, bolted and doweled for concentricity, and sized for 200 percent of the load imposed. All calculations for split gear shall use 85 percent of the allowable stress listed in AGMA 2001.D04.

7. Gear Design and Rating Criteria: Gearing shall be designed and rated using the criteria established by the following
   a) American Gear Manufacturers Association (AGMA) Standards:

   b) Surface Durability (Pitting) of Spur Gear Teeth: AGMA 2001.D04.

   c) Rating the Strength of Spur Gear Teeth: AGMA 2001.D04.

8. The output torque rating of the drive shall be based on the smaller of the two values determined from the above AGMA Standards.

9. Manufacturers shall submit calculations to the Engineer for approval substantiating the output torque rating of the drive selected. Calculations will include all spur gears and pinions in the drive train.

   a) The calculations shall clearly specify the values used for the following design parameters for Surface Durability and Strength ratings:

      1) Number of pinions

      2) Actual face width

      3) Tooth geometry factor (I and J factors)

      4) Load distribution factor

      5) Allowable contact stress

      6) Allowable bending stress

      7) Pinion pitch diameter

      8) Tooth diametric pitch

      9) Hardness ratio factor

      10) Elastic coefficient

      11) Life factor

   b) A load distribution factor of 1.3 minimum shall be used. The net face width for surface durability calculations shall not exceed 90 percent of the actual face width of the narrower of the two mating gears.

   c) For parameters which are material dependent, such as allowable contact stress, the calculations shall include a full description of the materials and heat treatment used and the tooth construction method.

10. Overload Device: The drive unit shall be equipped with an electrical-mechanical overload control device. The device shall be activated by thrust from the worm shaft.

    a) A calibrated spring will react to the worm thrust and allow axial movement of the worm shaft to activate a pointer. The pointer shall provide a visual reading of the relative main gear output torque on a 0 to 100 percent graduated scale.

    b) The device shall also activate an alarm switch and a motor cut-out switch. The alarm and motor cut-out switches in the control device shall be factory calibrated and set to the required torque as follows:

        1) Alarm torque set at 100 percent of the continuous design torque.

        2) Motor cut-out set at 120 percent of continuous design torque.

B. Center Assembly Option 2.

1. Design Parameters

    a) The drive unit shall be designed and manufactured by the clarifier equipment supplier to ensure unit responsibility. The drive unit shall be designed for the continuous torque values previously listed. It shall turn the mechanism at the design collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L-10 life of 100 years or 867,000 hours. The drive unit shall be capable of producing and withstanding the a momentary peak torque of two times the continuous torque value. The drive main gear shall be designed to a minimum AGMA 5 rating when rated in accordance with the latest AGMA standard. Gear teeth shall be designed for proper load distribution and sharing. Stub tooth design and surface hardening of the main gear shall not be allowed. The 47.25″ precision main

bearing shall be capable of withstanding the listed overturning moment without the aid of any underwater guides or bearings to ensure correct tooth contact for AGMA rating of the main gear.

b) All spur gearing shall be designed to the latest AGMA spur gear standard for strength and surface durability, based on a life of 175,000 hours. The design running torque rating of the drive gearing shall be based on the smaller of the strength and durability values determined from the above AGMA standard. To ensure safety and ease of maintenance, all components of the drive shall be direct coupled and enclosed within the gear housing.

2. Physical Characteristics:

a) The drive unit shall consist of the following items: Electric motor, speed reducer, overload protection, pinion gear, lower pinion bearing, internal 42″ main spur gear, cross contact precision main bearing fabricated steel support base and cage adapter. The drive shall be mounted on the center column and support the entire rotating load of the mechanism.

b) Support base for the drive shall be of cast iron to assure rigidity. The center cage shall be fastened to and supported from the cage adapter. The support base shall be designed to eliminate any condensate from coming in contact with the lower pinion bearing. The gear housing shall be designed so that the main bearing and gear teeth are 100% submerged in oil. It shall have an annular cavity for oil and condensate storage. Any condensate that collects shall flow 180 degrees away from the lower pinion bearing. The oil bath shall be enclosed and protected by a neoprene dust shield. A two inch diameter “Bulls Eye” type oil sight glass, oil fill pipe, and drain line shall be provided for the reservoir. Lubrication fittings shall be readily accessible.

c) The pinion shall be heat treated alloy steel. A lower pinion bearing shall be provided to support the separating loads caused from the gear-to-pinion mesh. No overhung pinions shall be allowed on the speed reducing unit. The lower pinion bearing shall not be located below the turntable base.

3. Overload Protection: A minimum of two adjustable set points (for alarm and motor cutout) shall be actuated from the reaction torque due to a heavy sludge loading in the tank. The two set points shall be set at the following percentages of design running torque: a) Alarm shall be set at 100 percent; b) Motor cutout shall be set at 120 percent. These two set points shall be factory calibrated and set. A torque indicator shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 160 percent of design running torque.

4. Turntable

a) The support base shall have a maximum allowable deflection in accordance with the bearing manufacturer’s specifications under load. The allowable tensile yield strength shall be a minimum of 45,000 psi.

b) The main internal gear shall be integral with the main bearing and be forged of alloy hardened steel. The drive bearing shall include fully contoured raceways hardened to a minimum 58-60 RC and protected by a neoprene seal. Ball bearings shall be of high carbon chrome alloy 52100 steel running in fully contoured races, as part of a precision gear/bearing set.

5. Speed Reducing Unit

a) The speed reducing unit shall consist of cycloidal, helical, or planetary speed reducers directly connected to a motor without the use of chains or v-belts, and shall be keyed to the pinion. All speed reducers shall be fully enclosed and running in oil or grease.

b) The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing

on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low speed shaft. Speed reducer efficiency shall be a minimum of 90% per reduction stage.

c) Speed reducer helical or planetary gearing shall be manufactured to AGMA standards and shall provide at least 95% power transmission efficiency per stage. The speed reducer shall have a minimum service factor of 1.25 based on the output torque rating of the drive.

d) The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and be grease or oil lubricated. As a safety feature, the speed reducer shall be back drivable to release any stored energy as the result of an over torque condition.

6. Motor: The motor shall be a minimum 3/4-horsepower totally enclosed gear motor. The motor shall be suitable for 230/460 V, 60 Hz, 3-phase service.

C. Control Panel: The entire control device shall be mounted in a NEMA 4X type 316 stainless steel enclosure with an integral conduit box and terminals. A repeat dry alarm contact and motor cut-out contact shall be provided for alarm and cut-out signals to the PLC and motor control center, respectively, as indicated on the Drawings. Contacts shall be rated for 120 V service. A top mounted, amber strobe alarm light and horn shall also be provided for indication of a high torque condition.

D. Walkway and Drive Platform: The 42-inch wide walkway shall be supported by the drive platform and the tank wall. The walkway shall be designed to safely support the dead load plus a live load of 50 pounds per square foot with a maximum deflection of 1/360, over the entire span. It shall consist of a galvanized steel truss design with diagonal and cross-bracing and minimum 11/4-inch by 1/4-inch I-bar aluminum grating for the walking surface. Truss sides serve as handrails on both sides of walkway. A 30-

inch wide aluminum safety gate and chain (inward opening) and 24-inch access ladder shall be provided on each side of the walkway at the launder.

1. A center drive platform shall be provided.

   a) It shall be a minimum of 10 feet 0 inches square and shall provide adequate clearance around the center assembly and drive control for maintenance and service of the drive assembly (minimum of 3 foot clear). .Platform to be supplied with a light mounting support for the contractor supplied light as shown on the drawings

   b) It shall consist of minimum ¼-inch aluminum checker plate attached to a structural steel frame with necessary stiffeners and supports, resting on the center assembly and provided with connections to the walkway.

2. Handrails 42 inches high of 1½-inch diameter Schedule 40 double row horizontal aluminum pipe shall surround the operating platform. Toe boards shall be provided on the drive platform to keep tools from falling into the tank (4 inches x 3/16-inch minimum). All handrails shall have an anodized finish.

E. Center Cage and Rake Arms: The center cage shall be of galvanized steel box truss construction a minimum of 5-foot" square. It shall be provided with connections for two sludge removal arms and feedwell supports. The cage top shall be bolted to the main gear which shall rotate the cage with the attached arms and feedwell. The minimum angle size used for construction of the cage and rake arms shall be 2 inch x 2 inch x 1/4 inch members.

1. The clarifier mechanism shall include two (2) sludge removal arms of steel truss construction, a minimum of 5 ft square with steel spiral rake blades and adjustable 20 gauge 304 stainless steel squeegees. The rake blades shall provide complete raking of the basin floor twice per revolution.

2. The rake blades shall consist of a minimum 3/16 inch thick steel plate. The blades shall be constructed to a logarithmic spiral curve with a constant 30 degree

angle of attack. Blade depth shall vary from 8 inches deep at the outer portion of the rake blade, to 24 inches near the tank center. Each rake truss support arm shall be provided with the necessary outrigger bracing and other blade support structures, to ensure that the complete blade can be properly located and adjusted in the field.

3. The rake blades shall terminate in the center to within 1 inch of the rotating sludge collection drum. The 1 inch space shall be sealed with a neoprene seal. The blades shall come within 6 inches of the stationary sludge ring if it is used.

4. The entire center drive cage and rake arm assembly shall have sufficient strength and rigidity that no member will be stressed beyond the allowable limits set forth in the latest AISC Specifications when the full-stalled torque load of the drive assembly is applied. The cage and rake arms shall be designed such that calculated stresses do not exceed the AISC allowable stress at twice the drive 100% rating. The structural calculations for the rake arm shall include an analysis of the torsional loads from the spiral curve blade.

F. Center Column: A 48-inch diameter by ¼-inch minimum thickness, galvanized steel stationary center column shall be provided which shall serve as the influent pipe and to support the main spur gear. One end shall have a galvanized steel support flange 1¼-inch minimum thickness for bolting to the foundation, with a minimum of eight 1¼-inch diameter stainless steel anchor bolts, and a similar flange at the top of the column for supporting the center assembly. Suitable influent openings shall be provided in the upper portion of the column to allow unrestricted passage of the flow into the feedwell.

G. Energy Dissipation inlet (EDI)

1. A rotating circular energy dissipating inlet with bottom shall be supported by the cage and be designed to diffuse the liquid into the flocculation well without excessive disturbance or formation of vertical velocity currents. The EDI shall be designed to positively prevent sludge from depositing within the EDI and shall include bottom drain holes.

2. Complete process calculations shall be included with the submittal substantiating the sizing of the EDI and outlets, and outer feedwell. The diameter, depth, and detention time of the EDI shall be included with the design calculations. The submittal shall include data from a minimum of two (2) successfully operating installations that verify the experience of the manufacturer.

3. The rotating EDI shall be designed with a full bottom extending to within 1" of the center column. It shall include an upper rim angle for stiffness. Multiple gate assemblies shall be provided to gently mix and diffuse influent flow between the EDI and flocculation well and specifically preclude any vertical currents. The outlet assemblies shall include baffled openings with dual fully adjustable gates designed to cause incoming flow to impinge upon itself. The gates shall extend past the outlet openings at least the same distance as the opening width. The outlet assemblies shall have a fixed bottom to prevent vertical currents as the flow exits the -EDI.

4. The EDI shall be made of not less than 3/16" thick steel plate with necessary stiffening angles. All gate adjustment hardware, including hinges, pins, and chains, shall be type 304 stainless steel.

H. Feedwell: The flocculating feedwell shall be located outside of the EDI to diffuse the liquid into the tank without disturbance or formation of velocity currents. The feedwell shall be 35'-0" diameter x 5'-1" side depth x 3/16-inch galvanized steel plate and supported by galvanized steel brackets attached to the center cage. The well shall be fabricated of steel plate, with top reinforcing rim angle and necessary angle stiffeners as supporting brackets. A minimum of eight (8) scum ports 4 inches in height by 16 inches long shall be provided equally spaced around the feedwell periphery to allow scum to exit from the feedwell at water level.

I. Surface Skimming Equipment:

1. Surface scum skimming equipment shall be furnished with the clarifier mechanism. It shall be arranged to have the surface scum swept along an angled skimmer blade to the skimmer assembly, attached at the end of the blade, for discharge to the scum box as shown on the plans. The surface of the clarifier shall be swept twice per revolution.

2. The skimmer blade shall be tangential to the rotating feedwell and be supported by vertical supports from the rake arm. The skimmer assembly shall be a pivoting aluminum skimmer device equipped with manual out-of-service lock out. The skimmer shall have replaceable neoprene rubber wipers on all three sides to form a pocket to trap the scum and discharge the scum into the scum box. Skimming blades shall be designed to support the extra weight and loadings of the launder cleaning brush system

3. The scum box shall be 5’ wide and fabricated from 1/4 inch steel plate, supported from the tank wall, and connected to a six (6) inch scum line, as shown on the drawings.

4. The clarifier equipment manufacturer shall furnish a flush valve assembly for automatic flushing of the scum box and scum pipe. The flush valve assembly shall be adjustable to allow 0 to 20 gallons of clarified effluent to enter the scum box as the skimmer assembly passes over the scum box. The assembly shall consist of a stainless steel lever, UHMW seal plate and neoprene diaphragm mounted to the scum box. The diaphragm shall be opened and closed by an easily adjustable, submerged actuation arm mounted to the rotating skimmer blade. The flush volume adjustment mechanism shall be above the water level and shall include at least three settings.

J. Feedwell Spray System: The equipment manufacturer shall supply a feedwell spray system to help direct scum to the scum ports in the feedwell and into the sedimentation zone. Each spray system shall include one (1) globe valve and a 1-inch diameter galvanized header pipe with a minimum of six (6) ¼-inch NPT swivel spray nozzles with 9/64-inch orifices to minimize clogging. The spray system

supply piping shall be supplied to a point even with the feedwell wall at the access walkway. The globe valve shall be accessible for manual operation from the walkway or center platform.

K. Weirs and Baffles (scum and water level):

1. All weir and baffle plates shall be fiberglass reinforced polyester plastic molded by the matched-die method to produce uniform, smooth surfaces. All surfaces shall be smooth, resin rich, free of voids and porosity; without dry spots, crazes or unreinforced areas; and shall provide for increased corrosion resistance and weathering. Weir and baffle plate to be as shown on the Contract Drawings and as specified herein. Weirs and baffles shall be manufactured by NEFCO, or equal.

2. Fiberglass Plates: Plates to be dimensioned and secured to the launder as shown on the Contract Drawings. All machined or cut edges shall be resin sealed with seal mix. All plates shall be installed as per manufacturer's instructions.

3. Supports: Special supports, such as L-type upper brackets, shall be used to ensure proper operation of the weir cleaning system

4. The weir and scum baffle design and installation shall be coordinated with the requirements with the clarifier mechanism, scum box and launder effluent channel configurations and weir cleaning system.

5. Fiberglass Properties: Minimum physical properties shall be as follows:

Property	Value	Test Method
Tensile Strength	14,000 psi	ASTM D638
Flexural Strength	25,000 psi	ASTM D790
Flexural Modulus	1.2×10^6 psi	ASTM D790
Notched Izod	13.5 ft-lb per inch	ASTM D256
Barcol Hardness	45	ASTM D2583
Water Absorption	0.2% (24 hours)	ASTM D570

L. Density Current Baffles:

1. Density Current Baffle shall be designed to improve the performance of the clarifier: A) by promoting the blanket formation, and; B) intercepting the density currents formed within the clarifier and redirecting them back into the main clarification volume of the tank. Baffles shall be as manufactured by NEFCO or equal.

2. The baffle shall consist of a series of panels that are attached to the wall of the clarifier to form a 30 degree inclined, shelf-like surface around the entire inner periphery of the tank. Each panel shall be molded of corrosion-resistant, UV-treated fiberglass. The panel shall be a maximum of 8 feet in length and shall be curved to follow the curvature of the clarifier tank. The width, inclination angle and mounting location of the baffle shall be determined based upon the clarifier configuration in order to provide optimum baffle performance. The panels shall be designed such that adjacent panels fit together without overlapping or cutting, and the completed baffle when installed, has a well-engineered and professional appearance.

3. Provision shall be made to attach the panels to the clarifier wall and support them at the proper angle using a triangular panel bracket. The panel and bracket shall be molded as an integral part of each panel, forming a baffle module. Panels may be cut as required to fit around obstructions.

4. Each baffle panel shall be molded of fiberglass-reinforced plastic. The resins and fiberglass reinforcing material shall be consistent with the environmental conditions and structural requirements.

5. The resin shall be an isophthalic polyester resin with corrosion-resistant properties, Corezyn COR75-AQ-010 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% by weight may be added to the resin. The resin shall be treated to provide UV suppression.

6. Glass reinforcement shall consist of chemically bonded surfacing mat and chopped strand roving. Surfacing mat shall be Type C veil. 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% by weight. The nominal thickness of each baffle panel shall be 1/4" ±1/16 inch thick with resin rich surfaces and edges to prevent migration of moisture and fiber "blooming." The baffle shall be black in color.

7. The upper surface of each panel shall be mold smooth and no glass fibers shall be exposed. Laminations shall be dense and free of voids, dry spots, cracks or crazes. The upper surface of the baffle shall be reinforced with one layer of surfacing veil followed by 2 ounces or more of chopped strand roving. In addition, the vertical mounting flange (return flange on launder mount applications) shall be reinforced with one layer of 24 oz woven roving. No other glass product is permitted between these layers. All factory-trimmed edges shall be "hot coated" with resin to prevent wicking.

8. Fiberglass Properties: Minimum physical properties shall be as follows:

Property	Value	Test Method
Tensile Strength	10,000 psi	ASTM D638
Flexural Strength	16,000 psi	ASTM D790
Flexural Modulus	1.0×10^6 psi	ASTM D790
Notched Izod	12 ft-lb per inch	ASTM D256
Barcol Hardness	40	ASTM D2583
Water Absorption	0.2% (24 hours)	ASTM D570

9. All weirs, baffles and density current baffles shall be supplied by the same manufacturer.

M. Algae Sweeping Cleaning System:

1. Provide and install an apparatus for cleaning algae and debris from the baffle, weir, spillway and effluent flow launder of the clarifier. The system shall consist of an attachment sleeve mounted to the clarifier equipment as directed by clarifier manufacturer, a mainframe member, several telescopic brush arms, numerous brushes of various sizes, and an assortment of springs in different configurations to provide the biasing forces. A series of brushes shall be mounted to the frame member

and biased into engagement with the baffle, weir, spillway and walls of the effluent flow channel. The equipment shall include a bridging device positioned over the effluent discharge to support the launder brush assembly. All metallic parts of the automated brush system shall be constructed of Type 316 stainless steel or greater.

2. Contractor shall be responsible for coordinating brush system installation and operation requirements with clarifier equipment manufacturer. The Automated Brush System shall be custom designed, constructed, for the removal of algae and debris on a circular clarifier. Two factory service technician shall be provided on site for a minimum of three working days to observe and advise the installation and provide operator training of Automated Brush System. Brush system shall be as manufacture red by Weir-Wolf by Ford Hall, or equal.

2.03 PAINTING AND SURFACE PREPARATION

A. All fabricated steel surfaces shall be hot-dip galvanized after fabrication in accordance with ASTM A123, A143, A384 and A385. Prior to hot dip galvanizing, all welds shall be ground to remove all weld spatter and slag. All sharp edges and corners shall be rounded to a smooth contour by grinding.

B. Surface preparation: After fabrication, all surfaces of the clarifier mechanisms and accessories except galvanized, non-ferrous, undamaged shop primed coated, or previously finish coated surfaces shall be prepared for shop coating as follows:

1. Remove all weld spatter and slag. All sharp edges and corners shall be rounded to a smooth contour by grinding.

2. All ferrous surfaces shall be near white metal abrasive blast cleaned to SSPC-SP10 to remove all visible oil, grease, dirt, dust, mill scale, rust, oxides, corrosion products and other foreign matter. Blast profile shall be 1 to 3 mils.

C. Shop Primer: All abrasive blasted surfaces, except except galvanized, non-ferrous plate, edges or areas to be field welded shall be coated with a primer which is compatible

with the finish coats to be field applied in accordance with Section 09900.

2.04 SPECIAL TOOLS AND CRITICAL SPARE PARTS

A. The following spare parts shall be furnished:

- None

B. All special tools and critical spare parts shall be properly packed and protected for long storage and placed in containers clearly identified with indelible markings as to contents.

2.05 BOLTS, NUTS, WASHERS AND ANCHORS

A. Anchor Bolts:

1. Location: It shall be the responsibility of the equipment manufacturer to determine the number, size and location of all anchor bolts to be set in concrete.

2. Material: Anchor bolts, nuts and washers shall be Type 316 stainless steel. All anchor bolts shall be furnished by the equipment manufacturer. Nuts shall have a hardness that is lower than that of bolts, anchor bolts, and washers by a minimum difference of 50 Brinell Hardness to prevent galling.

B. Fasteners:

1. Bolts: For the equipment assembly shall be of the best quality refined bar iron. Hexagonal nuts of the same quality of metal as the bolts shall be used.

2. Threads: Shall be clean cut and shall conform to ANSI B1.1-1960 for Unified Screw Threads.

3. Material: Bolts, nuts and washers shall be galvanized by the hot-dip process in conformity with the ASTM Standard Specifications for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip, Designation A123 or shall be zinc-coated, after being threaded, the Standard Specifications for Zinc Coating (Hot Dip) on Iron and Steel Hardware, Designation A153-67, as is appropriate.

PART 3 - EXECUTION

3.01 GENERAL

A. The equipment manufacturer shall furnish the services of a competent and experienced representative who has complete knowledge of proper operation and maintenance of the equipment for a period of not less than three (3) days in a minimum of two separate visits to inspect the installed equipment, supervise the initial test run and torque test, and to provide instructions to the plant personnel. At least one (1) of the three (3) days shall be allocated solely to the instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten (10) days in advance with the Owner and shall take place prior to plant start-up and acceptance by the Owner. The final copies of operation and maintenance manuals specified in Section 01730 must have been delivered to the Engineer prior to scheduling the instruction period with the Owner.

3.02 INSTALLATION

A. Secondary clarifier equipment shall be installed in accordance with the manufacturer's recommendations and erection drawings by mechanics skilled in the installation of this type of equipment. Erection drawings shall be submitted and approved prior to shipment of equipment. The work shall be inspected by the manufacturer's representative prior to operation of the equipment.

B. All necessary bolts, nuts, washers, and other hardware items for the anchoring and erection of the units shall be included. The manufacturer shall ship anchor bolts, bolting template drawings, and accurate bolt setting pattern to the Contractor in advance of shipping fabricated items and other equipment. The Contractor shall not proceed with construction of the clarifier foundations and floor slabs until all anchor bolting materials, templates and patterns are received.

C. Floor shall be grouted in accordance with the manufacturers recommended procedure and thickness to provide a smooth continuous bottom surface for operation of the blade.

3.03 TORQUE TEST

A. A torque test shall be conducted on each mechanism. The testing shall be carried out under the supervision and approval of the Engineer and Owner before the mechanisms are approved and placed into operation. The purpose of the test shall be to verify the structural integrity of the mechanism and drive. Manufacturer shall provide a service representative to provide supervision during all tests.

B. 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 torque load shall be applied to the scraper arms by means of a ratchet lever and cylinder connected to the cable assembly. The magnitude of the applied load shall be measured by a calibrated load cylinder from the distance of the line of action of each cable to the centerline of the mechanism. Readings shall be taken at 40, 85 , 100 and 120 percent of design torque value. The test load shall be applied such that the torque overload device can be used to indicate and signal the alarm and motor cut-out torque values of the drives. Loads shall not be applied by turning on the drive motor.

C. All equipment required for the test shall be provided by the manufacturer. After successful completion of the test, the equipment shall be returned to the equipment manufacturer.

3.04 INSPECTION AND TESTING

A. Upon completion of installation, the Contractor, in the presence of the Owner and a qualified manufacturer's representative, shall perform a preliminary test on the system to ensure the functioning of all component parts to the satisfaction of the Owner. The Contractor shall furnish all labor, equipment, water and power required to perform each test.

B. Approval of the preliminary test by the Owner shall not constitute final acceptance of the equipment furnished.

C. Certification: Provide a written certification from the equipment manufacturer that the clarifier equipment has been properly installed according to the Contract Drawings, Specifications and manufacturer's specifications, and that the equipment is operating

properly. Make all necessary corrections and adjustments including, but not limited to, labor, parts or freight at no additional cost to Owner.

D. Field Testing: Contractor shall operate each clarifier mechanism for a minimum of five (5) consecutive days with the basins filled with water and check for binding, sticking or overloading of the motors and gear boxes. The Contractor shall furnish all labor, water, materials and equipment required for such tests. Contractor shall correct all operational problems and verify that the clarifier mechanism has operated normally for a consecutive five (5) day period on a continuous basis. Test motor in accordance with requirements in Division 16.

E. See Section 01664 (System Start-up and Testing) for additional requirements.

END OF SECTION

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SECTION 11338 MECHANICAL MIXING EQUIPMENT

PART 1 - GENERAL

A. Description

Provide and test mechanical mixing equipment and appurtenances for the fermentation, first anoxic, second anoxic zones, and chlorine contact tank as indicated and in compliance with Contract Documents.

B. References

1. American Society for Testing and Materials International (ASTM):

   a. A36: Standard Specification for Carbon Structural Steel.

   b. A48: Specification for Gray Iron Castings.

   c. A276: Standard Specifications for Stainless Steel Bars and Shapes.

2. American Gearing Manufacturers Association (AGMA).

   a. 390.03: Gear Handbook Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Worm gearing and Racks Only as Unassembled Gears or DIN-ISO equivalent.

3. National Electrical Manufacturers Association (NEMA):

   a. MG1: Motors and Generators.

C. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following;

2. 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, 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.

3. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

4. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of three (3) years of continuous successful operating experience, from the time bids are opened, in the lower 48 states in the U.S. with a minimum of five (5) installations of the size of mixer in the service conditions as specified in Part 2.B. At a minimum the reference information shall include the following;

    (1) Current Owner Reference Contact Information

    (2) Installation Service Conditions

    (3) Size and Type of Mixer

    (4) Date of Final Completion of the Project

5. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size and arrangement as indicated and specified.

6. Submit coating information.

7. Identify each mixer by tag number to which the catalog data and detail sheets pertain.

8. Certified shop and installation drawings showing all details of construction, dimensions and anchor bolt requirements. The locations for mixer mounting and design loads shall be provided by the mixer manufacturer.

9. Shaft size and material.

10. Mixer body size, type and material.

11. The weight of each component: motor, gearbox, shafting and impeller.

12. The total weight of the complete assembled mixer.

13. Complete motor data including size, make, type and characteristics of the electric motor along with wiring diagrams.

14. Design calculations demonstrating that the equipment process design requirements are met.

15. The manufacturer shall perform a Computational Fluid Dynamics (CFD) simulation to demonstrate complete mixing in each of the service conditions specified in Part 2.B. CFD simulations are to be corroborated by either Particle Image Velocimetry (PIV), Laser Doppler Velocimetry (LDV), or Ultrasonic Doppler Particle Velocimetry (UDPV) data for each mixer/impeller type supplied. An average velocity magnitude of 0.5 feet per second shall be demonstrated within the CFD simulation. Show basin dimensions and provide volume calculations associated with each mixer. Failure to submit this information for prior review will disqualify a supplier from being considered a responsible, responsive, acceptable supplier.

16. Certified setting plans, with tolerances, for anchor bolts. During preparation of shop drawings, the Contractor shall submit written certification to the Owner that all existing conditions have been inspected and verify that all dimensions of columns, penetrations, obstructions, etc. are accurately represented within the submittal and incorporated into the equipment and baseplate selection.

17. Operating and maintenance instructions and parts list.

18. Listing of reference installations as specified with contact names and telephone numbers.

19. Bearing temperature operating range for the service conditions specified.

20. Recommended vibration limits.

21. Spare parts list.

22. Recommendations for short and long term storage.

23. Recommended baffle design, if baffles are required.

24. Motor shop test results.

25. Field inspection/testing reports.

26. Certified mixer shop test results.

27. Shop and field testing procedures and equipment to be used including the details of all equipment and testing set-up

D. Spare Parts

1. Comply with the requirements specified in Section 01600.

2. Provide the following spare parts:

   a. Two (2) motors for each size of mixer.

   b. Two (2) motor gear boxes for each size of mixer.

   c. If applicable, two (2) spare sets of rubber buffers for each size of mixer.

   d. If applicable, two (2) sets of all special tools (shaft clamping device) required for normal operation and maintenance shall be provided.

E. Quality Assurance

1. Coordination: All equipment included in this Section shall be furnished by or through a single mixer equipment manufacturer who shall be responsible for the design, coordination, testing and the satisfactory performance of all the components.

2. The Contractor shall obtain the mixer, motors, gear reducer, from a single mixer manufacturer as a complete and integrated package to insure proper coordination, compatibility and operation of the equipment.

3. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified.

   a. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve the Contractor of the obligation to provide sufficient services to place equipment in operation as specified.

   b. Preliminary Matters phase of System Start-Up and Testing as specified per Section 01664: At a minimum the Preliminary Matters phase shall include inspection of the anchor bolts, setting, leveling, alignment, field erection, coordination of instrumentation and electrical connections. The manufacturer's services shall be performed over a duration not less than the following

      i. 1 person-days per respective BNR Substantial Completion as specified in Sections 01040 and 01664.

   c. System Start-Up Testing phase of System Start-Up and Testing as specified per Section 01664: Calibrate, check, align and perform functional testing with running reclaimed water through the process to simulate the process operation. Field tests to include all items specified in Part 3.C. The manufacturer's services shall be performed over a duration not less than the following:

      i. 2 person-days per respective BNR Substantial Completion as specified in Sections 01040 and 01664.

      ii. The manufacturer shall provide the certification letter as specified in Part 3.G in preparation for the System Testing phase.

   d. System Testing phase of System Start-Up and Testing as specified per Section 01664: Perform Suspended Solids Concentration testing with the equipment operating in service with mixed liquor

in the process, as specified in Part 3.C. The manufacturer's services shall be performed over a duration not less than the following:

i. 1 person-days per respective BNR Substantial Completion as specified in Sections 01040 and 01664.

e. Operator Training: Provide classroom and field operation and maintenance instructions, including all slides, videos, handouts and preparation to lead and teach classroom sessions:

i. 1 person-days per respective BNR Substantial Completion as specified in Sections 01040 and 01664.

f. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

g. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

4. The mixer manufacturer is required to prove satisfactory experience in the design and manufacturing of the mixer and impeller type supplied. Prior to submitting shop drawings, submit data, records, contact names and numbers for all appropriate references.

a. Manufacturer of mechanical mixing equipment must have a minimum of three (3) years of continuous successful operating experience, from the time bids are opened, in the lower 48 states in the U.S. with a minimum of five (5) installations of the size of mixer in the service conditions specified in Part 2.B.

PART 2 – MATERIALS

Orange County Utilities performed a Mechanical Mixing Equipment Evaluation in order to evaluate mixers with rag-less impellers. Orange County Utilities determined that only those approved manufacturers with their respective rag-less impellers, as listed

below, are the only manufacturers and impellers which are acceptable. No other manufacturers, or alternative impeller types, from those specified herein, will be accepted.

A. Manufacturers

1. Manufacturers and Impellers:

   a. Chemineer with 316 SS RL-3 Ragless Impeller

   b. Invent Environmental Technologies, Inc. with FRP Hyperclassic Impeller

   c. Lightnin with 316 SS "Clean-Edge" Impeller

   d. Philadelphia Mixing Solutions, Ltd. with 316 SS ARI-2 Hydrofoil Impeller

B. Service Conditions

1. Fermentation, first anoxic, and second anoxic mixers shall be capable of handling biological activated sludge with a solids concentration of from 0.1 to 0.5 percent solids, with a Sludge Volume Index (SVI) of 80 ml/g or greater and shall be designed to prevent settlement in the tanks and to re-suspend biological material on the tank bottom. The mixer will be capable of mixing the mixed liquor without introduction of air.

2. Mixers shall be suitable for outdoors environmental temperature range of 20°F to 110°F, relative humidity of up to 100%, and fluid temperature range of 50 degrees F to 90 degrees F.

3. Reference the Contract Drawings for basin dimensions to determine the basin volume for each mixer.

4. Mixer performance conditions and design data shall be as shown below.

a. Phase I/II Fermentation (Process 210):

Number of Mixers Per Zone	1
Number of Zones	2
Equipment Tag Numbers:	211-M-1, 212-M-2
Maximum Motor Horsepower:	15 HP
Maximum Motor Speed:	1800 rpm
Maximum Impeller Speed:	37 rpm
Mixer Impeller Diameter:	As determined by the mixer manufacturer
Manufacturers and Impeller Models:	Chemineer: 316 SS RL-3 Ragless Impeller Invent: FRP Hyperclassic Impeller Lightnin: 316 SS Clean-Edge Impeller Philadelphia: 316 SS ARI-2 Hydrofoil Impeller

b. Phase I/II 1st Anoxic (Process 215):

Number of Mixers Per Zone	1
Number of Zones	4
Equipment Tag Numbers:	216-M-1, 217-M-1, 218-M-1, 219-M-1
Maximum Motor Horsepower:	15 HP
Maximum Motor Speed:	1800 rpm
Maximum Impeller Speed:	37 rpm
Mixer Impeller Diameter:	As determined by the mixer manufacturer

Manufacturers and Impeller Models:	Chemineer: 316 SS RL-3 Ragless Impeller Invent: FRP Hyperclassic Impeller Lightnin: 316 SS Clean-Edge Impeller Philadelphia: 316 SS ARI-2 Hydrofoil Impeller

c. Phase I/II 2nd Anoxic (Process 230):

Number of Mixers Per Zone	1
Number of Zones	2
Equipment Tag Numbers:	231-M-1, 232-M-1
Maximum Motor Horsepower:	15 HP
Maximum Motor Speed:	1800 rpm
Maximum Impeller Speed:	37 rpm
Mixer Impeller Diameter:	As determined by the mixer manufacturer
Manufacturers and Impeller Models:	Chemineer: 316 SS RL-3 Ragless Impeller Invent: FRP Hyperclassic Impeller Lightnin: 316 SS Clean-Edge Impeller Philadelphia: 316 SS ARI-2 Hydrofoil Impeller

d. Phase III Fermentation (Process 310):

Number of Mixers Per Zone	1
Number of Zones	4
Equipment Tag Numbers:	311-M-1, 312-M-1, 313-M-1, 314-M-1
Maximum Motor Horsepower:	15 HP
Maximum Motor Speed:	1800 rpm
Maximum Impeller Speed:	30 rpm

Mixer Impeller Diameter:	As determined by the mixer manufacturer
Manufacturers and Impeller Models:	Chemineer: 316 SS RL-3 Ragless Impeller Invent: FRP Hyperclassic Impeller Lightnin: 316 SS Clean-Edge Impeller Philadelphia: 316 SS ARI-2 Hydrofoil Impeller

e. Phase III 1st Anoxic (Process 315):

Number of Mixers Per Zone	1
Number of Zones	4
Equipment Tag Numbers:	316-M-1, 317-M-1, 318-M-1, 319-M-1
Maximum Motor Horsepower:	15 HP
Maximum Motor Speed:	1800 rpm
Maximum Impeller Speed:	37 rpm
Mixer Impeller Diameter:	As determined by the mixer manufacturer
Manufacturers and Impeller Models:	Chemineer: 316 SS RL-3 Ragless Impeller Invent: FRP Hyperclassic Impeller Lightnin: 316 SS Clean-Edge Impeller Philadelphia: 316 SS ARI-2 Hydrofoil Impeller

f. Phase III 2nd Anoxic (Process 330):

Number of Mixers Per Zone	2
Number of Zones	2
Equipment Tag Numbers:	335-M-1, 335-M-2, 336-M-1, 336-M-2
Maximum Motor Horsepower:	15 HP

Maximum Motor Speed:	1800 rpm
Maximum Impeller Speed:	30 rpm
Mixer Impeller Diameter:	As determined by the mixer manufacturer
Manufacturers and Impeller Models:	Chemineer: 316 SS RL-3 Ragless Impeller Invent: FRP Hyperclassic Impeller Lightnin: 316 SS Clean-Edge Impeller Philadelphia: 316 SS ARI-2 Hydrofoil Impeller

g. Chlorine Contact Tank (Process 580):

Number of Mixers	1
Equipment Tag Numbers	580-M-1
Fluid 1	Filtered Effluent
Flow rate, gpm	23,333
Specific gravity	1.0
Viscosity, 20°C	0.92
Fluid 2	Sodium Hypochlorite (12.5%)
Flow rate, gpm	2.83
Specific gravity	1.2
Viscosity, 20°C	2.0
Max. Suspended Solids, mg/L	5
Basin length, ft	14
Basin width, ft	12
Basin depth, ft	14.25
Basin volume, gal	18,000
Velocity Gradient “G” in basin:	250 / second
Minimum Motor Horsepower	7.5 HP
Maximum Motor Speed:	1800 rpm
Maximum Impeller Speed:	50 rpm

C. Materials

1. Design for long, continuous, and uninterrupted service; easy adjustment or replacement of parts; minimum 1/4-inch (6 mm) thickness, steel members; minimum 1/2-inch diameter, structural bolts.

2. Structural steel in accordance with ASTM A36.

3. Iron castings in accordance with ASTM A48.

4. Provide Type 316 stainless steel for fasteners and wetted parts of mixers. Stainless steel-clad or type 304 stainless steel shafts are not acceptable.

D. Hyperclassic Hyperboloid Mixer Materials

1. Hyperclassic Hyperboloid Mixer Shaft:

The drive shaft of the mixer shall be made from high quality fiberglass reinforced plastic and resistant to most chemicals and wastewater. The top end of the shaft shall be a steel tappet for the connection to the gear hollow shaft. At the lower end there shall be a flange. The connection to the mixer body itself shall consist of a flanged screwed.

2. Hyperclassic Hyperboloid Mixer Body:

The Hyperboloid Mixer Body shall be a streamlined stress-free body without any mounted or fitted parts. The transport ribs which accelerate the flow shall be integrated in the mixer body and be made of top quality, fiberglass reinforced plastic. The mixer body shall be coated with a gel coat and polished surface.

E. Vertical Turbine Blade Mixers

1. Gear Reduction Units:

a. 2.0 minimum AGMA service factor or oversize output shaft gearbox design.

b. Service factor based on motor nameplate horsepower.

c. Design housing to withstand mixing unit full-load operation.

d. Antifriction bearing: 100,000 hour L-10 life based on continuous operation at rated full load motor horsepower and speed.

e. The gearmotors for hyperboloid mixers shall be SEW Eurodrive. Gearmotor shall be built as a parallel helical gear shaft.

f. Helical or spiral bevel type gears or combination of both.

i. AGMA 390.03 gear quality, minimum 10 quality.

ii. Inspect and certify gears before assembly.

iii. Provide an oil lubrication system for gear surfaces and bearings.

g. Provide visual means of observing oil levels.

h. Provide oil dam around output shaft or grease fittings or prelubricated fittings or lip seal when not employing an oil dam.

i. Thermal Rating: Continuous operation within temperature range with no artificial cooling at specified service conditions.

j. Minimum Efficiency: 96 percent

k. Shop assembled drive motor and gear reducer assembly on common mounting base suitable for mounting entire assembly on support structure provided on top of mixing tank.

l. Provide all gearing contained within a single housing, lubricated by a common oil bath.

2. Impeller Shafts:

a. Impeller shaft will be designed for constant submergence (with sufficient liquid coverage) within the operating level range reflected in the Hydraulic Profile Drawings.

b. Design to withstand mixing tank drawoff operating loads. Minimum operating water level not to exceed manufacturer’s recommendations.

c. Provide rigid rabbeted flanged coupling connection.

d. Lower impeller shaft flanged with coupling. Flanged coupling welded to shaft.

e. Liquid immersed impeller shaft supported bearings are not acceptable.

f. Shaft support bearings located below top cover of mixing tank are not acceptable.

3. Drive Motors:

a. The motor shall be a three phase squirrel cage motor with helical gear having the following specifications:

i. Motor shall comply with specification Section 16150.

ii. Motors shall be premium efficiency.

iii. Squirrel cage induction for operation on 480 Volt, 3 Phase, 60 Hz. current. Synchronous speed shall not exceed 1800 rpm. The motor shall be of the totally enclosed, fan-cooled type suitable for outdoor operation having NEMA Class F insulation and Class B temperature rise at full load, a service factor of 1.15, rated for 40°C ambient temperature.

iv. Motors shall be equipped with three normally open winding temperature detectors for thermal protection of the motor.

v. Motors shall be approved for Class 1, Division 2 Group D hazardous areas.

vi. Motors shall be UL listed FM approved or UR listed CU-CSA approved.

b. Horsepower rating of motors: Not less than maximum brake horsepower requirements of mixers under any condition of operation specified and indicated without operating in the motor service factor.

c. In addition to the requirements for bearings specified under Electric Motors in Section 16150, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

d. Overall sound-pressure level of each motor shall not exceed 80 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall sound-pressure level as average of four or more readings at evenly spaced points, 3 feet (1 meter) from motor.

e. Operate without overheating at the speeds specified and indicated.

f. Service Factor: 1.15, with 1.0 inverter duty rating for mixers equipped with variable frequency motor controllers.

g. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

h. Rating: 460V, 3-phase, 60 Hertz.

i. Insulation: Class F with Class B temperature rise, 40 degree C ambient.

j. Site Altitude: Less than 3,300 feet above sea level.

k. Provide Inpro/Seal bearing isolators.

l. Outdoor Service: Weatherproof enclosures. 120-volt, 60 Hertz, single-phase electric space heaters.

4. Flexible Couplings:

a. Connect motor and gear reducer.

b. Design to withstand continuous full load motor horsepower including torques to 250 percent of full load running torque. Minimum 1.50 service factor.

c. All metal flexible type.

5. Guards:

   a. Supply rotating shafts, above platform level, with guards conforming to OSHA requirements.

6. Impellers:

   a. For wastewater and sludge applications provide an impeller designed specifically to prevent "ragging".

   b. Turbine type mixing impellers designed to achieve specified results. Maximum flow, minimum turbulence, constant pitch of blade, blade length to provide uniform flow velocities.

   c. Removable impellers with hub and hook-key arrangement.

   d. Impeller adjustment: 18 inches (450 mm) with 3-inch (75 mm) increments from nominal off-bottom placement.

   e. Maximum impeller assembly to fit minimum tank access.

F. Shop Tests

1. Motor Tests:

   a. Standard commercial test.

G. Shop Painting

1. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09900 System No. 10.

2. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer's printed instructions and as specified.

3. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

PART 3 - EXECUTION

A. Examination

1. Install items in accordance with manufacturer's printed instructions.

2. Contractor to coordinate with mixer manufacturer to provide any additional mounting hardware to facilitate mixer installation in existing conditions. Prior to submittal of shop drawings, the Contractor shall coordinate dimensions of all existing columns and equipment penetrations in the location of the proposed installation with the mixer manufacturer. Contractor shall provide adapter plates or enlarge the existing equipment penetrations as required to install the mixers at no additional cost to the Owner.

B. Field Touch-Up Painting

After installation and testing, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

C. Field Testing

1. During the Preliminary Matters phase of System Start-Up and Testing, as specified pert Section 01664, each mixer shall be checked by the manufacturer for location/installation of anchor bolts, setting, leveling, alignment, field erection, electrical and instrumentation connections, lubrication and rotation. The manufacturer’s representative shall notify the Contractor and Owner in writing of anything in the installation which is unacceptable to the manufacturer or require any corrective measure by the Contractor.

2. During the System Start-Up phase of System Start-Up and Testing, as specified pert Section 01664, the mixer shall be operated with reclaimed water flowing through the process to simulate process operation. The test run of the mixers shall determine acceptable running noise, speed and rotational direction. During the test runs of the mixers, the mixers shall be free of vibration and wobbling while operating at the design speed. All control interlocks shall be tested. The manufacturer’s representative shall notify the Contractor and Owner in writing of anything in the installation which is unacceptable to the manufacturer or require any

corrective measure by the Contractor. Upon successful completion of the System Start-Up Phase, the manufacturer shall provide the certification letter as specified in Part 3.G in preparation for the System Testing phase.

3. In the event of improper installation, correction of the work and subsequent test runs will be provided until the defects are corrected at no additional cost to the Owner. Manufacturer will provide written certification to the Owner and Contractor that the improper installation has been corrected in conformance with the manufacturers specified criteria.

4. After the System Start-Up phase is successfully completed and accepted by the Owner for the Process 580 Chlorine Contact Tank, the System Testing phase shall include a dye test to demonstrate uniform mixing. The dye shall be injected in the same locations and flow rate as specified for the Sodium Hypochlorite as designated within the Service Conditions specified in Part 2.B.

5. After System Start-Up for the respective unit process is completed and accepted by the Owner, for the fermentation, first anoxic, and second anoxic mixers, the System Testing phase shall include a Suspended Solids Concentration Test performed by the General Contractor utilizing an independent testing laboratory licensed in the State of Florida. The General Contractor shall furnish all labor, materials, laboratory testing, and equipment required for such test. The suspended solids test shall be conducted as follows:

    a. The mixer manufacturer shall guarantee the performance of each mixer and shall prove the quality of the mixer by performing a suspended solids concentration test demonstrating that each mixer achieves uniform mixing of the suspended solids within each zone.

    b. Suspended solids concentration test shall be conducted at mixed liquor suspended solids concentrations in a range of 2,750 mg/L–3,250 mg/L. The Sludge Volume Index (SVI) shall be in a range of 80 ml/g-120 ml/g. The Owner shall designate when the tests shall be performed based upon adequate representative BNR performance.

c. For one (1) zone within each of the representative zones listed in the service conditions of this specification, demonstrate that a uniform concentration of the mixed liquor suspended solids is achieved at the end of a 30 minute test period with the mixer running and no incoming flow. The Owner shall designate which respective zone shall be tested. Uniform mixing shall be defined as plus or minus ten (10) percent of the arithmetic average of suspended solids concentration for ninety (90) percent of the samples taken.

d. Within each testing location, a total of ten (10) samples shall be taken at locations as selected by the Engineer. Sample locations shall be equally spaced horizontally and vertically within each zone. The maximum depth at which any sample shall be taken shall be a minimum of 6-inches above the basin floor or above the diffusers installed. In addition, samples shall be collected a minimum of 12-inches from any wall. Samples shall be tested at an independent laboratory licensed in the State of Florida.

e. Should any portion of the system fail to meet the requirements specified, then the Contractor and manufacturer shall make any and all necessary modifications such that the system does meet the requirement of this Specification, at no additional cost to the Owner.

6. Remove and replace equipment at Contractor's expense if unable to demonstrate to the satisfaction of the Owner and Engineer that the mixer assemblies perform the services required and that they will operate free from vibration and overheating, the mixers may be rejected.

D. Contract Closeout

Provide in accordance with Section 01700.

E. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion

of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

F. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

G. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. The equipment is to be lubricated, in correct alignment, free from undue stress imposed by mounting bolts, and to be operated under full load conditions. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

SECTION 11345 PACKAGED CHEMICAL FEED SYSTEM

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of a packaged, skid-mounted chemical feed system for supplemental carbon. Components include:

1. Metering pumps to pump the chemical from the bulk storage tank to the point of application.

2. Interconnecting piping within the skid assembly.

3. Isolation valves within the piping.

4. Water piping for connecting to external sources for flushing.

5. Electrical power and control wiring and conduit between the above components.

6. A control panel for local control of the feed system and for sending and receiving alarms and control signals to or from an external plant wide control system.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit structural drawings showing the design of the fabricated skid. Show support systems for pumps and panels. Show materials of construction by ASTM reference and grade. Show sizes of members. Show welding, bolting, or other assembly arrangements.

3. Submit installation and arrangement drawings showing dimensions and locations of equipment on the fabricated skid. Show locations of pumps, variable speed drives, piping, electrical conduits and equipment, pipe and valve supports, and control panels.

4. Submit electrical wiring drawings showing wiring and conduit, controls, interlocks, terminals, and power disconnects. Show number and sizes of power and control wiring. Label each terminal showing which control or electrical power wire connects to each terminal.

5. Submit P&I Diagram – The PID shall indicate the following:

    a. All process piping, valves, pumps and accessories installed within the skid boundary including pipe sizes, materials and piping inlet and outlet information.

    b. All skid mounted electrical/instrumentation switches, controls, indicators etc. including voltage and current ratings for any devices that require a power source.

    c. All controls, indicators, inputs, outputs and surge protection devices included in the local skid mounted NEMA 4X terminal junction box.

    d. All controls, indicators, inputs, outputs and surge protection devices included for any remote mounted control or interface panels being provided.

6. Submit shop drawings for the individual pieces of equipment per those equipment specifications.

7. Submit data as a single complete package for pumps and motors, piping, structural skid or base design, valves and actuators, motor control center components, control panels, instrument components, power and instrumentation conduits and wiring, and other items.

8. Submit peristaltic hose metering pump operating capacity and discharge pressure limits (both minimum and maximum flow and pressure limits). Submit materials of construction for all metering pump components. Provide chemical compatibility charts for materials of wetted components to substantiate material selection for the associated chemical.

9. Submit calculations supporting the selection of the pulsation dampener sizes for each application.

10. Submit chemical compatibility charts for materials of wetted components including piping, fittings, valve bodies, gaskets, rings and seals to substantiate material selection for the associated chemical.

11. As part of the shop drawing submittal package for the chemical feed system, submit proposed format for reporting the results of the factory testing. Describe how control system will be tested and the results

tabulated. As a minimum, the report format shall present the results of testing for each input signal and each output and alarm signal (including correcting defective input and output and alarm signals). Describe procedure for performing the pressure testing of the skid piping and how results (including correcting defective piping components) will be tabulated or reported. Include the format for reporting the results of factory testing for individual system components and pieces of equipment, as described in the specifications for those components or pieces of equipment.

12. Submit report on results of factory testing. Do not ship system until the Engineer has reviewed the report.

13. Submit operations and maintenance manuals in accordance with Section 01300.

C. Manufacturer and System Responsibility

1. The Contractor shall assign the design and fabrication of the chemical feed system to a single system manufacturer. Assemble the complete system on a single fabricated skid or base. Assemble and factory test as a complete system, including pumps, piping, valves, controls, and motor starters. The packaged chemical feed system manufacturer shall coordinate the skid components such as pump-to-motor couplings and motor power rating such that the system is completely integrated with compatible components.

2. The packaged chemical system manufacturer shall determine and verify quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, and the packaged chemical system manufacturer shall review and coordinate each submittal with the requirements of the contract documents.

D. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and

maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. See the individual equipment specification sections for additional labor days for manufacturer's services for the pieces of equipment.

4. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Manufacturers

Blue Planet Environmental Systems, Inc., EnPro Technologies, Ltd., or acceptable equivalent equal.

B. Fabricated Skid or Base-General Requirements

1. Design skid or base to fit within the designated area shown on the drawings for each application.

2. Provide a common drip or drain pan having a minimum depth of 2 inches under all the pumps and tanks to collect leakage. Construct pan of 1/2-inch-thick thermally welded Type 1 PVC, 3/8-inch-thick (minimum) HDPE or 3/8-inch thick (minimum) FRP. Resin shall be Ashland Derakane 411 or 470, Reichhold Dion 9800, or Ashland Hetron 922. The pan shall extend under the pumps and tanks so that any leakage is contained within the skid or base. Slope the pan at least 1:20 toward a single end or corner of the skid, where a flanged drain opening at least 2 inches shall be provided to effect drainage. Pipe joints and pipe flange faces, including pump suction and discharge connections, shall be within the drain pan or drain collection area. Control panels may overhang the pan but shall be within the skid area.

3. Provide the skid or base with four lifting lugs, one at each corner, designed to lift the weight of the complete skid or base with all equipment attached to it. Alternatively the skid shall include forklift cutouts for lifting, straps may be fed through cutouts for lifting by crane or overhead lifting equipment.

4. Provide a design such that each pump is individually bolted to a baseplate. A single common baseplate, or individual pump baseplates, may be provided, but each

pump shall be individually bolted so that it is removable.

5. Each pump shall be removable by disconnecting only the piping connected to its inlet and outlet connections. It shall not be necessary to disconnect or remove any adjacent piping or electrical conduit or wiring in order to remove or replace any pump.

C. Thermoplastic Skid or Base

1. Fabricate skid and base using thermally welded PVC or high-density polyethylene plastic. Use plates or sheets to construct the skid or base. Minimum plate, sheet, or member thickness shall be 1/2-inch. Provide reinforcing gussets, as needed, beneath the deck to provide increased stiffness. Plates shall be heat welded to form permanent continuous bond. Design and construct skid such that the thermoplastic structural members and sheet material are supported so that the skid does not bend or sag. Thermoplastic welding shall conform to the applicable ASTM standards for the material used. Welds shall have a smooth and uniform finish.

2. Fasteners shall be stainless steel and shall comply with ASTM A193, Grade B8M or ASTM F593, Type 316. Nuts shall be ASTM A194, Grade 8M or ASTM F594, Type 316. Use ASTM A194 nuts with ASTM A193 bolts; use ASTM F594 nuts with ASTM F593 bolts. Provide washer for each nut and bolt head. Washers shall be of the same material as the nuts.

D. Packaged Chemical Feed System Components

1. For each chemical metering pump the piping system shall include (1) pulsation dampener; (1) pressure relief valve; (1) diaphragm protected pressure gauge; (1) back-pressure/anti-siphon valve; (1) flushing inlet; (1) flushing outlet; (1) in-line strainer and all required piping, valves and supports. In-line strainers shall be installed such that all media entering the pump (e.g. bulk supply, calibration column, flushing inlet, etc.) must pass through the strainer prior to entering the pump. Piping shall include isolation valves and unions for all serviceable components. The chemical supply piping shall feature a calibration column designed for independent use with any of the metering pumps such that any pump on the skid can be calibrated while other pumps remain inactive service. The discharge piping shall provide outlets as indicated on the process flow diagram

in the drawings. A reasonable amount of free pipe space on the suction and discharge piping sub-assemblies shall be provided to allow for future pump/piping modifications.

E. Peristaltic Hose Pumps (Tag Numbers 520-P-1, 520-P-2, 520-P-3 and 520-P-4)

1. The chemical metering pumps shall be motor-driven, peristaltic hose type. The pump shall include integral motor and oil-lubricated gear reducer mounted in aluminum housing.

2. The pump shall be fully tested to meet rated flow and pressure by the manufacturer.

3. The liquid end shall be physically separated from the drive unit by back plate with weep hole creating an air gap.

4. The pump shall include metallic rollers supported by sealed bearing on both ends. Pumps utilizing shoes, non-metallic rollers, or rollers not supported by sealed bearings shall not be acceptable.

5. The pump hose shall be heavy duty fabric reinforced EPDM, pumps utilizing tubing shall not be acceptable.

6. Pump end connections shall be 316SS, pumps utilizing non-metallic end connectors shall not be acceptable.

7. The metering pump shall include a sensor for hose rupture detection. Signal from detector shall be wired to the VFD by the skid manufacturer. Upon receiving a signal from the hose rupture sensor the VFD will shut down the pump and signal a fault to the plant PLC.

F. Piping on the Skid

1. Rigid piping on the skid shall be schedule 80 PVC.

   a. Pipe is supplied packaged in a manner to protect it from damage during shipment. Packaging style will vary based on quantity and shipment method

   b. All fittings shall be injected molded. Fittings shall have same wall thickness and pressure ratings as the pipe.

c. All fittings are to be packaged in a single polyethylene bag or boxed depending on size. All fittings are shipped in boxes.

d. Pipe and fittings shall be 150 psi rated at 68 °F. Consult manufacturer for pressure de-ratings at higher temperatures. Installers shall be pre-qualified through training on welding technique according to ASTM D-2657. Joining Equipment shall be either butt-fusion or socket fusion method.

2. Workmanship shall be in accordance with good commercial practice. Fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The fittings shall be commercially uniform in color, opacity, density and other physical properties.

3. Assembly shall be performed in a controlled shop environment by the skid manufacturer. All pipe shall be squarely cut on precision equipment with the ends chamfered and deburred. All socket welded connections shall follow the guidelines set by the pipe/fitting manufacturer for proper cleaning, priming and gluing procedures. A heavy bodied solvent suitable for use with all chemicals as listed under service conditions. Service Conditions shall be used. All threaded connections will utilize Teflon tape, a suitable thread sealant or a combination of both.

G. Isolation Valves Within the Skid or Base

1. Isolation valves shall be Type 310 Double Union PVC Ball Valves.

2. Provide an isolation valve on the suction and discharge piping of each pump.

H. Quick Connect Couplings for Flush and Drain Hose Connections

1. Drain/Flush Quick Connect Couplings

a. Provide 1-inch diameter quick connect couplings on the pump skid suction and discharge piping for flushing and draining the pump skid piping. Provide pipe reducers or transition bushings to transition pipe diameter to 1-inch diameter at the quick connect couplings if pump suction or discharge pipe is a size other than 1-inch diameter.

b. The quick connect couplings on skids with thermoplastic pipe shall be polypropylene. Quick connect coupling on the skid shall be Type 8A male end coupling. Provide a locking female end cap for each male coupling on the skid. Thermoplastic couplings shall be Evertite Part A, or equal.

c. Coordinate quick connect couplings with the following paragraph.

2. Chemical Resistant Hose and Quick Connect Couplings on Hose Ends

a. Provide two (2) 50-foot lengths of 1-inch diameter PVC hose for the chemical feed building. PVC hose shall be clear PVC inner tube with synthetic yard reinforcing and a white or grey PVC cover. Hose shall be Ryan Herco High Purity PVC Water Hose or equal.

b. Provide a Type 6A female end quick connect coupling on one end of each hose (as described above) for connection to the flush and drain quick-connect couplings on the skids as described above. The female coupling shall be the match of the male end couplings on the skids specified above. Provide polypropylene female end couplings Evertite Part C, or equal.

c. Provide a 3/4-inch diameter female end hose bibb connector on the other end of one of the hoses in each chemical room for connection to a standard 3/4-inch hose bibb. On the other hose, leave one end open for draining chemical from the skids.

I. Pulsation Dampeners

1. Provide discharge pulsation dampeners on metering pumps suitably size for displacement of each pump to limit discharge pressure to plus/minus 10 percent. Provide pulsation dampeners of type which has a diaphragm separating air chamber from liquid chamber. Provide diaphragm of molded construction and that prevents air charge from being dissolved in process fluid. Provide lower chamber of Type 316 stainless steel lined, or of inert plastic material to prevent corrosion by process fluid. Provide materials suitable for intended service. Charge air chamber with compressed air to pump manufacturer's recommended charging pressure. Equip

upper chamber with tire valve type of charging valve and air pressure gage with shutoff valve.

J. Pressure Relief Valves

1. Provide one external pressure safety relief valve located in the discharge piping for each chemical metering pump.

2. Sizing shall allow maximum capacity requirements per service to pass through at a set pressure of 140 psig.

3. Inlet and Outlet connections shall be a minimum of 1/2-inch NPT.

4. Pressure relief valves will use a diaphragm design and be externally adjustable by means of a screwdriver. Valve body shall be constructed of PVC. Diaphragm shall be constructed of Viton, PTFE, or encapsulated by PTFE as compatible with the service.

5. Pressure relief valves shall be manufactured by Model PRT or PRV as manufactured by Griffco Valve, or equal.

K. Pressure Sustaining (Backpressure) Valves

1. Provide one pressure sustaining (backpressure) valve for each hydraulic diaphragm chemical metering pump.

2. Sizing shall allow maximum capacity requirements per service to pass through at a set pressure of 35 psig above maximum suction pressure.

3. Inlet and Outlet connections shall be a minimum of 1/2-inch NPT.

4. Design shall use a Teflon diaphragm to isolate an externally adjustable spring. Adjustment range shall be from 20 to 50 psig minimum. Designs utilizing springs within the fluid pumped are not acceptable. Valves shall be designed for at least 150 psig working pressure.

5. The packaged chemical feed system skid manufacturer will select the backpressure valve based on the chemical discharge pulsating flow rate and pressure range associated with the metering pumps. Backpressure valve shall be externally adjustable by means of a screwdriver. Valve body shall be constructed of PVC.

6. Pressure sustaining valves shall be model BPT or BPV as manufactured by Griffco Valve or equal.

L. Calibration Tube

1. A clear calibration column shall be provided in the chemical supply piping of each system. The piping shall be designed for the calibration column to be used with any of the metering pumps. The calibration column shall be self-filling so that the discharge manifold will allow for filling of the calibration column in the event of non-flooded suction conditions. The top of the calibration column shall allow for connection to rigid piping for “vent”. Calibration columns may also be used as de-gassing chambers. All materials shall be compatible with chemicals as listed under section Service Conditions.

2. Provide a clear Pyrex or clear PVC calibration tube having engraved graduations and a minimum volume as follows:

Chemical	Minimum Volume	Engraved Graduations (Units)
Supplemental Carbon	1000 mL	10 mL

2. Calibration tube shall be located in the piping between the metering pumps and the day tank. Provide isolation valve between the tube and the piping. Calibration tube shall be Griffco, Primary Fluid Systems, Inc. or equal.

M. Pressure Gauges with Diaphragm Seals

1. Pressure gauges shall be stainless steel case, tube and stem, 2-1/2 inch face with white background and black lettering.

2. Gauges shall be glycerin filled.

3. Provide a diaphragm seal with each gauge. Diaphragm seals shall have PVC bodies with PTFE or encapsulated PTFE diaphragms. Diaphragm seals shall be glycerin filled. Diaphragm seals shall be Plastico, Plast-O-Matic, Blacoh, Marquest, or equal.

4. Size each pressure gauge for the service conditions such that the pressure reads in the middle range of the gauge under normal operating conditions.

5. A fabricated PVC bracket shall be provided for each pressure gauge to secure the isolator and prevent lateral movement of the pressure gauge.

6. Pressure gauges shall be Ashcroft, Meriam Instruments in Cleveland, OH, or equal.

N. Wiring and Conduit Within the Skid or Base

1. Power wiring and conduits for 480-volt circuits shall be sized per the NEC.

2. Power wiring for 120-volt circuits shall be No. 12 AWG with No. 12 AWG ground. Wiring for control circuits shall be No. 14 AWG. Install wiring per the NEC.

3. Color-code control wiring in switching and control assemblies per ICEA Method 1, NEC applications, Option A. Jacket shall be black PVC. Lay out conductors neatly so they may be followed by eye form one terminal to another. Wiring shall be vertical or horizontal. Color-coding shall be such that electrically common interconnections of devices are the same color. The colors may be used more than once but not in the same circuit or cable grouping.

4. Power and control cable shall be copper, insulated for 600 volts, 75°C wet and 90°C dry locations, UL Type THWN or XHHW. Insulation jacket shall be nylon. Install bare or green insulated copper conductors in power circuits for grounding connections. The cable shall meet the requirements of UL 83.

O. Variable Speed Drive Units for Peristaltic Metering Pumps

1. Each chemical metering pump shall be provided with a local NEMA 4X drive for local and remote operation as specified with required I/O as indicated on P&ID drawings and herein. The drive shall be capable of encoderless vector operation with a 90:1 turndown.

2. Drive shall be rated for wash down environment.

3. All operating parameters shall be made at the drive via the built-in display. The controller shall feature an intuitive menu system and shall not require additional hardware or software for programming.

4. In the local mode the drive shall respond to local pushbuttons, which shall provide control from 0 – 100% as indicated on the display.

5. In remote the drive shall respond to an external “RUN” command to start the pump and a 4-20 mA reference signal for 0 – 100% speed control.

6. The drive shall provide the following status signals for remote monitoring:

   a. DO = RUN

   b. DO = IN REMOTE

   c. DO = FAULT

   d. AO = SPEED FEEDBACK

7. The drive shall operate using a sinewave carrier input with microprocessor controlled PWM encoderless vector output adjustable from 1 – 5 kHz standard and 5 – 16 kHz in quiet mode.

8. The drive shall feature internal protection for over voltage, over current, under voltage, external trip, motor overload, over temperature, output shorted or ground. An LED indicator shall indicate a trip condition and a separate message and trace log shall be provided with the last 10 trips stored in memory.

9. The display shall be a backlit graphical LCD 128 x 64 with 14 key membrane keypad with tactile response. The display shall provide all parameter values for setup and review. The display shall indicate output frequency, set frequency, output current (%), voltage, motor RPM, custom units power or energy consumed as selected by the operator.

10. Drive shall be as manufactured by Baldor H2 Series, Leeson Speedmaster, Danfoss VLT 2800 or equal.

P. Pump, Motor, Drive and Component Integration

The chemical feed system manufacturer shall select compatible pump, motor and drive units and shall be responsible for integrating the components to provide a complete working system using the following input power supply:

1. A 120 volt AC, 1-phase.

Q. Factory Testing

1. Test each package system by using water. Fill each tank and operate the control system by simulating the external control signals. Verify that the control system automatically controls the packaged system in response to the specified external control signals. Verify that metering pumps respond to the external flow-pacing signal.

2. Verify that the various specified alarm signals are generated and transmitted from the system control panel. Simulate metering pump running, tank low alarm shutdown and high and low pressure alarms.

3. Pressure test skid piping (except for overflow and vent piping) to a pressure of 150 psi for duration of three hours. There shall no leakage at any pipe joint or connection to any valve or piece of equipment. Repair or replace any defective pipe joint or connection and retest.

R. Service Conditions

1. The supplemental carbon solution has the following characteristics:

Liquid Pumped:	EOS MicroC2000™ or 20% Diluted Acetic Acid
Liquid Specific Gravity:	1.22 @ 20°C
Viscosity:	140 cP @ 0°C
Operating Temperature:	20 to 100˚F

2. Supplemental Carbon Feed System (Process 520):

a. Skid No. 1: Phase I/II

(1) Provide one (1) supplemental carbon metering system with pumps 520-P-1 and 520-P-2 (standby) for supplemental carbon addition. The supplemental carbon metering system should be pre-plumbed, pre-wired, pre-programmed complete with variable speed drives, pressure

sustaining and relief valves, pump isolation valves and mounted control package.

(2) Metering a supplemental carbon solution to two (2) injection points located at the Phase I/II 2nd Anoxic Basins.

(3) The following table provides system design criteria for Skid No. 1:

Pump Tag No.	Operating Point	Liquid End or Tubing Material	Elastomer Material	Valve/ Piping and Accessory Material	Motor HP
520-P-1	28 gph (105 l/h) @ 32 psi	Schedule 80 PVC	PTFE	Schedule 80 PVC	1/2
520-P-2	28 gph (105 l/h) @ 32 psi	Schedule 80 PVC	PTFE	Schedule 80 PVC	1/2

(4) Pumps 520-P-1 and 520-P-2 shall be Prominent Dulcoflex or W&T Chemtube PPS, or acceptable equivalent equal.

b. Skid No. 2: Phase III

(1) Provide one (1) supplemental carbon metering system with pumps 520-P-3 and 520-P-4 (standby) for supplemental carbon addition. The supplemental carbon metering system should be pre-plumbed, pre-wired, pre-programmed complete with variable speed drives, pressure sustaining and relief valves, pump isolation valves and mounted control package.

(2) Metering a supplemental carbon solution to two (2) injection points located at the Phase III 2nd Anoxic Basins.

(3) The following table provides system design criteria for Skid No. 2:

Pump Tag No.	Operating Point	Liquid End or Tubing Material	Elastomer Material	Valve/ Piping and Accessory Material	Motor HP
520-P-3	34 gph (126 l/h) @ 32 psi	Schedule 80 PVC	PTFE	Schedule 80 PVC	1/2
520-P-4	34 gph (126 l/h) @ 32 psi	Schedule 80 PVC	PTFE	Schedule 80 PVC	1/2

(4) Pumps 520-P-1 and 520-P-2 shall be Prominent Dulcoflex or W&T Chemtube PPS, or acceptable equivalent equal.

S. Spare Parts

1. Provide the following spare parts to the OWNER for each chemical metering skid upon delivery of the pump skid. Spare parts shall include all parts required for (2) years of normal maintenance of all components of the chemical metering system. All parts shall be in one box labeled with the Skid ID Information:

   a. (1) Spare pump for each pump size.

   b. (1) Replacement hose that is identical to and interchangeable with the installed hose for all peristaltic pumps.

   c. (1) Maintenance kits for each chemical metering pump. Maintenance kits shall include but not be limited to lubricants, gaskets and o-rings.

   d. (1) Maintenance kits for each pressure relief valve for each pump skid.

   e. (1) Maintenance kit for each back pressure valve for each pump skid.

   f. (1) Spare bladder for each pulsation dampener for each pump skid.

   g. (1) Spare valve of each size for each pump skid.

   h. (1) Parts list for all serviceable components.

2. Pack spare parts in a plastic container; label with the job location, pump type and model, manufacturer's name and local representative's name, address, and telephone number and attach list of materials contained within.

T. Factory Testing

1. Each chemical feed system shall be subjected to a nonwitnessed factory performance test. Test each package system by using water. Provide a separate water supply test tank and operate the control system by simulating the external control signals. Verify that the control system automatically controls the packaged system in response to the specified external control signals. Verify that metering pumps respond to the external flow-pacing signals.

2. Verify that the various specified alarm signals are generated and transmitted from the system control panel. Simulate metering pump running, drain pan liquid level, flow switch activation, and high and low pressure alarms.

3. Pressure test skid piping (except for overflow and vent piping) to a pressure of 75 psi for duration of two hours. There shall be no leakage at any pipe joint or connection to any valve or piece of equipment. Repair or replace any defective pipe joint or connection and retest.

PART 3 - EXECUTION

A. Installation:

1. Install the chemical metering skids as indicated on the drawings and specified and in compliance with the manufacturer’s instructions.

2. Upon completion of installation, a full operating test shall be performed in the presence of the Engineer and a qualified direct company employed manufacturer’s representative. The Contractor shall furnish all labor, materials and equipment required for such test and shall correct any deficiencies noted.

B. Assembling Skid or Base

1. Assemble and mount components on the fabricated skid or base at the factory. Provide the following minimum clearances around equipment:

   a. 12 inches between adjacent pumps.

   b. 6 inches between parallel pipes.

2. Design skid to provide access for hose changes for the metering pumps.

3. Mount control panel on the back of the skid. The panel door shall open toward the front (away from the skid structure).

4. Provide at least one side (preferably the front) of the skid clear of any piping or conduits to allow for maintenance access to the skid components. This clear access side shall not include any side that is within 3 feet of a wall.

C. Assembling Skid Piping and Electrical Conduit

1. Provide separate supports for pulsation dampener and calibration tube. Do not mount unsupported devices directly on the piping.

2. Provide fiberglass supports with Type 316 stainless steel fasteners and hardware for the piping. Provide a support for each pipe at its termination point at the edge of the skid, within 3 inches of any isolation valve.

3. Route electrical conduit around the ends and sides of the skid or base. Do not install conduit overhead. Install wiring on the skid or base in PVC conduit with a minimum size of 3/4 inch. Install power and control wiring in separate conduits. Terminate conduits at the control panel.

4. Do not run any conduit or piping beneath the drain pan.

D. Isolation Valve Locations

Provide isolation valves at the following points:

1. Inlet connection to each pump.

2. Outlet connection from each pump.

3. Connection to water supply quick connect coupling.

4. As shown on the drawings.

E. Pressure-Relief Valve Locations

Provide pressure-relief valve on the discharge piping of the metering pump discharge header. Size valve to match the associated metering pump capacity.

F. Pressure Sustaining Valve

1. Provide pressure sustaining valve on the discharge piping of the hydraulic diaphragm metering pump. Size to match the associated metering pump capacity.

G. Pipe Terminations

1. Terminate metering pump discharge pipes at the side of the skid.

2. Terminate connections to skid drain pan and piping at the rear of the skid.

3. Terminate water and air supply piping connection at the side of the skid.

H. Control Logic

1. Provide logic to accomplish the following control functions:

2. TBD

I. Service Conditions

Skid Number	**Skid No. 1 Supplemental Carbon**	**Skid No. 2 Supplemental Carbon**
Location	Outdoor Under Roof	Outdoor Under Roof
Chemical Pumped	EOS MicroC 2000™ or 20% Diluted Acetic Acid	EOS MicroC 2000™ or 20% Diluted Acetic Acid
Number of Pumps	2	2
Pump Tag Numbers	520-P-1, 520-P-2	520-P-3, 520-P-4

Pump Type	Hose	Hose
Liquid End	Schedule 80 PVC	Schedule 80 PVC
Maximum RPM	32	32
Motor Horsepower	0.5	0.5
Voltage	120 Volt, 1 Phase	120 Volt, 1 Phase
Stroke Rate Control	4-20 mA	4-20 mA
Maximum Pump Capacity	45 gph	45 gph
Maximum Pump Pressure	60 psi	60 psi
Piping Material	Schedule 80 PVC	Schedule 80 PVC
Piping Size (inch)	3/4	3/4
Valve Types	Ball	Ball
Options	Hose Leak Detection	Hose Leak Detection

J. Field Testing

1. Test each package system by using water for the system. The Owner will provide sufficient water for a test period of 24 hours. Fill each tank and operate the control system. Verify that the control system automatically controls the packaged system in response to the specified external control signals. Verify that metering pumps respond to the external flow-pacing signal.

2. Verify that the various specified alarm signals are generated and transmitted from the system control panel. Verify metering pump running, tank overflow, tank high and low alarm levels, drain pan liquid level, flow switch activation, and high and low pressure alarms.

K. Contract Closeout

1. Provide in accordance with Section 01700.

L. Warranty

The equipment shall be warranted for three (3) years commencing from date of substantial completion of the respective unit process in which the system is installed.

M. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

N. Certification

1. Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

SECTION 11373 CAST-IRON MULTISTAGE CENTRIFUGAL BLOWERS

PART 1 - GENERAL

A. Description

1. This section includes materials, testing, and installation of horizontal, cast-iron, multistage, centrifugal blowers.

2. New blowers (Process 320 and 420) located in the main electrical/blower building shall utilize a 120V local blower control panel and interface with an existing master blower control panel (PLC-06B) which is PLC controlled. Motor control and power is provided from remote starters located in a motor control center (provided by others).

3. Modifications to the existing master blower control panel is included in the scope of work.

4. New blowers associated with Process 220 shall utilize a 480V local blower control panel which provides power for the motor and associated motor operated valves.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. 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, 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.

3. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

4. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the respective project of the installation. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall consist of multistage blowers of a minimum of 200 HP in wastewater service.

   a. Current Owner Reference Contact Information

   b. Installation Service Conditions

   c. Equipment Model Numbers

   d. Date of Final Completion of the Project

5. Submit dimensional drawings.

6. Submit manufacturer's catalog data and detail drawings showing all blower parts and described by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show linings and coatings. Identify each blower by tag number to which the catalog data and detail sheets pertain.

7. Submit manufacturer's instruction manual. Show method of installing and aligning blower, motor, and coupling.

8. Submit electrical drawings for surge control equipment, vibration sensor, and ammeter/flowmeter. Show wiring, controls, interlocks, terminals, and disconnects. Label each terminal, showing which electrical power or control wire connects to each terminal.

9. Submit capacity curves showing discharge capacity versus discharge pressure. Show the specified operating point on the curve. Show surge capacity.

10. Show certified pressure losses through the silencers and filters at the specified capacities.

11. Submit motor data per Section 16150.

12. A list of spare parts that are to be supplied with the project in accordance with this specification.

13. At least two weeks before testing the blowers at the factory, submit the blower manufacturer's form for reporting the test results. The form should contain the data shown in the sample report form in Section 6 of the ASME PTC-10.

14. Submit copies of the noise level tests for each model and size of blower.

15. Submit six copies of a written report prepared by the manufacturer certifying that the equipment has been properly installed, lubricated, and test run.

16. Operation and Maintenance Manuals per Section 01300 with installation instructions, operation and start-up procedures including lubrication requirements and a complete bill of materials for all equipment.

17. Pack and ship one copy of the manufacturer’s standard installation instructions with the equipment.

C. Definitions

Terms shall be as defined in the ASME PTC-10.

D. Qualification

The Blower supplier is required to demonstrate successful experience in the design and manufacturing of multistage centrifugal blowers.

All blowers shall be manufactured and tested within the United States of America. As of the date in which Bids are submitted, the manufacturer shall have a minimum of twenty (20) operating installations with equipment of the equivalent size and similar service conditions as specified herein operating for not less than four (4) consecutive years from final completion of the respective project of the installation. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. Comparable units shall consist of multistage blowers of a minimum of 200 HP in wastewater service.

E. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the blowers. Perform the following tasks as part of these duties:

   a. Inspect blowers for alignment when they are check run for rotation.

   b. Inspect blowers for alignment after a test run of not less than one hour while blowers are hot.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. The blower start-up representative shall insure that all control functions are properly carried out by the control panel as part of the start-up procedure.

4. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Blower Design

1. Equipment for the blowers, including motors and baseplates, shall be provided as a complete unit by the blower manufacturer.

2. Blowers shall be of the multistage centrifugal type with outboard mounted bearing construction in which the impellers are keyed to a heavy ground steel shaft and supported by anti-friction type bearings. To prevent shifting of the impellers while in operation, the hubs of all impellers shall butt together, either directly or through one-piece metal spacers. The entire assembly shall be secured with a lock washer and lock nut.

3. Blowers shall be of the type in which the intermediate section is cast integrally with the casing to assure optimum operating efficiency. Where the blower shaft passes through the inlet and outlet heads, non-contact labyrinth seals shall be provided to prevent leakage and to assure non-contamination of the bearing lubricant.

4. Seals shall be replaceable without having to disconnect inlet or discharge piping. Blower casing shall be rated for a pressure of 25 PSIG.

5. The housing shall consist of sections held between inlet and outlet heads with tie rods. The pressure-capacity curve shall rise continuously from the rated point to the surge point.

6. The blower shall be capable of continuous operation at any capacity at least 10% greater than the surge capacity.

7. When producing a flow 50% below the rated flow at design maximum inlet air temperature of 105°F and 100% RH, the blower shall develop a discharge pressure at least 10% above the design discharge pressure of 7.9 psig and operate without being in surge and shall not overload the motor above motor nameplate rating.

B. Noise Level

The blower and motor combination, when operating with silencers, shall not produce a sound pressure level in excess of 90 dBA when operating at the specified capacity

and discharge pressure and when measured at a distance of 1 meter. Conduct tests on one blower for each service specified in the section on "Service Conditions" in accordance with the Compressed Air and Gas Institute (CAGI) Pneurop Test Code for the Measurement of Sound of Pneumatic Equipment.

C. Casing

Impeller housings shall consist of cast iron intermediate sections held securely between cast iron inlet and outlet heads with steel tie rods. The modular housing components shall be sealed by precision-machined rabbet joints and bonded with a sealant that can withstand the operating temperature of the blower. A tapped drain hole with a 304 stainless steel pipe plug shall be provided in the bottom of each section. The inlet and outlet connections shall have an ASA 125 pound drilled, tapped, and flanged pattern. The flanged connections shall be an integral part of the head castings.

D. Flexible Coupling

1. The blower will be furnished with a suitable spacer-type flexible coupling between the blower shaft and the motor shaft having a service factor of, at least, 1.5 over the motor nameplate rating. Coupling shall be of the flexible disc design with stainless steel disc packs. Design the casing and supports to limit change of alignment to 2 mils at the coupling flange.

2. Provide coupling guard conforming to OSHA standards.

3. Install the blower and motor on the baseplate at the factory. Align the motor and blower and install the spacer between the blower and motor shafts for fit.

E. Impellers and Shafts

1. Shafts shall be one piece, with bearing journals, ground to a maximum roughness of 32 micro inches. Shaft shall extend completely through the casing. Support shaft by bearings mounted in housings outside the casing. Shaft diameter shall be of sufficient diameter to operate at least 20% below the first critical speed and shall be fabricated from high strength carbon steel.

2. Each impeller shall be dynamically balanced to insure mechanical operation of not more than 1.25 mils (peak to

peak) vibration amplitude when measured on the bearing housing in the vertical direction and 0.235 in/sec (peak to peak) vibration velocity when measured on the bearing housing in the vertical, horizontal and axial direction. Vibration readings will be taken with the blower at operating speed. Tip speed of the impellers will not exceed 388 fps.

3. Diffuser sections shall be provided between impellers. These sections shall receive air from one impeller and guide it into the next impeller. Diffuser vanes shall be an integral part of the intermediate section casting. Guide vanes shall be an integral part of the return channel in the intermediate casting.

4. The blower shall have one-piece stainless steel baffle rings connected to the castings directly or by mounting rings.

F. Blower Connections

1. Inlet and outlet connections shall be flanged, with drilling patterns matching Class 125, ASME B16.1. Flanges shall be flat faced.

2. Gaskets shall be Viton suitable for an air pressure of 50 psi at a temperature of 300°F.

G. Bearings

1. Provide two outboard antifriction bearing assemblies. One assembly shall be free to float within the frame to carry radial thrust only. Design the other assembly to carry both radial and axial thrust. Bearing life shall be a minimum of 80,000 hours per the AFBMA L-10 rating.

2. Bearings shall be oil lubricated. Provide bullet sight glasses. Oil temperature shall remain within manufacturer's recommended limits during normal operation. Provide a drain system to maintain the oil and foam below the shaft-end seals.

3. It shall be possible to replace the bearings without disconnecting any piping or disassembling the blower casing.

H. Vibration and Residual Unbalance of Rotors

1. The vibration in any plane shall comply with API 617 (6th edition), paragraph 2.9.5.5.

2. Maximum residual unbalance in rotors shall not exceed a balance quality grade of G2.5 per ISO 1940/1.

I. Materials of Construction

Materials of construction for the blower shall be as follows:

Component	**Material**	**Specification**
Casing, heads, bearing housings	Cast iron	ASTM A48-85 Class 30
Shaft	Steel	ASTM A108 Grade 1045 HRS carbon steel or higher
Impellers	Aluminum	UNS A04430, A0356-T6, or ASTM SC64C Sr-319
Base	Steel	ASTM A36 Hot Rolled Structural Steel

J. Bases

1. Provide fabricated or cast steel base containing a motor connected to the blower via a reinforced flexible expansion connector. The design and construction of the baseplate shall comply with Section 3.8 in Chapter 5 of API 686 (first edition).

2. Provide pedestal for motor. Provide resilient foundation mounting pads beneath the base.

3. Provide lift lugs or eyebolts for four-point lift. Lifting the base with the equipment mounted on it shall not distort the base or machinery.

K. Inlet Filters

1. Provide inlet filters when required in the section on "Service Conditions." Filters shall be the cylindrical dry type and shall provide the following performance: 1) provide at least 99.5% removal efficiency with particles 2 microns and larger; and 2) at least 97% removal efficiency with particles 1 micron and larger. Pressure drop through filter at rated capacity shall not exceed 3 inches of water. Filter capacity shall be at least 120% of the blower rated capacity. Main filter element shall be pleated paper element. Provide a metallic corrosion-protected weather hood finished with baked industrial

enamel. Filters shall be Universal Series CCS, Burgess-Manning BD, Jacobs Air Water Systems (JAWS), or acceptable equal.

2. Provide inlet filters with differential pressure gauge with 1/8-inch NPT high and low pressure taps. Standard range shall be 0 to 10 inches W.C. with 0.2 inch W.C. minor divisions.

L. Expansion Joints for Discharge Piping

Provide reinforced, flexible rubber expansion connectors or expansion joint between the blower and outlet piping. This will isolate the blower from the piping system. Expansion joint material shall be EPDM with steel retaining rings. Expansion joints shall be suitable for a maximum pressure of 20 psig and a maximum temperature of 300°F. Ends shall be flanged, with drilling pattern matching Class 125, ASME B16.1. Provide restraining rods. Expansion joints shall be General Rubber or equal.

M. Pressure Gauges

Provide pressure gauges as specified in Section 13315, integrally mounted on the blower or attached immediately to the discharge piping to indicate outlet pressure. Provide pressure gauges for outlet gauges with a range of 0-15 psi.

N. Pressure Transmitters

Provide pressure transmitters per Section 13315. Install transmitters where shown on the drawings.

O. Valves

1. Provide inlet butterfly valves (Type V200) with modulating electric motor actuators in accordance with Sections 15100 and 15119. Provide discharge butterfly valves (Type V200) in accordance with Section 15100. Inlet and discharge butterfly valves shall be sized to match the blower inlet and discharge piping show in the drawings.

2. Provide a discharge check valve (Type V760) in accordance with Section 15100 to prevent backflow in the discharge piping of each blower. The check valve shall be sized to match the blower discharge piping as shown in the drawings.

P. Motors

Provide motor in accordance with Section 16150 and as specified in the "Service Conditions".

Q. Control System--Local Blower Control Panel (120V)

1. Provide a local control panel for new blower 420-B-4 and modify the existing local control panels for new blowers 320-B-1 and 320-B-2 for increase in horsepower from 150 hp to 200 hp.

2. Local control panel shall comply with control panels specified in Section 13325. The panel shall be mounted in such a location that an operator can have full view of the panel front while manipulating the blower inlet butterfly throttle valve.

3. Manual Start/Stop - Provide a Hand-Off-Auto selector switch so that in the 'Hand' position the motor will run.

4. Motor Overload Protection - The panel shall include a solid state meter with a digital read out to indicate motor amperage as well as air flow on the panel front. An adjustable set point switch shall be incorporated to provide a warning of high amperage. A second adjustable set point switch shall open a set of contacts that will cause the motor to shut down when the amperage draw reaches the motor's FLA. Two lights will be provided to indicate impending high amperage and high amperage trip. A reset pushbutton shall be provided that must be pressed before the motor can be restarted following an overpower trip. An adjustable 0 to 30-second time delay relay shall be incorporated in the circuitry to prevent a motor overload trip while the motor is being started. A suitable current transformer for the ammeter shall be provided by the blower manufacturer and installed in the motor starter enclosure by the electrical contractor. The ammeter shall hold and indicate the last amperage reading at the time of an overload trip.

5. Blower Surge Protection - The solid state ammeter shall include adjustable switches to alarm impending surge and to trip the blower motor at the blower surge set point. Two lights will be provided to indicate impending surge and surge trip. A reset pushbutton shall be provided that must be pressed before the motor can be restarted following a surge trip. An adjustable 0 to 30-second

time delay relay shall be provided to prevent a transitory surge trip. This meter will retransmit the scfm of the respective blower to the main panel in the form of a 4-20mADC signal proportional to the flow range of the blower.

6. Blower Bearing Vibration Protection - The panel shall include a solid state bearing vibration protection system with a face mounted digital indication of individual bearing vibration for both bearings displayed in inches per second. Vibration sensors shall be mounted directly on the bearing housings. Sensors shall be 2-wire, 4-20mADC piezo-electrical velocity transmitters. The electrical contractor shall run electrical leads between the sensors and the panel in a single metal conduit. The conduit shall not contain any wires that carry AC current. A front mounted light shall indicate vibration warning which will discontinue when the vibration level reaches a satisfactory level. Blower motor trip will occur when vibration reaches approximately 0.75 inches per second. Blower motor trip will be accompanied by a pilot light. It will be necessary to press a reset button in order to restart the blower motor following a high vibration trip. When a vibration trip occurs, the vibration indicator shall hold the reading that existed when the trip occurred. Time delay relays shall be provided to disable the vibration protection while the motor is being started. Time delay relays shall also prevent vibration warnings and shutdowns caused by transient vibrations. The vibration protection system will have the ability to detect when vibration transmitters are defective by detecting transmitters that contain a short or open circuit. The protection system will alert the operator through the displays when a velocity transmitter has failed in this manner.

7. Common Alarm Indication - An external common alarm acknowledge/silence pushbutton shall be supplied on the panel front.

8. Motor Amperage Indication - A front mounted solid state digital continuous readout of motor amperage shall be provided.

9. Blower Air Flow Rate Indication - A front mounted solid state digital continuous readout of blower airflow rate in cubic feet per minute shall be provided.

10. The local control panel for blowers 320-B-1, 302-B-2, and 420-B-4 are to communicate with the PLC in the existing Gardner Denver control panel. Communication shall include input and output command and status signals (discrete and analog, as applicable). Coordinate with Part 1 A.2.

R. Control System--Local Blower Control Panel (480V)

1. The Manufacturer shall provide a NEMA 4X, 316 stainless steel, 480VAC control panel meeting the requirements of Section 16191, PART 2, paragraph B and as modified herein.

2. Local blower control panel shall be UL Listed, FM approved.

3. Control panel shall include all power and control for blower and its associated motor operated valve.

4. Solid state motor control or variable frequency drive is acceptable. If this is provided, single phase protection is inherent and the phase monitor is not required.

5. PLC control is allowed rather than the relay control specified in 16191, but the PLC-based panel must conform to the Division 13 requirements, and include a Siemens S7-300 series PLC, Ethernet connectivity, operator touchscreen, and an internal UPS. Internal PLC wiring shall be allowed to be 18 AWG but shall be rated 600 volts. Internal dividers or barriers shall be provided to allow instrumentation technicians to access the PLC components without being exposed to 480 volts.

6. Provide a local blower control panel for each blower, referenced in the Service Conditions below. The panel shall be mounted in such a location that an operator can have full view of the panel front while manipulating the blower inlet butterfly throttle valve, except for Blowers 220-B-1 and 220-B-2 which shall be located as shown in the drawings.

7. Manual Start/Stop - Provide a Hand-Off-Auto selector switch so that in the 'Hand' position the motor will run.

8. Motor Overload Protection - The panel shall include a solid state meter with a digital read out to indicate motor amperage as well as air flow on the panel front.

An adjustable set point switch shall be incorporated to provide a warning of high amperage. A second adjustable set point switch shall open a set of contacts that will cause the motor to shut down when the amperage draw reaches the motor's FLA. Two lights will be provided to indicate impending high amperage and high amperage trip. A reset pushbutton shall be provided that must be pressed before the motor can be restarted following an overpower trip. An adjustable 0 to 30-second time delay relay shall be incorporated in the circuitry to prevent a motor overload trip while the motor is being started. A suitable current transformer for the ammeter shall be provided by the blower manufacturer and installed in the motor starter enclosure by the electrical contractor. The ammeter shall hold and indicate the last amperage reading at the time of an overload trip.

9. Blower Surge Protection - The solid state ammeter shall include adjustable switches to alarm impending surge and to trip the blower motor at the blower surge set point. Two lights will be provided to indicate impending surge and surge trip. A reset pushbutton shall be provided that must be pressed before the motor can be restarted following a surge trip. An adjustable 0 to 30-second time delay relay shall be provided to prevent a transitory surge trip. This meter will retransmit the scfm of the respective blower to the main panel in the form of a 4-20mADC signal proportional to the flow range of the blower.

10. Blower Bearing Vibration Protection - The panel shall include a solid state bearing vibration protection system with a face mounted digital indication of individual bearing vibration for both bearings displayed in inches per second. Vibration sensors shall be mounted directly on the bearing housings. Sensors shall be 2-wire, 4-20mADC piezo-electrical velocity transmitters. The electrical contractor shall run electrical leads between the sensors and the panel in a single metal conduit. The conduit shall not contain any wires that carry AC current. A front mounted light shall indicate vibration warning which will discontinue when the vibration level reaches a satisfactory level. Blower motor trip will occur when vibration reaches approximately 0.75 inches per second. Blower motor trip will be accompanied by a pilot light. It will be necessary to press a reset button in order to restart the blower motor following a high vibration trip. When a

vibration trip occurs, the vibration indicator shall hold the reading that existed when the trip occurred. Time delay relays shall be provided to disable the vibration protection while the motor is being started. Time delay relays shall also prevent vibration warnings and shutdowns caused by transient vibrations. The vibration protection system will have the ability to detect when vibration transmitters are defective by detecting transmitters that contain a short or open circuit. The protection system will alert the operator through the displays when a velocity transmitter has failed in this manner.

11. Common Alarm Indication - An external common alarm acknowledge/silence pushbutton shall be supplied on the panel front.

12. Motor Amperage Indication - A front mounted solid state digital continuous readout of motor amperage shall be provided.

13. Blower Air Flow Rate Indication - A front mounted solid state digital continuous readout of blower airflow rate in cubic feet per minute shall be provided.

S. Factory Testing

1. Each blower shall be tested at the manufacturer's facility to determine that vibration and bearing temperature levels are within specified tolerances. Each blower shall be operated until it reaches a sustained temperature before measurements are recorded.

2. Each blower shall be mechanically run tested prior to shipment with the job motor.

3. Perform a bearing signature analysis. Report vibration levels and bearing housing temperatures.

4. Pressure test the casings and heads at the factory with water for 30 minutes minimum at a pressure of 25 psig. Test shall show zero leakage. If leaks are observed, repair the blower and retest.

5. Test each blower per the ASME PTC-10. Conduct tests from the surge point to 120% of rated capacity. Take readings at a minimum of five points, approximately equally spaced, in this range. Tests shall be Class II per PTC-10. No motor overload above nameplate rating will be

allowed at minimum temperature (see "Service Conditions") while maintaining constant air weight flow.

T. Spare Parts

1. Provide the following spare parts for each blower service specified in the subsection on "Service Conditions."

Quantity	Description
2	Inboard bearings
2	Outboard bearings
2	Shaft seals
5	Filter elements (Per Blower)
1	manufacturer recommended lubricants for 2 oil changes and 1 year of routine maintenance

PART 3 - EXECUTION

A. Shipment and Storage

1. Prepare equipment for shipment including blocking of the rotor when necessary. Identify blocked rotors by means of corrosion-resistant tags attached with stainless steel wire. The preparation shall make the equipment suitable for six months of outdoor storage from the time of shipment, with no disassembly required before operation, except for inspection of bearings and seals.

2. Provide the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the jobsite and before start-up.

3. Coat exterior machined surfaces with a rust preventative.

4. The interior of the equipment shall be clean and free from scale, welding spatter, and foreign objects.

5. Provide flanged openings with metal closures at least 3/16-inch thick, with elastomer gaskets and at least four full-diameter bolts. For studded openings, use all the nuts needed for the intended service to secure closures.

6. Provide threaded openings with steel caps or solid-shank steel plugs. Do not use nonmetallic (such as plastic) plugs or caps.

7. Clearly identify lifting points and lifting lugs on the equipment or equipment package. Identify the recommended lifting arrangement on boxed equipment.

8. Identify the equipment with item and serial numbers and project equipment tag numbers. Material shipped separately shall be identified with securely affixed, corrosion-resistant metal tags indicating the item and serial number and project equipment tag numbers of the equipment for which it is intended. In addition, ship crated equipment with duplicate packing lists, one inside and one on the outside of the shipping container.

9. Wrap exposed shafts and shaft couplings with waterproof, moldable waxed cloth or volatile-corrosion-inhibitor paper. Seal the seams with oil-proof adhesive tape.

B. Blower Installation

1. Install blower in accordance with the manufacturer’s recommendations.

2. The coupling surfaces normally used for checking alignment shall be concentric with the axis of coupling hub rotation within the following limits: 0.0005-inch total indicated runout per inch of shaft diameter, with a minimum applicable tolerance of 0.001-inch total indicated runout and a maximum of 0.003-inch total indicated runout. All other diameters not used for location, registration, or alignment shall be to the coupling manufacturer's standard, provided balance requirements are met. Misalignment between the blower and motor shafts shall not exceed 0.20 mils per inch of shaft separation. Use the reverse indicator or laser alignment method per API 686, Chapter 7, to determine alignment.

3. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.

4. Verify that the installed blower is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the blower assembly. Adjust the position

of the blower assembly so that the blower flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning, or supporting equipment.

5. Provide continuous protection of the equipment from the elements, dust, debris, paint spatter, or other conditions that will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing. Store and protect blowers per API 686 (first edition), Chapter 3, paragraphs 1.4 through 1.10, 1.12, 1.13, 1.20, and 1.21.

C. Painting and Coating

1. Coat motor and base per Section 09900, System No. 10. Apply prime, intermediate, and finish coats at factory. Color of finish coat shall match the color of the connecting piping. Provide "touch-up" paint for field application after installation.

2. Coat blower per Section 09900, System No. 17. Apply prime, intermediate, and finish coats at factory. Provide "touch-up" paint for field application after installation.

D. Service Conditions

1. Blower performance conditions and design data shall be as shown below.

2. Blower Tag Numbers: 220-B-1 and 220-B-2

Location:	Adjacent to Phase III Process Basins (Process 320)
Environment:	Outdoors environmental temperature range up to 110°F
Elevation:	90 feet above mean sea level
Relative humidity:	Up to 100%
Barometric pressure:	14.7 psi
Process gas:	Air
Maximum inlet temperature:	105°F
Minimum inlet temperature:	30°F
Rated capacity:	3900 scfm
Differential pressure at rated capacity:	7.9 psi

Minimum isentropic efficiency at rated capacity:	70%
Secondary operating point	4,200 scfm
Differential pressure at secondary operating point	7.6 psi
Maximum blower speed:	3,600 rpm
Motor horsepower (maximum):	200 HP
Motor type:	Horizontal, heavy duty, TEFC per Section 16150. Motor shall be rated for continuous duty at an ambient temp-erature of 40° Celsius.
Impeller and interior casing coating:	No
Inlet filter:	Yes
Manufacturer's and models:	Gardner Denver Series 751C, Houston Service Industries (HSI), Inc. Model 12607, or HIBON V-CENTRIF.

3. Blower Tag Numbers: 320-B-1, 320-B-2, and 420-B-4

Location:	Blower/MCC/Generator Building (Process 185)
Environment:	Indoor environmental temperature range up to 110°F
Elevation:	90 feet above mean sea level
Relative humidity:	Up to 100%
Barometric pressure:	14.7 psi
Process gas:	Air
Maximum inlet temperature:	105°F
Minimum inlet temperature:	30°F
Rated capacity:	3900 scfm
Differential pressure at rated capacity:	7.9 psi
Minimum isentropic efficiency at rated capacity:	70%
Maximum blower speed:	3,600 rpm
Motor horsepower (maximum):	200 HP

Motor type:	Horizontal, heavy duty, TEFC per Section 16150. Motor shall be rated for continuous duty at an ambient temperature of 40° Celsius.
Impeller and interior casing coating:	No
Inlet filter:	Yes
Manufacturer's and models:	Gardner Denver Series 751C, Houston Service Industries (HSI), Inc. Model 12607 or HIBON V-CENTRIF.

E. Field Testing

1. Bump motor to ensure that motor has been connected for proper rotation.

2. Start up the blower system in accordance with API 686, Chapter 9. Comply with Sections 5.1 through 5.3 in Chapter 9. Operate the equipment for 30 consecutive days, during which time no repairs or adjustments shall be required. Operate start-up sequencing system and assure that valves open and close in the specified manner. Perform this starting sequence on each blower at least once every five days.

3. Throttle the discharge valve on each blower, and assure that surge control system shuts off blower. Perform this test on each blower at least once every five days.

4. Conduct vibration level tests with blowers operating at their rated capacity. Adjust or replace blowers that exceed the maximum specified vibration levels.

5. Assure that in the automatic mode each blower responds to its pressure signal. Assure that each blower operates at a steady rate (±5% of set point) at any given pressure for 60%, 80%, and 100% of the rated capacity specified.

F. Contract Closeout

Provide in accordance with Section 01700.

G. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

H. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

I. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County.

END OF SECTION

SECTION 11376 FINE BUBBLE MEMBRANE DISC DIFFUSERS

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of fine bubble disc diffusers. All fine bubble diffusers in all process basins shall be of the same manufacturer and model.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit manufacturer's catalog data and descriptive literature. Call out materials of construction of discs, gaskets, headers, baseplates, and other parts. Show head loss through disc at specified minimum and maximum airflows.

3. Submit piping layout showing arrangement and location of discs and air piping in the various basins in the project. Show location and type of expansion joints. Show location of every pipe support. Show how the future air requirements provided under “Service Conditions” will be met in the future (i.e. provide space and provisions for pipe connections and additional diffusers to be installed in the future).

4. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of ten (10) operating installations, at a minimum of five (5) different facilities, for not less than three (3) consecutive years from final completion of the respective project of the installation. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. At a minimum the reference information shall include the following;

   a. Current Owner Reference Contact Information

   b. Installation Service Conditions

   c. Equipment Model Numbers

d. Date of Final Completion of the Project

5. Submit details of pipe support system within the basins. Describe material of construction of supports and anchor bolts by ASTM reference and grade.

6. A list of spare parts that are to be supplied with the project in accordance with this specification.

7. Submit copies of report on the results of the factory testing of the discs.

8. Submit six copies of a written report prepared by the manufacturer/manufacturer's representative certifying that the equipment has been properly installed.

9. Operation and Maintenance Manuals per Section 01300 with installation instructions, operation and start-up procedures and a complete bill of materials for all equipment.

C. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Six labor days (one labor day per basin non-consecutive days, see sequence of construction) to check the installation, supervise start-up, and supervise testing and adjustment of the disc diffusers.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. Refer to Section 01010 for additional requirements.

D. Qualification

The diffuser manufacturer is required to prove satisfactory experience in the design and manufacturing of fine bubble diffused aeration systems.

As of the date in which Bids are submitted, the manufacturer shall have a minimum of ten (10) operating installations, at a minimum of five (5) different facilities, for not less than three (3) consecutive years from final completion of

the respective project of the installation. The installations must be within the contiguous lower forty-eight (48) States of the United States of America.

PART 2 - MATERIALS

A. Manufacturer

Diffuser system shall be manufactured by Sanitaire, Ashbrook Simon Hartley (fka Wilfley-Weber) or Aquarius Technologies.

B. Fine Bubble Diffuser Design Criteria

1. Provide a system of fine bubble membrane disc diffusers in each of the locations listed in the subsection on "Service Conditions." The air diffuser system shall consist of circular, EPDM Membrane discs mounted on a submerged plastic piping network.

2. The design of the piping or grid system shall provide a maximum head loss of 0.03 psi per 100 feet of piping. Minimum piping size for the grid system shall be 4 inches.

3. Determine the number of membrane disc diffusers required to meet the design conditions given in the section on "Service Conditions."

C. Piping and Supports

1. The submerged air piping shall connect to a flanged Type 304L stainless steel drop header connection as shown on the drawings.

2. Submerged manifolds and distribution piping shall be unplasticized polyvinyl (UPVC). Pipe shall conform to Type I, Grade 1 (Class 12454-B) per ASTM D 1784 and D 1785. Minimum pipe wall thickness shall be Schedule 40 or equivalent wall thickness. Provide 2% titanium dioxide (by weight) in the pipe shell for ultraviolet protection.

3. Fittings shall be of the same material as the pipe. Minimum wall thickness shall be Schedule 40 or equivalent wall thickness.

4. Mount piping on Type 316 stainless steel adjustable saddles. Mounting bracket, base, and strap shall be Type 316 stainless steel. Anchor bolts shall be Type 316

stainless steel with a minimum embedment length of 2 inches. Minimum anchor bolt size shall be 3/8 inch. Saddles shall permit raising or lowering the pipe to compensate for variations in the tank floor elevation. Provide a variance of ± 1-1/4 inches from the mean elevation of any piping. Design supports to compensate for sloping and variations in the tank floor elevation. Equivalent pipe supports that are designed to accommodate a sloped floor if necessary and provide vertical adjustment for leveling the system will also be acceptable.

D. Membrane Disc Diffusers

1. Manufacture circular membrane diffuser discs of EPDM synthetic rubber compound with precision die formed slits.

2. Diffuser shall be a one-piece molded part with a minimum thickness of 0.080" for nominal 9-inch diameter unit. This part thickness shall limit the maximum tensile stress of the rubber membrane to 10 PSI when operating at 2.4 SCFM per square foot of membrane media. Larger disc diffusers shall be proportionately thicker to limit the maximum tensile stress at the specified air rate.

3. The EPDM rubber compound shall have the following minimum characteristics:

PARAMETER	VALUE/UNITS	ASTM
Base Polymer:	EPDM	
UV Resistance:	Carbon Black	
Specific Gravity:	1.25 or Less	
Ozone Resistance:	Pass	D1171
Durometer, Shore A:	45 Point ± 5	2240
Tensile Strength:	1200 PSI	D412
Elongation at Break:	350%	D412
Accelerated Aging Max. Compression Set:		
@ 23°C, 22 Hrs.	20%	D573
@ 70°C, 22 Hrs.	40%	D573

Extractable Oil Content: 24% (Maximum)

4. Furnish diffuser membranes with uniform distribution of air bubble release across the active surface of the diffuser element when submerged in water. Manufacture membrane discs with integral sealing gasket.

5. Furnish diffuser membranes to meet or exceed the following criteria:

   a. Membrane shall collapse and seal when aeration system air is turned off.

   b. Membrane shall be able to collapse onto support base when air is not being diffused.

E. Diffuser Assemblies

1. Furnish diffuser assemblies consisting of a diffuser membrane with diffuser holder, air flow control orifice, and retaining device with gaskets as required. Diffusers utilizing ceramic or plastic type diffusion media elements will not be acceptable as alternatives to the membrane disc design. Diffusers that require a center bolt to limit membrane deflection will not be allowed. Tubular type diffusers shall not be allowed.

2. Furnish diffuser units that are either an integrated membrane and base-plate in one or diffuser element holders with an air plenum chamber below the diffuser support plate. Provide a mechanism to attach the diffuser to the holder.

   a. Element holders shall provide complete peripheral edge support for the membrane diffuser element.

   b. Attach element holders to the distribution headers to resist dead load of 200 lbs. applied vertically to the outer edge of the diffuser unit.

   c. Diffusers shall be factory assembled and ready to mount on the distribution headers without field assembly.

   d. Furnish retaining device to securely hold and seal the membrane diffuser to the holder.

3. Design diffuser assembly to prevent air escape at the diffuser element-sealing gasket interface.

4. Sealing method or retaining device shall generate a minimum of 50 pounds per inch of circumference of the sealing gasket to provide a long term positive seal and prevent air escape except through the active area of the diffuser membrane.

5. If a screw on retainer ring is used, it shall be provided with a positive o-ring seat and a minimum of 2 1/2 complete threads for engagement. Threads shall have a minimum cross section of 1/8 inch.

6. Maximum spacing between diffuser assemblies shall not exceed 4 feet to minimize solids build-up between the diffuser assemblies.

F. Expansion Joints and Fixed Joints

1. Provide a PVC expansion system to prevent thermally induced stresses due to expansion and contraction over a temperature range of 125 degrees F (52 degrees C). All expansion joints shall be airtight and permit free and easy movement of the plain end of the pipe within the coupling barrel.

2. Expansion joints shall consist of a barrel section solvent welded to one end of the lateral pipe, an O-ring gasket and a threaded, screw-on retainer ring. Expansion couplings shall meet the following criteria:

   a. Minimum stroke – 4 inches (100 mm).

   b. Average force to operate – 50 lbs (23 kg).

3. Fixed joints shall consist of a spigot section solvent welded to one end of a distribution lateral, a threaded socket section solvent welded to the mating distribution lateral, an O-ring gasket, and a threaded screw-on retainer ring.

G. Purge Sump or Drainline, Sump, and Airlift Purge System

1. Provide a Purge Sump Assembly with internal suction tube located within the low point of the manifold to discharge above the high water level with purge valve accessible from the deck.

2. Alternatively the manifold pipe can be used as the drainline for the grid with low point within the manifold pipe and airlift purge system.

a. Connect drain sump or manifold pipe to ¾-inch (19 mm) diameter airlift eductor line extending to the drainline invert elevation. Extend airlift eductor to a point 18 inches (450 mm) above the basin water level and terminate with a PVC ball valve.

b. Support airlift eductor with Type 316L stainless steel brackets at walkway or platform beam location.

c. The PVC ball valve and termination piping shall be supported by the handrail using aluminum pipe supports such that the PVC ball valve is accessible from the walkway.

d. Systems using drainlines at the ends of the aeration grids shall be provided with a combination support/thrust anchor at each header-drainline connection to prevent joint blow-apart.

H. Laboratory Testing of Disc Diffusers

1. Conduct a shop clean water performance test to demonstrate the capacity of equipment to meet the specified oxygen requirements. Conduct tests at the manufacturer's facility by independent testing firm and allow witnessing by the County’s representative. Include all costs for testing, exclusive of witnesses' expenses, in the equipment price. Tests shall be based on the proposed diffuser grid layout for each process basin configuration.

2. Perform tests in accordance with the latest ASCE Clean Water Test Procedure.

3. Conduct at least (3) test runs each at the design conditions.

4. Testing shall be conducted in either a rectangular tank having a surface area greater than 200 square feet or a circular tank having a surface area greater than 112 square feet in order to eliminate the potential of wall effects. Testing shall be conducted at the specified submergence and at diffusers densities equivalent to the actual project tank configuration. Diffuser density is defined as the RATIO of the total tank surface area to the total combined diffuser surface area.

5. Submit data from all tests for acceptance by the County’s representative following the completion of the testing and prior to equipment shipment.

I. Spare Parts

1. Provide the following spare parts for the fine bubble diffuser system:

Quantity	Description
2% of the quantity installed	Membrane Disc Diffusers
2% of the quantity installed	Threaded retainer rings
5% of the quantity installed	Expansion joints for the UPVC grid piping system
2	Disc Installation Tool
5	Hose Clamps
5	Rubber Couplings
5	Expansion Couplings
5	Mounting Brackets with Anchors

2. Pack the spare parts in wooden boxes; label with the manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained within.

PART 3 - EXECUTION

A. Installing Disc Diffusers

1. Mount the membrane discs to the baseplates attached to the UPVC pipe. Install O-ring seals and apply the manufacturer's recommended lubricant before screwing on the threaded retainer rings.

2. Bolt the pipe saddles to the concrete floor using Type 316 stainless steel wedge anchors.

3. Provide PVC joints at 20’ nominal intervals and furnish expansion couplings, guide supports and fixed supports at locations appropriate to accommodate expansion and contraction of the piping system.

4. Provide header pipe supports at maximum spacings of 7’-6”.

5. The top of the diffuser assemblies shall be at the same elevation, ±1/8 inch. After the diffuser assemblies are

installed, fill a basin with water to the top of the discs and check that each disc is within this range.

6. The top of the diffuser assemblies shall be at the elevation shown in the drawings, ±1/8 inch.

B. Storage and Protection of Piping and Diffusers

Store piping and diffusers indoors prior to installation. Within 48 hours of installing the diffusers, fill the basin with water to a level 1 foot above the tops of the discs.

C. Uniform Air Distribution/Leakage Test

Fill the basin with water to a level 1 foot above the tops of the diffusers. Start the air supply blowers. Visually inspect the water surface and check that airflow is uniformly distributed across the basin. Replace or repair any plugged diffusers. Replace or repair any diffusers in which air leaks through the seating gasket.

D. Service Conditions[1]

1. Phase I/II BNR Basins

Zones Containing Diffusers:	**Aeration Basins**	**Reair: Zone 1**	**Reair: Zone 2**	**Reair: Zone 3**
Aerated Zone Length:	See drawings[2]	See drawings	See drawings	See drawings
Aerated Zone Width:	See drawings[2]	See drawings	See drawings	See drawings
Number of Drop Headers (Grids) Per Zone:	1	1	1	1
Minimum Drop Header Diameter:	8″	4″	4″	4″
Design Sidewater Depth:	13′-0″	12′-0″	12′-0″	12′-0″
Minimum Diffuser Submergence (H)	12′-0″	11′-0″	11′-0″	11′-0″
Minimum SOTE at Design SOR:	22.1%	N/A	N/A	N/A
Design AOR (lb/d):	2,451	N/A	N/A	N/A
Design SOR (lb/d):	5,520	N/A	N/A	N/A

Zones Containing Diffusers:	Aeration Basins	Reair: Zone 1	Reair: Zone 2	Reair: Zone 3
Design Mixing Requirement (scfm/1,000 cf):	N/A	20	20	20
Maximum Mixing Requirement (scfm/1,000 cf):	N/A	30	30	30
Design Airflow(scfm):	1,000	73	34	109
Peak Airflow (scfm):	1,333	N/A	N/A	N/A
Future Sidewater Depth:	13′-9″	12′-0″	12′-0″	12′-0″
Minimum Diffuser Submergence	12′-9″	11′-0″	11′-0″	11′-0″
Minimum SOTE at Future SOR:	23.4%	N/A	N/A	N/A
Future AOR (lb/d):	5,874	N/A	N/A	N/A
Future SOR (lb/d):	13,302	N/A	N/A	N/A
Future Peak Airflow(scfm):	2,300	N/A	N/A	N/A
Maximum Pressure at Drop Header Connection:	6.5 psig	5.8 psig	5.8 psig	5.8 psig
Maximum Design Flow (scfm), per disc: 9 in	2.0	2.0	2.0	2.0
10 in	2.36	3.0	3.0	3.0
Minimum No. of Diffusers[3]: 9 in	500	38	18	56
10 in	440	26	12	38

Notes:
(1) Values provided under “Service Conditions” are requirements per zone per basin
(2) Dimensions are maximum lengths and maybe smaller per diffuser manufacturer’s recommendations. Refer to drawings for additional limitations to floor space available.
(3) Specified minimum diffuser quantity correspond to the design airflow and design SOR. Provide provisions in the system layout to accommodate the specified future condition to be achieved through the addition of air distributors, diffusers and associated piping to attach to capped saddles at the manifold.

2. Phase III BNR Basins

Zones Containing Diffusers:	Aeration Basins	Reair: Zone 1	Reair: Zone 2	Reair: Zone 3
Aerated Zone Length:	See drawings[2]	See drawings	See drawings	See drawings
Aerated Zone Width:	See drawings[2]	See drawings	See drawings	See drawings
Number of Drop Headers (Grids) Per Zone:	1	1	1	1
Minimum Drop Header Diameter:	8″	4″	4″	4″
Design Sidewater Depth:	15′-0″	15′-7″	14′-11″	14′-11″
Minimum Diffuser Submergence	14′-0″	14′-0″	13′-11″	13′-11″
Minimum SOTE at Design SOR:	25.7%	N/A	N/A	N/A
Design AOR (lb/d):	1,781	N/A	N/A	N/A
Design SOR (lb/d):	4,006	N/A	N/A	N/A
Minimum Mixing Requirement (scfm/1,000 cf):	N/A	20	20	20
Design Mixing Requirement (scfm/1,000 cf):	N/A	30	30	30
Design Airflow(scfm):	624	164	63	128
Peak Airflow (scfm):	975	N/A	N/A	N/A
Maximum Pressure at Drop Header Connection:	6.5 psig	7.1 psig	7.1 psig	7.1 psig
Maximum Design Flow (scfm), per disc: 9 in	2.0	2.0	2.0	2.0
10 in	2.0	3.0	3.0	3.0

Zones Containing Diffusers:	Aeration Basins	Reair: Zone 1	Reair: Zone 2	Reair: Zone 3
Minimum No. of Diffusers:				
9 in	312	82	32	64
10 in	312	55	22	43

Notes:
(1) Values provided under “Service Conditions” are requirements per zone per basin
(2) Dimensions are maximum lengths and maybe smaller per diffuser manufacturer’s recommendations. Refer to drawings for additional limitations to floor space available.

E. Contract Closeout

Provide in accordance with Section 01700.

F. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

G. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

H. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer’s specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County.

END OF SECTION

SECTION 11395 FRP CENTRIFUGAL FANS

PART 1 - GENERAL

A. Description

This section includes materials and installation of FRP centrifugal fans. The FRP centrifugal fan specified herein shall be provided as part of a biologically based air treatment system and shall be provided by the Biofilter supplier, complete for total system responsibility. Refer to Section 11530.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's catalog data and descriptive literature. Submit dimensional drawings. Call out materials of construction by ASTM reference and grade.

3. Submit performance curves showing pressure, capacity, horsepower, and efficiency from shutoff to 120% of rated capacity.

4. Submit a certificate listing the type of resin to be used, describing the manufacturer's brand name or designation, composition, and characteristics.

5. Submit FRP construction details. Show laminate thickness, interior corrosion barrier design, and glass and resin content.

6. Submit motor data per Section 16150.

7. Operation and Maintenance Manuals per Section 01300 with installation instructions, operation and start-up procedures including lubrication requirements and a complete bill of materials.

8. A list of spare parts that are to be supplied with the project in accordance with this specification.

C. Manufacturer's Services

See Section 11530.

PART 2 - MATERIALS

A. Manufacturer

Hartzell, New York Blower Company, or Versantis Environmental Solutions Group.

B. FRP Centrifugal Fan Design

1. Design and construction shall comply with ASTM D4167, except as modified below.

2. Fans (including housing and wheel) shall be FRP, centrifugal type, SISW, with backward inclined wheel, nonoverloading. Fan housings shall be grounded to the support bases.

3. Fan housings shall be of a curved scroll design with a 3/4-inch flanged drain outlet at the lowest point of the scroll. Fan inlet and outlet nozzles shall be flanged.

4. Provide gasketed FRP access door bolted to the wheel housing.

5. Provide two laminated layers in the FRP construction: one for the inner surface, plus a glass-reinforced layer for structural strength. Surfacing mat shall be resin rich, shall consist of Type C glass monofilament surfacing or Nexus organic fiber, and shall be a minimum of 20 mils thick. Glass content in the inner surface layer shall not exceed 23% by weight. The structural layer shall be composed of chopped-strand mat having a minimum glass content of 30% by weight. The overall glass content of the finished laminate shall be at least 30% by weight.

6. Determine glass content per ASTM D2584.

7. Laminate thickness shall be at least 1/4 inch.

8. Resin shall be corrosion resistant as defined by ASTM C581. Medium shall be odorous air containing 10 to 200 ppm of hydrogen sulfide gas and saturated with water vapor. Resin layers in contact with the airstream shall contain carbon to allow for control of static electricity.

C. Quality Control

1. Fiberglass construction shall comply with ASTM D2563, Level II, except as modified by ASTM D4167, Table 1. Wall hardness shall be at least 90% of the resin manufacturer's recommended Barcol hardness, with a minimum Barcol hardness of 30, with the resin fully cured. Maximum strain in the laminate shall be 0.001 inch/inch. Maximum air bubble size in the laminate shall be 1/16 inch. Maximum frequency of air bubbles in the liner portion of the laminate shall be 10 per square inch of laminate.

2. Fan shall be rated and constructed per AMCA.

D. Fan Housing Fasteners

Fasteners shall be Type 316 stainless steel.

E. Shafts, Shaft Seal, and Shaft Sleeve

1. Fan shafts shall be Type 316 stainless steel.

2. Provide Viton shaft seal with FRP backup plate bolted to the housing. Provide FRP shaft sleeve.

F. Shaft Bearings

1. Provide two antifriction bearing assemblies. Locate bearings outside the fan housing. One assembly shall be free to float to carry radial thrust only. The other assembly shall carry both radial and axial thrust. Bearings shall be either spherical or tapered-roller type. Bearings subject to radial thrust only shall be single row or double row. Bearings subject to both radial and axial thrust shall be double row.

2. Minimum bearing life per the AFBMA L-10 rating shall be 50,000 hours. Bearings shall be oil or grease lubricated. Provide constant level oilers for oil lubrication. Provide external Type 303 or 316 stainless steel ZERK fittings for grease lubrication.

G. Vibration

The vibration in any plane measured on the bearing housings shall not exceed 2 mils peak to peak. This requirement is in addition to those in ASTM D4167, Section 8.

H. Fan Drive

1. Provide motor in accordance with Section 16150 and the following.

2. Motor enclosure shall be explosion proof, Class I, Div. 2, Group D.

3. Provide drive per AMCA Publication 99. Provide V-belt drive. Provide belt guard conforming to OSHA requirements.

I. Controls.

See Section 11530.

J. Fan and Motor Baseplate

Provide fabricated ASTM A36 steel baseplate. Provide pedestal for motor. Provide rubber base pads: Korfund Elasto-Rib, Mason Industries, or equal. Provide lift lugs or eyebolts for four-point lift. Lifting the base with the equipment mounted on it shall not distort the base or machinery.

K. Grout, Epoxy Primer, Nonbonding Filler for Anchor Bolt Sleeves, and Epoxy Grout Liquid for Baseplate

See Section 03600.

L. Inlet Control and Discharge Backdraft Dampers

1. Inlet control damper shall be designed to control airflow.

2. Backdraft damper shall be designed to prevent air from flowing back into the system when the fan is turned off.

3. Damper frame shall be of one piece construction with a resin rich interior corrosion barrier minimum of 100 mils. A structural lay-up shall consist of alternate layers of chopped strand mat and woven roving to conform to ASME/ANSI RTP-1 and PS15-69. The glass to resin ratio shall be a minimum of 35% glass to 65% resin.

4. Wall thickness, flange thickness, drilling pattern and width shall conform to PS15-69. Exterior surface of the damper shall contain UV inhibitors and a gel-coat, color to match duct system.

5. The damper blade shall be constructed of the same material as the damper frame and shall have a resin rich surfacing veil on both sides. Blade stiffeners shall be FRP or FRP encapsulated as required for stiffness.

6. The axle shall be pultruded fiberglass.

7. Damper shall be provided with stainless steel hand locking quadrant operators.

8. All interior metal shall be 316 stainless steel.

9. Gaskets shall be EPDM.

10. Dampers shall be as manufactured by Belco Manufacturing Company or equal.

M. Flexible Duct Connectors

1. Provide non-metallic flexible duct connectors designed to match inlet and outlet flanges of the fan.

2. Flexible duct connectors shall be integrally flanged non-metallic connector used in applications where large movements are required and where vibration and sound absorption are needed.

3. Flexible duct connector material shall be EPDM.

N. Spare Parts

1. Provide the following spare parts for each blower and damper:

Quantity	Description
2 sets	V-Belts
1 set	Radial bearings
1 set	Thrust bearings
1 set	Seals, gaskets
1 set	Damper bearing inserts

2. Provide the manufacturer’s recommended lubrication in a quantity for a minimum of two (2) service changes for each fan indicated in the “Service Conditions.”

3. Pack spare parts in a wooden box; label with the manufacturer's name and local representative's name,

address, and telephone number; and attach list of materials contained therein.

PART 3 - EXECUTION

A. Fan Installation

1. FRP Centrifugal Fan shall be installed and fastened to concrete pad as per manufacturer’s recommendations.

2. Install drivers and driven equipment after the baseplate has been fastened to concrete pad after pad has cured for a minimum of 24 hours. The coupling surfaces normally used for checking alignment shall be concentric with the axis of coupling hub rotation within the following limits: 0.0005-inch total indicated runout per inch or shaft diameter, with a minimum applicable tolerance of 0.001-inch total indicated runout and a maximum of 0.003-inch total indicated runout. All other diameters not used for location, registration, or alignment shall be to the coupling manufacturer's standard, provided balance requirements are met. Misalignment between the blower and motor shafts shall not exceed 0.20 mil per inch of shaft separation. Use the reverse indicator or laser alignment method per API 686, Chapter 7, to determine alignment.

3. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.

4. Verify that the installed fan is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the fan assembly. Adjust the position of the blower assembly so that the fan flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning, or supporting equipment.

5. Provide continuous protection of the equipment from the elements, dust, debris, paint spatter, or other conditions that will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing. Store and protect fans per API 686 (first edition), Chapter 3, paragraphs 1.4 through 1.10, 1.12, 1.13, 1.20, and 1.21.

B. Painting and Coating

Coat motor, baseplate, and exposed ferrous metal (other than stainless steel) per Section 09900, System No. 10. Apply prime and intermediate coats at factory. Color of finish coat shall be as specified by Owner.

C. Service Conditions

1. Fan performance and operating conditions shall be as shown below. Ratings shall conform with AMCA 210.

2. Motors shall be provided in accordance with Section 16150.

3. Equipment Tag Numbers: 500-B-1 & 500-B-2

Location:	Odor Control System (Process 500)
Rated capacity:	7,000 cfm
Differential pressure at rated capacity:	20-inch W.C.
Motor horsepower (minimum):	35.0
Maximum fan speed (RPM):	2,500

D. Field Testing of Dampers

Operate inlet damper blades from fully open to fully closed 10 times. Assure that dampers operate without binding or sticking.

E. Field Testing of Fans

1. For each fan of rated capacity 500 scfm or greater, conduct a Type B field test per AMCA 203 to verify flow rate and static pressure.

2. Measure the current drawn by the motor. No motor overload above nameplate rating will be allowed between 0% and 120% of the fan rated capacity.

3. Conduct vibration level tests with fans operating at their rated capacity. Adjust or replace fans that exceed the maximum vibration levels.

F. Contract Closeout

Provide in accordance with Section 01700.

G. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

H. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

I. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County.

END OF SECTION

SECTION 11530 BIOTRICKLING FILTER

PART 1 - GENERAL

A. Description

1. This section includes materials, equipment, installation, and testing of a biologically based air treatment system for treating odorous air produced from raw sewage.

2. The biologically based air treatment system shall be provided complete by one supplier for total system responsibility, including pumps, fan, valves, meters, piping, fittings, controls and startup equipment.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following;

2. 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, 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.

3. A copy of the contract mechanical process, structural, electrical and instrumentation drawings relating to the submitted equipment, with addendum updates that apply to the equipment in this section, marked to show specific

changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

4. In order to demonstrate satisfactory experience and qualifications, provide an installation list for a minimum of ten (10) operating installations at a minimum of five (5) different facilities with equipment of the equivalent size and similar service conditions as specified herein operating for not less than three (3) consecutive years from final completion of the respective project of the installation. The installations must be within the contiguous lower forty-eight (48) States of the United States of America. At a minimum the reference information shall include the following;

   a. Current Owner Reference Contact Information

   b. Installation Service Conditions

   c. Equipment Model Numbers

   d. Date of Final Completion of the Project

5. Certified shop and working drawings. Drawings for the vessels and fans shall also include a complete description of the laminate construction as specified within this section and be accompanied by a detailed postcure procedure that will be utilized.

   a. Drawings shall include plan views, sectional views, title block, and details of all related items. In cases where certain information is Proprietary and is omitted, provide a statement indicating that the information is proprietary and is being omitted.

   b. Submit tower manufacturer's recommended bolt torques for flanges.

   c. Files shall include Tag Names, Parts List (identifying each component), Dimensions, and connection sizes.

   d. Files shall be drawn to scale.

e. Drawings shall be in conformance with all other requirements as specified in this specification.

6. Provide signed and sealed design calculations for unit to include construction, internal support system and anchoring system by a structural engineer, registered in the State of Florida.

7. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

8. Submit a certificate listing the type of resin to be used, describing the manufacturer's brand name or designation, composition, chemical resistance, and characteristics.

9. Provide anticipated set points for operating pH, water use and chemical addition. Operation and maintenance manuals shall be updated after start-up to reflect actual field determined set points.

10. Submit annual utility and chemical usage calculations.

11. Submit a list of materials of construction with ASTM reference.

12. Submit electrical/control diagrams detailing the requirements and features of the control system, including interlocks, terminals, wiring, controls, disconnects, and panel layouts.

13. Submit warranty as indicated in Part 3, Paragraph G.

14. Manufacturer’s literature and specifications. Show catalog dates.

15. Operating and maintenance instructions and parts list.

    a. In operating instructions incorporate a functional description of entire system including system schematics.

    b. In maintenance instructions, clearly define requirements for particular system and show special calibration and test procedures.

16. Clearly mark all drawings and data to show only items applicable to work. Show all data, nozzle schedule, bill of materials, rated capacities, material of construction, layouts and construction details of all

components. Show dimensions, mounting and external connection details on all drawings.

17. Number and identify all equipment to correspond with terminology on drawings. Also use these numbers on all submittals sheets and shop drawings.

18. Submit details of:

    a. Resin Type

    b. Types and amounts of filler

    c. Corrosion liner description

    d. Reinforcement types for hand lay-up or chopped laminates

19. Shop test results.

20. Motor shop test results.

21. Qualifications of field service technician.

22. Schematic control and power wiring diagrams.

23. Shop and Field inspections reports.

24. List of recommended spare parts other than those specified.

25. Recommendations for short and long term storage.

26. Special tools.

27. Shop and field testing procedures and equipment to be used.

28. Number of service technician days provided and per diem field service rate.

29. Manufacturer’s product data, specifications, and color charts for shop painting.

30. Provide a listing of the materials recommended for service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and as indicated.

31. The most recent ISO 9000 series certification.

32. Material Certification:

    a. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

33. Submit six copies of a written report prepared by the manufacturer certifying that the equipment has been properly installed, lubricated, and test run.

C. Qualification

The biotrickling filter manufacturer is required to prove satisfactory experience in the design and manufacturing of odor control equipment for removal of hydrogen sulfide and other odorous compounds at preliminary treatment structures at municipal wastewater treatment facilities.

As of the date in which Bids are submitted, the manufacturer shall have a minimum of ten (10) operating installations at a minimum of five (5) different facilities with equipment of the equivalent size and similar service conditions as specified herein operating for not less than three (3) consecutive years from final completion of the respective project of the installation. The installations must be within the contiguous lower forty-eight (48) States of the United States of America.

D. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. Two (2) labor days for each service listed in the subsection on "Service Conditions" to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Three (3) labor days to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

3. The biotrickling filter start-up representative shall insure that all control functions are properly carried out by the control panel as part of the start-up procedure including FRP Fan (see Section 11395).

4. Refer to Section 01010 for additional requirements.

PART 2 - MATERIALS

A. Manufacturers

Odor reduction system shall be manufactured by Siemens Water Technologies, Envirogen Technologies Inc., BioREM, or BioAir Solutions, Inc.

B. Reactor Vessel(s)

1. System shall be designed to treat odorous air as specified in the “Service Conditions” and herein. Provide second stage/polishing unit and media at no additional cost to the Owner if required to meet specified effluent and quality.

2. The reactor vessel(s) shall be constructed of corrosion resistant FRP. The vessel(s) shall be designed to support the required number of media layers and treatment stages. All materials of construction shall be corrosion resistant. The exterior of the vessel(s) shall incorporate a UV resistant coating. Vessels shall comply with ASTM D4097 for contact molded tanks, or with ASTM D3299 for filament wound tanks.

3. Resin shall be Ashland Derakane 411, Hetron 922, Reichhold 9800, or CORVE 8401. Resin shall be suitable for continuous immersion in the liquid described in the subsection herein on “Service Conditions” and shall be resistant to those fluids as defined by ASTM C581.

4. The resin system should provide a class 1 flame spread rating. Antimony, Nyacol or any other additives are not allowed.

5. Biotrickling filter manufacture shall coordinate tank dimensions, nozzle sizes, and nozzle orientation for construction.

C. Laminate Construction

1. Provide at least three inner laminated layers as a corrosion barrier on the tank interior and an exterior reinforcement layer. The inner surface layer shall be resin rich, shall consist of organic fiber, and shall be a minimum of 0.254 mm thick. Glass content in the inner layer shall be 20% ±5% by weight.

2. The remaining two layers (interior layer) shall be composed of chopped strand mat having glass content by weight of 25% ±5% applied at a rate of 3 ounces per square foot. The interior layer shall be formed, not sprayed. Chopped roving fibers shall be 1/2 to 2 inches in length.

3. The average glass content of the inner three layers shall be 27% ±5% by weight. The total thickness of the inner surface layer and interior layers should be no less than 2.5 mm.

4. The exterior layer shall be comprised of 1.5 ounces per square foot chopped strand mat or equivalent weight of chopped roving.

5. The total tank wall thickness (excluding additional thickness provided for knuckle reinforcement) shall have an average glass content by weight of 55% ±5% per ASTM D2584.

D. Quality Control

Construction shall comply with ASTM D2563, Level II, except that maximum frequency of air bubble in liner portion of laminate shall be 10 per square inch of laminate with maximum bubble size of 1/16 inch. Wall hardness shall be at least 90% of the resin manufacturer's recommended Barcol hardness, with a minimum Barcol hardness of 35, with the resin fully cured. Maximum strain in the laminate shall be 0.001 inch/inch. Appearance of the tank interior and exterior shall comply with ASTM D3299, Section 9.

E. Ultraviolet Protection

Provide ultraviolet protection in the form of a surface coating of a permanent resin-rich exterior layer, pigmented white. Surfaces shall be smooth, hard, and glossy.

F. Wall Thickness

Wall thickness shall be sufficient to support its own weight in an upright position with any exterior supports. Wall thickness shall be determined based on structural design calculations in accordance with ASTM D4097 or ASTM D3299. At a minimum wall thickness shall be 3/8-inch.

G. Structural Design

Design tower, baseplate, anchors, anchor bolts, and top flange per the following requirements:

1. Design the tower and anchorage system per the 2010 Florida Building Code (FBC) requirements supplemented by ASCE 7-10 for wind loading requirements:

Basic Wind Speed, mph:	150
Risk Category:	3
Exposure:	B

2. An unreinforced concrete housekeeping pad above the reinforced concrete structural slab shall not be considered to have structural value in the design of the anchor bolts. Tension and shear values for drilled or epoxied anchor shall be FBC approved. Maximum hoop stress shall not exceed 1/10 of the ultimate hoop strength of the laminate.

3. Provide with the Certificate of Unit Responsibility, certification for all equipment signed by a structural engineer, registered in the State of Florida, stating that computations were performed and that all components have been sized for the wind load specified and indicated.

H. Grease Filter/Mist Elimination (GFME):

1. Provide a particulate filter consisting of a Type 316L stainless steel pad for grease and particulate filtration in front of a polypropylene (PPL) pad with Type 316 stainless steel grid for mist elimination,

housed inside a PPL, FRP, or HDPE enclosure. Minimum combined thickness of 8 inches.

2. Provide the pads removable for cleaning and the housing with a hinged door and quick-latches or drop-out flange on either side of the filter housing, to allow removal and replacement of the filter pads.

3. Particle removal efficiency shall be 99% of particles 10 microns or larger.

4. Provide a Dwyer Series 2000 Magnehelic differential pressure gauge installed on the housing to indicate pressure drop through the unit. Provide the PPL or FRP housing flanged and drilled per NBS PS 15-69 and complete with EPDM gaskets, ready for installation.

5. GFME shall be installed in the orientation as indicated. Provide supports. Elevate unit sufficiently to allow drain line with minimum 8 inch deep trap. Drain line shall be full size of combined drain connections on GFME unit or 1-1/2 inch, whichever is larger. Drain line shall be in accordance with duct drains specified in Section 15855.

6. The Contractor is responsible to provide a structural support system, spray and drain piping as specified by the GFME manufacturer for a complete operating system. Provide isolation valves and pressure reducing valves as specified by the GFME manufacturer.

I. Bolts

Tie-down lugs and anchor bolts shall be Type 316 stainless steel. Bolts shall conform to ASTM A 193, Grade B8M or ASTM F 593, Type 316. Nuts shall conform to ASTM A 194, Grade 8M or ASTM F 594, Type 316. Use ASTM A 194 nuts with ASTM A 193 bolts; use ASTM F 594 nuts with ASTM F 593 bolts. Lugs shall be integrally molded into the tank walls or bases or tank shell. Do not sue cable restraint systems. Provide washers (minimum 1/8 inch thick) of the same materials as the nuts.

J. Fittings—General Requirements

1. Place fittings at least 6 inches away from tank knuckle radius’ and flange lines.

2. Orientation of flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B16.5.

3. Flange dimensions to conform to ANSI B16.5, Class 150. Flanges shall be flat faced. The flange face shall be 4 to 6 inches from the tank shell.

4. Maximum wall thickness for each flange fitting size shall be determined in accordance with ASTM D4097 or ASTM D3299.

5. Gaskets for flanges shall be EPDM.

K. Bolts and Nuts for Flanged Nozzles

Bolts shall be Type 316 stainless steel, per ASTM A 193, Grade B8M. Nuts shall conform to ASTM A 194, Grade 8M. Provide washer for each nut and bolt head. Washers shall be of the same material as the nuts.

L. Ladders

1. Provide safety cages with ladders. Ladders shall be constructed of FRP. Design ladders to meet OSHA standards: OSHA 2206, 1910.27.

2. Attach ladders to the tank to allow for tank expansion and contraction due to temperature and loading changes. The mounting system shall be determined by the ladder material specified and the tank size requested. Connect top ladder mounts to integrally molded-in attachment lugs that allow for tank movement. Ladder mounts may be bolted. Bolted mounts shall consist of a bracket bolted to the tank sidewall with 1/2-inch encapsulated bolts which allows tank movement without tank or ladder damage.

M. Media

1. Provide a multi-stage odor control system designed for treatment of hydrogen sulfide and other odor control causing compounds such as mercaptans typically found in vapors emitted by the wastewater treatment process. Odorous air shall be collected at the preliminary treatment structure and delivered to the biotrickling filter as shown in the drawings. The odor control system shall be designed to treat odorous air at the specified flow rate and hydrogen sulfide concentrations and other odorous compounds such as mercaptans typical of municipal wastewater to the specified effluent air quality described under the “Service Conditions”.

2. Two-stage system where each stage occurs in a separate reactor vessel: The first reactor vessel shall contain self supporting inorganic biological media which supports biological growth. The second reactor vessel shall contain polishing media. The polishing media shall be virgin, un-impregnated granular activated carbon derived from bituminous, sub-bituminous or lignite coal. The system shall be designed such that short circuiting does not occur.

   a. The activated carbon shall be suitable for vapor phase adsorption of Hydrogen Sulfide and other odor odour causing compounds such as mercaptans typically found in vapors emitted by the wastewater treatment process.

   b. Activated carbon shall conform to the following minimum requirements:

H_2S breakthrough capacity (Per ASTM D6646)	g H_2S removed/cc	0.3 minimum
Moisture (per ASTM D2867)	wt. percent	8 maximum
Mesh size (per ASTM D5158)		
Greater than 4 Mesh (4.75 mm)	percent	10 maximum
Less than 8 Mesh (2.36 mm)	percent	5 maximum

   c. Submit a certificate certifying that the carbon meets the specified requirements.

3. Two-stage system, without carbon, that uses two stages of biological treatment within the same vessel: The reactor vessel shall be supplied with one or more distinct types of media within a single vessel. The media shall be biologically active synthetic or inorganic material. The media shall be self-supporting and installed such that the treatment layers are designed to not short circuit.

N. FRP Centrifugal Fans

1. The fans shall be provided in accordance with Section 11395.

2. For each fan provide the following: high discharge pressure switch, range 0-20 in WC, setpoint 10 in WC; low suction pressure switch, range -20 - 0-in WC, setpoint -10 in WC; Refer to Section 13315 for pressure switch specification

O. Liquid Distributors

1. Provide a surface spray irrigation system capable of evenly saturating the entire surface of the media.

2. Provide either single or dual spray system. Provide isolation ball valve(s) (V310) for each spray assembly.

3. Liquid distributor shall be of the single spray nozzle type.

4. Distributor shall be self-supporting and removable from the vessel exterior.

5. The spray nozzles shall use liquid pressure alone to produce a fine spray with uniform distribution. The nozzles shall be designed for maximum coverage of the media.

P. Nutrient Addition System

1. A nutrient addition system shall be provided, to supplement the nutrients in the potable irrigation water supply.

2. The nutrient addition system shall include the following:

a. Piping and valves.

b. Provide an opaque HDPE nutrient storage/mixing tank with mixer and low liquid level switch. Tank to be sized for a one-month supply of nutrient.

c. Water Cabinet as described herein.

d. Provide a float type low level switch. Switch shall be Gems LS Series or equal

Q. Recirculating Pump

1. Provide recirculating pumps (one active and one stand-by unit) as required, to deliver water collected in the sump of the reactor vessel to the liquid distributors within the tower.

2. The pump(s) shall be horizontal centrifugal type pump of the closed coupled design and be capable of handling solids.

3. The liquid end components shall be plastic suitable for recirculated fluid and designed for corrosion resistance.

4. Provide the following for each pump:

   a. Piping and valves.

   b. 0-60 psi pressure gauge.

   c. Flow switch

5. Piping shall be PVC in accordance with Section 15290.

6. Pressure gauge and flow switch shall be as specified in Section 13315.

R. Basket Strainers

1. Provide a basket strainer on the make-up water supply line and on the recirculation line upstream of the recirculation pumps as shown in the drawings to remove unwanted particles from the liquid stream.

2. Provide a perforated strainer basket contained inside the strainer body. Basket shall have 1/8" perforations.

3. Strainer shall have threaded end connections. Strainer body and basket shall be PVC. Seals shall be EPDM.

S. Motors

Motors for nutrient system mixers and recirculation pumps shall be provided in accordance with Section 16150.

T. Control Panel

1. The Manufacturer shall provide a NEMA 4X control panel of 316 stainless steel construction, 480VAC control panel meeting the requirements of Section 16191, PART 2, paragraph B and as modified herein.

2. Control system shall be PLC controlled as specified in 16191, but the PLC must conform to the Division 13 requirements (Siemens) and an internal UPS in accordance with Division 13 shall be required. Internal PLC wiring shall be allowed to be 18 AWG but shall be rated 600 volts. Internal dividers or barriers shall be provided to allow instrumentation technicians to access the PLC components without being exposed to 480 volts.

3. Control Panel shall be Class 1, Division 2, Group D and in accordance with NFPA 820.

4. Control panel shall be UL listed, FM approved.

5. Provide the enclosure with a full size, 316 stainless steel, swing-out, dead-front panel for mounting of selector switches and indicating lamps.

6. The instrumentation and controls system, specified herein, shall accept single phase, 120 V, 60 Hz AC electrical power, unless otherwise noted.

7. Operator Interface: Provide and install the following selector switches and indicating lamps, mounted on the swing-out panel.

    a. Selector Switches:

        (1) FRP Centrifugal Fan No. 1/2 Selector Switch

        (2) FRP Centrifugal Fan No. 1 ON/OFF/AUTO

        (3) FRP Centrifugal Fan No. 2 ON/OFF/AUTO

        (4) Water Solenoid OPEN/CLOSE/AUTO, if applicable

        (5) Nutrient Feed Pump ON/OFF/AUTO

        (6) Recirculation Pump ON/OFF/AUTO, if applicable

    b. Indicating Lamps:

        (1) Control Power ON/OFF

        (2) FRP Centrifugal Fan No. 1 ON/OFF/FAULT

        (3) FRP Centrifugal Fan No. 2 ON/OFF/FAULT

        (4) Water Solenoid OPEN/CLOSED, if applicable

        (5) Nutrient Feed Pump ON/OFF/FAULT

        (6) Recirculation Pump ON/OFF/FAULT, if applicable

    c. Local Indication

        (1) Differential Pressure

    d. The following shall be operator adjustable through the OIT, if applicable:

(1) Solenoid valve operating frequency, if applicable.

(2) Solenoid valve operating duration, if applicable.

(3) Nutrient addition frequency, if applicable.

(4) Nutrient addition duration, if applicable.

(5) Demister flush frequency.

(6) Demister flush duration.

8. External Interfaces:

a. Provide isolating relays and terminal blocks for field wiring of the following status and alarm signals

(1) Control Power ON

(2) System ON

(3) System FAIL

(4) Nutrient Feed System ON

(5) Recirculation Pump ON

9. Functional Requirements:

a. The FRP Centrifugal Fan(s) shall be activated and deactivated manually. The Fan shall operate continuously whenever the ON/OFF/AUTO selector is in the ON or AUTO mode. Stop motor operation whenever the ON/OFF/AUTO selector is in the OFF mode. Stop motor when Low/High Air Pressure Alarm occurs.

b. When in AUTOMATIC mode, operate the water solenoid (OPEN/CLOSED) using a repeat cycle timer, if applicable. For constant make-up water systems, supply water is continuous and solenoid valve and timer is not required.

c. When in AUTOMATIC mode, START the nutrient feed pump whenever the water solenoid valve (if applicable) is OPEN, and STOP the feed pump when the solenoid valve (if applicable) is CLOSED. For constant make-up water systems, supply water shall be continuously

supplied to the system and solenoid valve and timer is not required. When in AUTOMATIC mode, the nutrient feed pump is ON. STOP the feed pump whenever the FRP Centrifugal Fan is OFF.

d. Provide a System ON status whenever the FRP Centrifugal Fan is ON.

e. Provide a Nutrient Feed System ON status whenever the water solenoid (if applicable) is OPEN and/or the nutrient feed pump is ON.

f. Provide a System FAIL status whenever the following occurs:

(1) FRP Centrifugal Fan is faulted.

(2) Low/High Air Pressure Alarm (at FRP Centrifugal Fan Pressure Switch)

(3) Motor Overload Recirculation Pump

(4) Motor Overload Nutrient Feed Pump

(5) Low Water Flow Alarm, Recirculation

(6) Low Nutrient Level Alarm

(7) Low Level Alarm (Biofilter Vessel)

(8) Combustible gas is detected

(9) Fire/flame is detected

10. Special Requirements:

a. Provide and install a control power transformer to provide 120 VAC, single phase electrical power for the control circuit.

b. Provide and install water solenoid valve and a S5 Repeat Cycle Timer, unless system operates with a constant make-up water supply. For constant make-up water systems, supply water shall be supplied continuously to the system and solenoid valve and timer is not required.

U. Water Cabinet

1. Provide a single NEMA 4X panel constructed from FRP to house the following:

   a. One (1) Nutrient feed pump.

   b. Water solenoid valves, as applicable.

   c. Water flow rotometer.

   d. Piping and valves (water and nutrient).

   e. Water pressure regulating valve.

   f. 0-100 psi pressure gauge.

2. Isolation valves shall be Type 310 double union PVC ball valves as specified in Section 15100.

3. Pressure regulating valves shall be the spring-actuated type. Regulators 2 inches and smaller shall automatically convert high, varying inlet water pressure to a lower, constant outlet pressure. Provide a valve design consisting of a spring in a chamber acting on a diaphragm that transmits motion to the valve. Outlet pressure shall be adjustable by turning an adjusting screw to vary spring tension. Body shall be PVC. Diaphragm shall be nitrile. Maximum inlet pressure shall be at least 200 psi.

4. Flow rotameters shall be Wallace and Tiernan glass tube Varea-Meter, ABBSeries 10A2235A, or equal.

5. Solenoid valves, if applicable, shall be V900 as specified in Section 15100.

6. Pressure gauge shall be as specified in Section 13315.

V. Labeling and Marking

Provide labels on the tower per Section 15075.

W. System Drain

The manufacturer shall design a drain made of schedule 80 PVC for the reactor vessel designed for the maximum pressure of the reactor vessel. Contractor to provide and install Type 310 double union ball valve and drain piping installed at a slope to the drain.

X. Spare Parts

Provide the following spare parts:

Quantity	Description
1	Nutrient feed pump
1	Recirculation Pump
1 set	Spray Nozzles

PART 3 - EXECUTION

A. Shipping and Inspection

Ship per ASTM D 1998 and the following. Wrap tanks with protective polyethylene sheet and protective tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit. Cover or plug fittings and flange faces with weatherproof metal covers.

B. Installation

1. Install tanks level as shown in the drawings. Provide a grouted base, or provide layers of roofing felt, between the tank bottom and the underlying slab as recommended by the manufacturer.

2. Fill the reactor vessel with water to the air inlet level and allow to settle for seven days. Do not attach connecting piping and ductwork until after this period to allow for any differential settlement. Check for leaks and correct or repair any leaking areas.

C. Service Conditions

Biotrickling filter system design data shall be as shown below:

Reactor Tag Number(s):	500-BF-1
Rated airflow:	7000 cfm
Minimum Influent H2S Concentration:	30 ppm

Average Influent H_2S Concentration:	100 ppm
Maximum Influent H_2S Concentration:	300 ppm
Inlet Air Temp:	30-100 F
Inlet Air Relative Humidity:	30–100%
Biotrickling Filter Reactor Dimensions	12′-0″ diameter (max)
Biotrickling Filter Reactor Height (With Stack):	36 ft (max)
Reactor Bed Height:	15 ft (min)
Carbon Polishing Unit Reactor Dimensions (if applicable):	10′-0″ diameter (max)
Carbon Polishing Unit Reactor Height (if applicable):	14′-1″ (max)
Pressure Drop System (includes Fan, Biotrickling Filter, connecting FRP Duct and Carbon Unit, if applicable):	20 in W.C. (max)
Effluent H_2S Removal Efficiency:	99% H_2S removal or an effluent concentration less than 0.1 ppm, whichever is greater
VOC Removal Efficiency:	90% odor removal or an effluent concentration of less than 600 odor units (D/T), whichever is greater

D. Field Acceptance Test

1. The manufacturer shall startup and operate the unit with potable water. During this startup the manufacturer shall provide all necessary equipment to allow biological growth within the reactor vessel.

2. Once the manufacturer indicates the reactor is operational, operate Biotrickling filter system

initially for a period of 15 continuous days. During this time, confirm that all system components have been installed correctly, are operating properly, and are performing their intended function.

3. Performance testing to occur no sooner than two weeks or later than 6 weeks from start-up. Performance test to consist of measurement of inlet and outlet H2S readings for a period of not less than 4 continuous hours.

4. Performance Testing:

   a. Provide the complete testing apparatus necessary to determine the performance of the Biotrickling filter system and differential pressure drop across each tower. Apparatus shall include H_2S detectors, a manometer, and a pH analyzer.

   b. Test results shall demonstrate the specified percentage removal of H_2S from the airstream.

   c. In addition to meeting performance, all equipment shall show evidence of mechanical soundness with no liquid or gas leaks and no undue vibration.

   d. If system fails for any reason, make changes or alterations and reconduct the above-described test at no cost to the Owner until system is acceptable.

E. System Balancing:

1. The testing and balancing shall be performed by an independent certified testing and balancing company not associated with the manufacturer or the contractor that is competent, experienced and has formerly done similar work and whose qualifications and performance shall be subject to the approval of the Engineer.

2. The testing and balancing company shall be responsible for all testing and balancing of all odor control ductwork up to and including the odor control fan.

3. Furnish the necessary labor, materials, instruments and devices required to test, adjust and balance the air system.

4. Adjust manual and automatic control devices to balance air flows so they perform as indicated and specified.

5. Balance air systems so each outlet is within 10-percent and each fan is within 5-percent of values indicated.

6. Submit a certified report to the Owner outlining balancing procedures used; report to include:

   a. Type of measuring devices used.

   b. Air quantities at each outlet, damper and fan.

   c. Fan speeds.

   d. Fan suction and discharge pressures.

   e. Air quantities through fan, by test and by summation of air quantities at outlets.

F. Contract Closeout

Provide in accordance with Section 01700.

G. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

3. The Manufacturer shall warrant the suitability of the biological support media for a period of ten (10) years from the date of substantial completion of the respective unit process in which the biotrickling filter is installed.

4. The Manufacturer shall warrant the integrity of the FRP exterior shells of the reactors for a period of ten (10) years from the date of substantial completion of the respective unit process in which the biotrickling filter is installed.

H. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

I. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County.

END OF SECTION

Orange County Utilities

Eastern Water Reclamation Facility
Phase V Improvements

Bid Package A

Technical Specifications
Volume II of II

Prepared By:

AECOM

CDM Smith

60222491

Bid Set
April 2014

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ORANGE COUNTY UTILITIES
EASTERN WATER RECLAMATION FACILITY
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SECTION 13090 POLYETHYLENE STORAGE TANKS

PART 1 - GENERAL

A. Description

This section includes materials and installation of vertical crosslinked high-density polyethylene (XLHDPE) tanks for aboveground chemical storage service.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit tank layout drawings showing dimensions, wall thicknesses, mounting brackets, knuckle radii, nozzle locations and orientation, and nozzle and gasket construction.

3. Submit manufacturer's data showing materials of construction and chemical resistance. Submit a certificate listing the type of resin to be used, describing the manufacturer's brand name or designation, composition, chemical resistance, and characteristics.

4. Submit installation instructions for installing tank on a concrete slab.

5. Submit tank manufacturer's recommended bolt torques for flanges.

6. Submit design calculations for structural design of tie-down lugs (number, size, and embedment length of anchor bolts).

7. Submit manufacturer's certification that tank construction complies with ASTM D1998, Type I for XLHDPE, and these specifications.

PART 2 - MATERIALS

A. Manufacturers

XLHDPE tanks shall be manufactured or supplied by Poly Processing Company, or equal.

B. Tank Construction

Polyethylene tanks shall be rotationally molded polyolefin. Tanks shall be vertical, exterior flat/interior sloped bottom with domed top. Provide minimum 24-inch flanged access port on the top. Provide molded-in lifting lugs. Provide fittings and accessories indicated in the drawings and herein.

C. Design Criteria

1. Volume shown in the drawings is measured from the tank bottom to the invert of the overflow nozzle.

2. XLHDPE tanks shall comply with ASTM D1998, Type I.

3. Polyethylene resin material shall contain an ultraviolet stabilizer as compounded by the resin manufacturer. Pigments shall not exceed 0.25% (dry blended) of the total weight.

4. Mechanical properties of tank material shall be as follows:

Property	ASTM	Value
Density (Resin)	D1505	0.938-0.944 g/cc
Tensile (Yield Stress 2 inches/minimum)	D638	2,600 psi minimum
Elongation at Break (2 inches/minimum)	D638	400% minimum
ESCR (100% Igepal, Cond. A, F50)	D1693	1,000 hours minimum
ESCR (10% Igepal, Cond. A, F50)	D1693	1,000 hours minimum
Vicat Softening Degrees F Temperature	D1525	248 minimum
Flexural Modulus	D790	100,000 psi minimum

5. The top head shall be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. Design the top head of tanks to accommodate the fittings and nozzles indicated.

D. Structural Design

1. Design storage tank, anchors, anchor bolts, and restraint system per the following requirements:

   a. Design the storage tanks and anchorage system per the most recent Florida Building Code (FBC) requirements supplemented by ASCE 7-10 for wind loading requirements:

      Basic Wind Speed, mph: 150

      Risk Category: 3

      Exposure: B

   b. See subsection on "Liquids Stored" herein for the specific gravities of the tank contents.

2. An unreinforced concrete housekeeping pad above the reinforced concrete structural slab shall not be considered to have structural value in the design of the anchor bolts. Tension and shear values for drilled or epoxied anchor shall be FBC approved. Maximum hoop stress shall not exceed 1/10 of the ultimate hoop strength of the laminate.

3. Provide with the Certificate of Unit Responsibility, certification for all equipment signed by a structural engineer, registered in the State of Florida, stating that computations were performed and that all components have been sized for the wind load specified and indicated.

E. Anchors and Anchor Bolts

1. An unreinforced concrete housekeeping pad above the reinforced concrete structural slab shall not be considered to have structural value in the design of the anchor bolts. Tension and shear values for drilled or epoxied anchor shall be FBC approved.

F. Wall Thickness

1. Determine wall thickness per ASTM D1998, Section 6, assuming a fluid specific gravity as described in the subsection on "Service Conditions" with a minimum specific gravity of 1.22. Minimum total wall thickness shall be 3/8 inch for tanks having a diameter 4 feet 0 inches or less and a height of 8 feet 0 inches or less.

Wall thickness for larger tanks (in either diameter or height dimension) shall be at least 1/2 inch. The minimum required wall thickness for the cylinder straight shell shall be sufficient to support its own weight in an upright position without any external support.

2. Provide flat areas to allow the attachment of fittings on the cylinder straight shell.

G. Restraint System

1. Metal components to be Type 316 stainless steel, edge softeners, and tension ring with Type 316 stainless steel cables and clamps.

2. Tank restraint system shall be supplied and the design of same certified by a Structural Engineer registered in the State Florida. Design shall conform to the most recent edition of the Florida Building Code (FBC). Anchor bolts as required by the calculations shall be supplied by the tank manufacturer.

H. Fittings - General Requirements

1. Place fittings at least 6 inches away from tank knuckle radius and flange lines.

2. Orientation of flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B16.5.

3. Flange dimensions to conform to ASME B16.5, Class 150. Flanges shall be flat faced. The flange face shall be 4 to 6 inches from the tank shell.

I. Fittings for Polyethylene Tanks

1. Provide an integrally molded flanged outlet (IMFO) at the bottom sidewall in a location that allows the tank to be fully drained. The IMFO shall be integrally molded into the tank during the rotational molding process. The IMFO shall be seamless, flanged, and manufactured from the same material as the tank. Inserts are not acceptable. A CPVC companion flange assembly with a split backing ring, Type 316 Stainless bolts, and EPDM gasket shall be provided. The single IMFO shall serve as the tank discharge and drain line connection.

2. Provide self-aligning universal ball dome fitting (bulkhead style) shown in the drawings. The maximum allowable size for threaded fittings shall be 3 inches. Construct threaded bulkhead fittings of CPVC. Gasket material for non-wetted bulkhead fittings shall be EPDM.

3. Provide bolted double flange fittings for below liquid level installation where shown in the drawings and for all fittings larger than 1 inch.

4. Provide flexible PTFE expansion joint for tank discharge designed to compensate for the misalignment, expansion, contraction and vibration isolation. Expansion joint shall be Ethylene Flexijoint® or equal. Expansion joint shall provide the following minimum characteristics:

Characteristic	Parameter
Axial Compression	≥ 1.5-inches
Axial Extension	≥ 0.625-inches
Lateral Deflection	≥ 0.750-inches
Angular Deflection	≥ 14°
Torsional Rotation	≥ 4°

5. Allowable flanged fitting sizes based on tank diameter for curved surfaces are shown below.

Tank Diameter (inches)	Maximum Bolted Fitting Size Allowable for PVC, CPVC, or Polypropylene Construction (inches)
120 to 142	8

Tank Diameter (inches)	Maximum Bolted Fitting Size Allowable for Stainless Steel Construction (inches)
64 to 142	4

The bolted double flange fittings shall allow tank wall thickness up to 2 1/2 inches.

6. Each bolted double flange fitting shall consist of one flange each on the inner and outer shell surfaces and shall be constructed with two each 150-pound flanges,

two each 150-pound flange gaskets, and the correct number and size of all-thread bolts for the flange specified by the flange manufacturer. Construct the fittings of CPVC or polypropylene. Provide a minimum of four each all-thread bolts. The bolts may have gasketed flanged metal heads or bolt heads encapsulated in Type II polyethylene material. Design the encapsulated bolt to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 inch of the threads closest to the bolt head. The polyethylene shall be color coded to distinguish bolt material. Each encapsulated bolt shall have a gasket to provide a bolt sealing surface against the inner flange.

J. Integrally Mounted Flanged Outlet Pad

Provide tank mounting pad specifically made for the integrally mounted flanged outlet tanks. Pad shall be designed to cradle the tank and keep the integrally mounted flanged outlet elevated above the floor, concrete pad or mounting surface.

K. Gaskets for Nozzles and Manways

Provide 1/4-inch-thick fullface EPDM 40 to 50 durometer for flanged nozzles and manways. When the mating flange has a raised face, remove the raised face.

L. Bolts and Nuts for Flanged Nozzles and Manways

Bolts shall be Type 316 stainless steel, per ASTM A193, Grade B8M. Nuts shall conform to ASTM A194, Grade 8M. Provide washer for each nut and bolt head. Washers shall be of the same material as the nuts.

M. Reverse Float Level Gauge

1. Construct reverse float level gauge of PVC. Connect the level gauge to the tank with two 3/4-inch fittings. Provide each fitting with a right-angle isolation valve.

2. Construct the sight level gauge fittings and valves of PVC. Gaskets shall be EPDM .

N. Fill and Overflow Pipes

Fill pipes shall be supported at 4-foot-maximum intervals with support structures. Down pipes shall provide vacuum

breaker and fill pipes shall be Schedule 80 PVC. Provide vacuum breaker on down pipes. Fill pipe shall include internal drop pipe with free standing internal pipe support and be the same diameter as external fill piping. Internal drop pipe shall terminate 2-inches above bottom of tank.

O. Liquids Stored

Liquids stored within the tanks are described below. See the subsection on "Service Conditions" to determine which tanks contain the particular liquid described.

Liquid	EOS MicroC2000™
Specific Gravity	1.22
Temperature	20°F To 100°F

P. Factory Leakage Testing

Test each tank at the factory or place of manufacture by filling with potable water. Allow the water to stay in the tanks for at least 12 hours. Check tank and nozzles and knuckles for leaks. Repair leaks and retest the tank until no leaks are observed.

PART 3 - EXECUTION

A. Service Conditions

1. Tank service conditions shall be as shown below.

2. Tank Tag Number: 520-TK-1 and 520-TK-2

Description	Bulk Storage Tanks
Liquid Contained	EOS MicroC2000™
Capacity, each tank, Minimum	6,000 gallons
Tank Outside Diameter, Maximum	10′-2″
Tank Overall Height, Maximum	12′-8″
Access Manway Diameter	24 inches
Maximum Internal Temperature	90°F
Minimum Internal Temperature	30°F
Maximum External Temperature	100°F
Minimum External Temperature	20°F
Resin Type	Type I crosslinked

Bolted Double-Flange Fitting Material	PVC or Polypropylene
Nozzle and Fitting Bolt and Nut Material	Type 316 stainless steel
Gasket Material for Nozzles, Manways, Sight Level Gauges, and Float Level Gauges	EPDM
Flanged outlet size	4”
Insulation Required	No
Heating System Required	No

B. Factory Cleaning

Remove dirt, chips, and debris from interior surfaces. Rinse with clean water. Rinse and dry exterior with clean water.

C. Shipping

Ship per ASTM D1998, Section 14 except delete paragraph 14.5, and the following. Wrap tanks with protective polyethylene sheet and protective tarpaulins to prevent deposition of road salts, fuel residue, and other contaminants in transit. Cover or plug fittings and flange faces with weatherproof metal covers.

D. Tank Installation

Install tanks level as shown in the drawings. Provide a rubber pad or provide layers of roofing felt between the tank bottom and the underlying slab as recommended by the tank manufacturer.

E. Installation Verification

1. Prior to checking final piping alignment to the tank, the piping system shall be complete as follows.

2. Complete pipe pressure testing, dry out the system, and remove hydrotest blind flanges.

3. Install and adjust permanent supports and hangers.

4. Remove temporary supports and hangers.

5. The system piping components and tank shall be at the same ambient temperature within a range of 10°F before starting final piping alignment checks.

6. Verify that the connecting tank piping is properly constructed. This inspection shall include verification of gasket material, gasket size, and the material, size, and length of flange bolts, studs, and nuts.

F. Flange and Piping Alignment Requirements

1. Do not spring flanges of connecting piping into position.

2. Line up pipe flange bolt holes with tank nozzle bolt holes within 1/16 inch maximum offset from the center of the bolt hole to permit insertion of bolts without applying any external force to the piping.

3. The tank and piping flange faces shall be parallel to less than 0.001 inch per inch of pipe flange outer diameter up to a maximum of 0.030 inch. For piping flange outer diameters smaller than 10 inches, the flanges shall be parallel to 0.010 inch or less.

4. Flange face separation shall be within the gasket spacing ±1/16 inch. Use only one gasket per flanged connection.

5. Separately work connecting piping systems into position to bring the piping flanges into alignment with the matching tank flanges. Do not move tank to achieve piping alignment.

G. Field Testing

1. Fill each tank with potable water and allow tank to set for 24 hours. Do not attach connecting piping until after the test period to allow for any differential settlement. Check for leaks and correct or repair any leaking areas.

2. During the tank filling, check that liquid level gauges operate smoothly without binding.

H. Warranty

The equipment shall be warranted for three (3) years commencing from date of substantial completion of the respective unit process in which the system is installed.

I. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

J. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

SECTION 13121 PRE-ENGINEERED METAL BUILDINGS

PART 1 - GENERAL

A. Description

This section includes materials, installation, and manufacturer's design of prefabricated metal buildings.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following:

2. Submit letter of certification identifying the metal building manufacturer is an AISC Class MB certified fabricator and that all building components will be designed in accordance with the current edition of the FBC Building Code.

3. Submit certification that the metal building manufacturer has been in business for at least 10 years and has designed and supplied at least five buildings similar to the specified project building. Include names of owners and locations for the referenced buildings.

4. Submit manufacturer's catalog data describing the building construction and components. Submit project-specific design and erection drawings, shop painting and finishing specifications, instruction manuals, and other data to describe the design, materials, sizes, layouts, construction details, fasteners, and erection.

5. Submit engineering design calculations for structural members and covering components, bracing, equipment supports, and anchor bolts. Submit the stress values utilized in the analysis stating the design criteria and procedures used. Design calculations shall be signed by a civil engineer registered in the state of Florida.

6. Submit certificate that the design meets the specified building codes.

7. Submit erection drawings and diagrams for each building. Submit calculations verifying the base anchor/foundation assemblies indicated in the drawings are adequate to accommodate the project-specific metal building reactions. Show column base anchor details and anchor bolt sizes. Show roof and wall bracing.

8. Submit color charts of the colors available for wall and roof panels, however, contract to include the cost to custom color match owners' preferred color for exterior and interior wall panels & liners, as indicated on the architectural elevation sheet in the design drawings.

C. Guarantee

1. Buildings shall be guaranteed against water leaks arising out of or caused by ordinary wear and tear by the elements for a period of five years. Such guarantee is in addition to the guarantee required in the General Conditions and shall start upon final acceptance of the work by the Owner.

2. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period, ABC Standard..

3. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - MATERIALS

A. Manufacturers

Prefabricated metal buildings shall be manufactured by American Buildings, Butler, Varco-Pruden, or equal.

B. Design Criteria

1. Buildings shall be of the size and shape shown, complete with all accessories.

2. The design of the building and components shall be in accordance with Metal Building Manufacturer's Association's "Recommended Design Practices Manual," latest edition, and the FBC Building Code.

3. Design building for the dead load, specified live load, and the combinations of these loads as specified below. Reduction of loads due to tributary loaded area is permitted only for the rigid frames. Include the following loads in addition to the dead load:

a. Live load 20 psf.

b. A uniform collateral load of 10 psf in addition to the dead load of the building.

c. Weights of mechanical equipment and process piping supported by the structure if greater than 10 psf.

d. Wind load per the FBC requirements supplemented by ASCE 7-10: See Drawings.

4. Rigid frame shall consist of welded up plate section columns and foot beam complete with necessary splice plates for bolted field assembly.

5. End rigid frames shall be the same as interior rigid frames

6. Design structural steel members in accordance with AISC publication, "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings." Design structural cold-formed steel framing members in accordance with AISI publication, "Specification for the Design of Cold-Formed Steel Structural Members."

7. Purlins and Girts shall be 8 in. minimum deep “Z” sections, precision roll formed.

8. Eve struts shall be 8in. minimum deep “C” sections.

9. All columns shall be designed as “Pin” connected. Moment transfer to footings will not be allowed.

10. The building foundation plan is a preliminary design, the foundation design will be reviewed by the engineer once the Prefabricated Metal Building submittal is approved.

11. Design framed openings to replace structurally the covering and framing displaced.

12. Welding of steel shall be in accordance with AWS D1.1.

13. Except as modified hereinafter, design steel covering in accordance with AISI publication "Specification for the Design of Cold-Formed Steel Structural Members."

14. Maximum wind load deflection for Primary Framing shall not exceed 1/60 of the eave height of the building.

15. Maximum wind load deflection for wall sheets shall not exceed 1/180 of the span between supports, and maximum

live load deflection for roof sheets shall not exceed 1/180 of the span between supports. Maximum deflections shall be based on sheets continuous across two or more supports with sheets unfastened and fully free to deflect.

C. Bracing

Provide roof bracing. Design bracing for controlling wind or seismic load combinations. Brace compression flanges of structural members as required by the code.

D. Assembly and Disassembly

1. The size of the prefabricated components and the field connections required for erection shall permit easy assembly and disassembly by means of the building manufacturer's standard fasteners and construction tools. The maximum size of any shop-assembled component of the building shall permit transportation from factory to site by commercial carrier.

2. Clearly and legibly mark each and every piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and/or instruction manuals.

E. Exterior Covering Components--Steel

1. Roof Covering shall be standing seam with minimum 24-gauge galvanized steel conforming to ASTM A653, G90 coating designation, factory color finished. Panels shall have 2 major corrugations, 2 inches high not exceeding 24inches.

2. Wall Covering shall be rib panel with minimum 24-gauge galvanized steel conforming to ASTM A653, G90 coating designation, factory color finished.

F. Accessories

Flashing, trim, metal closure strips, caps, and similar metal accessories shall be not less than the minimum thicknesses specified for covering. Molded closure strips shall be bituminous-saturated fiber, closed-cell or solid-cell synthetic rubber or neoprene, or PVC premolded to match configuration of the covering.

G. Dissimilar Metal Isolation

Coat steel in contact with aluminum or aluminum-coated steel covering per Section 09900, System No. 51 or provide rubber or nylon gaskets between steel and aluminum surfaces.

H. Fasteners

1. All structural framing shall utilize high-strength (H-S) bolts. H-S bolts, nuts, and washers shall conform to ASTM A325, Type 1 galvanized, ASTM A563, and ASTM F436, respectively.

2. Fasteners for securing covering and accessory items shall be Type 316 stainless steel.

3. Use stainless steel or aluminum fasteners with aluminum items and covering. Use stainless steel fasteners with steel items and covering.

4. Provide gasketed washers of a material compatible with the covering and with a minimum diameter of 3/8 inch for structural connections to waterproof the fastener penetration on the exterior side. Gasketed portion of washers shall be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Exposed wall fasteners shall be factory color finished or provided with plastic color caps to match the covering.

I. Painting of Roof Panels

1. Color finish roof covering at the factory on both sides. Prepare surfaces for coating by thoroughly cleaning, pretreating, and priming (if required by the finish coat) to provide a film that is compatible with the metal surface and the color finish. Treat galvanized steel surfaces per DOD-P-15328D. Clean surfaces of oil, grease, loose scale, and other foreign substances. Prime coat shall be in accordance with the manufacturer's standard system.

2. Color finish shall consist of a Kynar 500/Hylar 5000 fluoropolymer coating.

3. Dry-film coating thickness of the color coat shall be not less than 1.0 mil for exterior and interior surface finish. The exterior and interior finishing systems shall meet the quality standards specified in The Aluminum Association publication, "Aluminum Standards

and Data," except that for salt spray resistance, exposure shall be 450 hours, and maximum undercutting from the scored line shall not exceed 1/8 inch. Colors shall be as selected by the Owner's Representative from manufacturer's standard colors.

J. Painting of Girts, Purlins, Beams, Columns, Bracing, and Eave Strut

1. Rigid frames and special structural framing shall be shop coated with a primer meeting the following:

   a. Solids by Volume: 61% (percent ±2)

   b. Type: Zinc Rich Aromatic Urethane

   c. Dry Film Thickness: 3 to 3.5 mils

   d. Number of Coats: One

   e. V.O.C. (Max): 2.67 (Unthinned)

2. Shop primer shall be compatible with specified field paint system

3. Field paint with a 5 mil DFT Polyamide epoxy and a finish coat of 3 mil of acrylic polyurethane. Polyamide epoxy product shall be Tnemec N69 or Sherwin-Williams Macropoxy 646. Acrylic polyurethane product shall be Tnemec Series 73 or Sherwin-Williams B65-350. Color to be selected by Owner.

K. Sealant

Provide sealant of the type recommended by the building manufacturer at each joint.

L. Spare Parts

Provide a minimum of 5% excess over the required amount of nuts, bolts, screws, washers, and other required fasteners with each building. Provide separate boxes for the parts for each building. Label each box with the name of the building to which it pertains; the building manufacturer's name; and the local representative's name, address, and telephone

number. Provide individual boxes for each item (nuts, bolts, washers, etc.).

PART 3 - EXECUTION

A. Storage and Protection

1. Deliver, store, handle, and erect prefabricated components, sheets, panels, and other manufactured items such that they will not be damaged or deformed. Stock materials stored on the site before erection on platforms or pallets and cover with tarpaulins or other weathertight covering. Store metal sheets or panels so that water will drain off. Upon arrival on the jobsite, remove moisture on sheets and panels, restack, and protect until used.

2. Do not store the sheets or panels in contact with materials that might cause staining. Remove stained, discolored, or damaged sheets from the site.

B. Erection

1. Determine anchor bolt layouts before pouring concrete footings, walls, or slabs to support the buildings.

2. Erect in accordance with the manufacturer's erection instructions and drawings and the requirements herein. Plug improper or mislocated drill holes with an oversize screw fastener and gasketed washers. Do not use sheets with an excess of such holes or with such holes in critical locations. Keep exposed surfaces clean and free from sealant, metal cuttings, and other foreign materials.

3. Accurately set anchor bolts by template while the concrete is in a plastic state. Provide uniform bearing under baseplates and sill members using nonshrink grout. Accurately space members to assure proper fitting of covering. As erection progresses, securely fasten the work and brace to resist vertical loads and horizontal wind or earthquake loads.

4. Apply wall covering with the longitudinal configurations in the vertical position. Apply roof covering with the longitudinal configurations in the direction of the roof slope.

5. Except for self-framing buildings, make end laps over framing members with fasteners into framing members approximately 2 inches from the end of the overlapping sheet. Side lap distances, end lap distances, joint sealing, and spacing of fasteners shall be in accordance with the manufacturer's standard practice insofar as the maximum fastener spacing specified is not exceeded and provided such standard practice will result in a structure that will be free from water leaks and meet design requirements.

6. Spacing of fasteners shall present an orderly appearance and shall not exceed 8 inches on center at end laps of covering, 12 inches on center at connection of covering to intermediate supports, 12 inches on center at side laps of roof coverings, and 18 inches on center at side laps of wall covering. Install fasteners in straight lines within a tolerance of 1/2 inch in the length of a bay.

7. Seal side laps and end laps of roof and wall covering and joints at accessories. Drive fasteners normal to the surface and to a uniform depth to properly seat the gasketed washers. Fasten accessories into framing members.

8. Insulate incompatible dissimilar materials that are in contact by means of gaskets or insulating compounds.

C. Field Painting

1. Touch up factory-coated finish surfaces with the building manufacturer's touch-up paint for the particular finish coat used.

END OF SECTION

SECTION 13300 PROCESS INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

A. Scope of Work

1. A single Instrumentation System Supplier (ISS) shall furnish all services and equipment defined herein and in other Specification Sections as listed below under Related Work, and as shown on Instrumentation Drawings.

2. The ISS shall provide all materials, equipment, labor, and services required to achieve a fully operational system. The ISS shall design and coordinate the instrument and control system for proper operation with related equipment and materials furnished by other suppliers under other sections of these Specifications and with related existing equipment.

3. Auxiliary and accessory devices necessary for system operation or performance, such as transducers or relays to interface with existing equipment or equipment provided by other suppliers under other Sections of these Specifications, shall be included whether they are shown on the instrument drawings or not.

4. Substitutions on functions or type of equipment specified will not be acceptable. In order to insure the interchangeability of parts, the maintenance of existing equipment, the ease of interfacing between the various subsystems, and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained. In order to insure compatibility between all equipment, it shall be the responsibility of the ISS to coordinate all interface requirements with mechanical and electrical system suppliers and furnish any signal isolation devices that might be required.

5. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity

with detailed Drawings, Specifications, engineering data, instructions and recommendations of the equipment manufacturer as accepted by the Engineer.

6. To facilitate the Owner's future operation and maintenance, products shall be of the same major instrumentation manufacturer, with panel mounted devices of the same type and model as far as possible.

7. Equipment removed in the course of this work shall be the property of the Owner. ISS shall coordinate with Contractor and Owner in the removal of all designated existing equipment.

8. The Orange County East Regional Water Reclamation Facility is an operating facility, and all work shall be coordinated with its operating personnel to minimize impact on its daily operation.

9. All equipment and installations shall satisfy applicable Federal, State, and local codes.

10. Supplementing this Section, the Drawings and the related Specification sections provide additional details showing panel elevations, instrument device schedules, functional requirements of the system, and interaction with other equipment.

11. All materials, equipment, labor, and services necessary to achieve the monitoring and control functions described herein shall be provided in a timely manner such that the monitoring and control functions are available when the equipment is ready to be placed into service.

B. Related Work

1. The ISS shall furnish all materials, labor and services specified in the following Specification Sections as required to ensure a single, coordinated system is supplied:

a. Section 13305 – Application Engineering Services

b. Section 13310 – Programmable Logic Controllers (PLC) and Digital Equipment

c. Section 13315 – Field Instrumentation

d. Section 13320 – Fiber Optic Data Highway Network

e. Section 13325 – Control Panels And Panel Mounted Equipment

2. Divisions requiring coordination shall include, but not be limited to, the following:

a. Division 11 – Equipment

b. Division 13 Special Construction

c. Division 15 – Mechanical

d. Division 16 Electrical

C. Coordination Meetings

1. The ISS shall schedule three (3) mandatory coordination meetings. The meetings shall be held at the Owner's or Engineer's offices and shall be attended by, as a minimum, attendance by the Owner, the Engineer, the ISS project engineer, and the Electrical Subcontractor.

a. The first meeting shall be held in advance of the first ISS shop drawing submittal. The purpose of the meeting shall be for the ISS to: summarize their understanding of the project; discuss the design intent and philosophy of each control loop to assist in development of loop narratives; discuss any proposed substitutions or alternatives; schedule testing and delivery milestone dates; discuss number and type of graphic displays and reports; provide a forum for the ISS, APS, Engineer and Owner to coordinate hardware and software related issues;

discuss exact number and content of submittals; and request any additional information required from the Engineer and Owner. The ISS should bring draft working documents to the meeting to provide the basis for the Engineer's and Owner's input into their development.

b. The second meeting shall be held after the first complete shop drawing package has been reviewed by the Engineer and returned to the ISS. The purpose of the second meeting is to discuss comments made on the submittal package; to refine scheduled milestone dates; and to provide a forum for any further required coordination, ensuring that the design intent is preserved.

c. The third meeting shall be held prior to factory acceptance testing. The purpose of this third meeting is to discuss any remaining coordination requirements.

D. Submittals

1. Submit Shop Drawings in accordance with Section 01300. These Shop Drawings shall fully demonstrate that the equipment and services to be furnished will comply with the provisions of these specifications and shall provide a true and complete record of the equipment as manufactured and delivered. Submittals shall be bound in separate three ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11 in x 17 in for inclusion within the binder.

2. Project Plan Submittal

a. The Project Plan shall provide an overview of the proposed system including the approach to work, proposed system architecture diagrams (both Ethernet and Profibus), a preliminary bill of materials of major items to be provided, the proposed work schedule indicating milestones and meetings, project personnel and organization, overviews of testing

procedures and training, and a paragraph by paragraph review of the Specifications indicating any proposed deviations.

b. The schedule shall illustrate all major project milestones including the following:

i. Schedule for all subsequent project submittals.
ii. Tentative dates for all project design review meetings.
iii. Schedule of manufacture and staging of all instrumentation and control system equipment.
iv. Schedule for all tests.
v. Schedule for shipment of all instrument and control system equipment and all peripheral devices.
vi. Schedule for equipment startup.
vii. Schedule for all training.

c. The project personnel section shall include the project manager, project engineers and all field technicians/staff anticipated to be used on this project. Provide up to date résumés for all personnel identified.

d. The Project Plan must be submitted and approved before any further submittals will be accepted.

3. Instrumentation Submittal

a. This submittal shall provide complete documentation of all field instruments, panel components, and other instrument and control equipment not specified to be submitted elsewhere.

i. Provide data sheets for each component listing all model numbers, optional, and ancillary devices that are being provided. The data sheets shall be provided with an index and proper identification and cross referencing. They shall include but not be limited to the following information:

1) Plant Equipment Number and ISA tag number per the Loop Diagrams.
2) Product (item) name used herein and on the Contract Drawings.
3) Manufacturers complete model number.
4) Location of the device.
5) Input output characteristics.
6) Range, size, and graduations.
7) Physical size with dimensions, enclosure NEMA classification and mounting details.
8) Materials of construction of all components.
9) Instrument or control device sizing calculations where applicable.
10) Certified calibration data on all flow metering devices.

b. Provide equipment specification sheets which shall fully describe the device, the intended function, how it operates, and its physical, environmental and performance characteristics. Each data sheet shall have appropriate cross references to loop or equipment identification tags. As a minimum the specification sheets shall include the following:
   i. Dimension, rigid clearances.
   ii. Mounting or installation details.
   iii. Connection.
   iv. Electrical power or air requirements.
   v. Materials of construction.
   vi. Environmental characteristics.
   vii. Performance characteristics.

c. Detailed drawings covering control panels, consoles and/or enclosures which shall include:
   i. Cabinet assembly and layout Drawings to scale. These shall include both front and rear layouts.
   ii. Fabrication and painting specifications.
   iii. Color selection samples for selection by the Engineer.
   iv. Panel wiring diagrams showing all power connections to equipment within and on the enclosure, combined panel power draw

requirements (volts, amps), breaker sizes, fuse sizes, and grounding. This wiring diagram shall be in ladder logic format and shall reference the appropriate Loop Drawing for continuations or details where required. Show all wire numbers and terminal block designations.

d. The submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards, and equipment layouts in order to enable the ISS to proceed with the detailed site preparation for all equipment.

e. This submittal shall include:
   i. A list of and descriptive literature for tools, spares, expendables, and test equipment as specified in Instrumentation Specifications.
   ii. A separate list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the ISS.
   iii. Unit and total costs for the additional spare items recommended for each subsystem.
   iv. Storage instructions for all spare parts.

4. Digital System Hardware Submittal

a. This submittal shall provide complete documentation of the proposed control room and system equipment other than that included in the Instrumentation submittal: computers, communications equipment, peripherals, fiber optic cable, radio telemetry equipment, etc.

b. Provide a complete system block diagram(s) showing in schematic form, the interconnections between major hardware components such as: control centers, panels, power supplies, consoles, computer and peripheral devices, telemetry equipment, local digital processors and like equipment. The block diagram shall reflect the total integration of all

digital devices in the system and shall reflect any HMI locations. All components shall be clearly identified with appropriate cross references to the location of each. The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.

c. Provide a data sheet and manufacturer cut sheets for each hardware component listing all model numbers, optional, auxiliary and ancillary devices that are being provided. The data sheets shall be provided with an index and proper identification and cross referencing.

d. The Digital System Hardware submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, radio survey information, plug identifications, safety precautions or guards, and equipment layouts in order to enable the ISS to proceed with the detailed site preparation for all equipment.

e. The ISS shall provide fiber optic power budget for each cable run in excess of 500 feet. Cable budget shall include transmitter power, receiver sensitivity, connector losses, cable losses and a 3 dB aging margin. Fiber optic transmission line shall maintain a minimum of 3 dB safety margin.

f. This submittal shall include:
   i. A list of and descriptive literature for tools, spares, expendables, and test equipment as specified in Instrumentation Specifications.
   ii. A separate list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the ISS.
   iii. Unit and total costs for the additional spare items recommended for each subsystem.
   iv. Storage instructions for all spare parts.

5. Software Submittals

a. Operator Interface and Process Control Strategy

i. This submittal shall cover the specific plant control schemes as well as the details of the plant reports and process graphic displays.
ii. The submittal shall contain the semifinal details of all logs, reports, and process graphic displays. The specifics of what shall appear on each display and what calculations are required to support them shall be developed and submitted.
iii. Submitted process graphic displays shall be no less than 8-1/2 inches by 11 inches and in full color.
iv. A complete listing of all signals to be collected for long term historical information shall be provided. This listing shall include frequency of data sampling and duration for which the data shall be immediately accessible.
v. A complete listing of all signals to be collected for trend display shall be provided. This listing shall include frequency of data sampling and duration for which the data shall be immediately accessible.
vi. The process control schemes shall be developed in a ladder logic diagram or functional block (logic) diagram presentation based on information from the Specifications. Included with each diagram shall be:

1) Brief scope of the Control Function
2) Listing of all scanned inputs to the control function
3) A loop narrative for each control loop
4) Any assumptions made in developing the program
5) I/O database listing showing all field inputs and outputs (i.e., AI, DI, AO, DO) associated with the control function.
6) Cross reference list of all I/O showing to which I/O modules or software modules they are linked
7) Listing of all operator inputs/outputs to and from the control function. Any special CRT

displays related to the function shall be illustrated. A description of the operation of any panels shall be described as it relates to the control function.

vii. Failure contingencies shall be described in detail.

viii. This submittal shall cover all of the associated ladder logic developed under this Contract required to implement the control functions specified.

ix. Submit annotated ladder logic in 8-1/2″ x 11″ format and as a PDF file on CD-ROM for all logic developed. Annotation shall be 3 lines of 6 characters each for every logic contact. In addition, each network or rung shall be annotated so that a non-technical person can read and easily comprehend what control function the rung or network is performing.

x. This submittal shall also include copies of the PLC I/O configuration tables, I/O reference usage table, complete cross reference too specific rung used of all inputs, outputs, internal coils, data registers, and special purpose coils. In addition, any special switch settings or hardware configuration requirements such as communications port configurations shall be described in detail and submitted.

6. Testing Submittals

a. The test plan shall be submitted after all hardware submittals have been approved by the Engineer.

b. The test plan shall demonstrate that the ISS has designed and configured a system that meets the design specifications. The documents for the test plan shall be structured so that the Owner understands what the inputs are, what the predicted outputs should be and what the actual outputs are. The test plan should have sign off and date block for the ISS, the Engineer and the Owner, and where applicable, the APS.

c. The complete test plan should include as a minimum descriptions for the following:
   i. System hardware and software summary.
   ii. A schedule for the testing describing the specific tasks to be performed and the time allotted for each.
   iii. Communications test to the various PLCs for Discrete and Analog I/O data transfer.
   iv. 100 percent I/O point test including all spare points based upon the previously submitted System I/O list.

d. Test Procedures: Submit the procedures proposed to be followed during the test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests.
   i. Preliminary test procedure submittals: Prior to the preparation of the detailed test procedures, submit outlines of the specific proposed tests. Submittals shall include examples of the proposed forms and checklists. The same test forms may be used for unwitnessed and witnessed tests.
   ii. Test Procedure Submittals: After the preliminary test procedure submittals have been reviewed by the Engineer and returned stamped either "approved" or "approved as noted, confirm" submit the proposed detailed test procedures. Testing may not be started until all Testing Submittals have been approved.

e. Test Documentation: Submit a copy of the signed off test procedures upon completion of each required test.

7. Training

a. The training plan shall include:
   i. Definitions of each course.
   ii. Specific course attendance.
   iii. Schedule of training courses including dates, duration, and locations of each class.

iv. Resumes of the instructors who will actually conduct the training.

8. Refer to Related Sections of the Specifications for other required submittals.

E. Reference Standards

1. American Society for Testing and Materials (ASTM).

a. ASTM A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

2. International Society of Automation (ISA)

a. ISA-5.1 – Instrumentation Symbols and Identification
b. ISA-5.2 Binary Logic Diagrams for Process Operations
c. ISA-5.3 Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems
d. ISA-5.4 Instrument Loop Diagrams
e. ISA-5.5 – Graphic Symbols for Process Displays

3. American National Standards Institute (ANSI)

a. ANSI X3.5 Flowchart Symbols and Their Usage in Information Processing

4. National Electrical Manufacturers Association (NEMA)

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

F. Quality Assurance

1. The ISS shall perform all work necessary to select, furnish, install, connect, and place into operation all hardware specified within this Division.

2. Actual installation of the system need not be performed by the ISS's employees; however, the ISS shall be responsible for the onsite technical supervision of the installation.

3. The ISS shall furnish equipment that is the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.

4. The ISS shall be one of the following parties:

   a. Control Instruments Inc. (C2i)
      5253 Oakdale Road
      Smyrna, GA 30082
      TEL: (404) 351-1085

   b. Curry Controls Company
      P. O. Drawer 5408
      Lakeland, FL 33807
      TEL: (863) 646-5781

   c. Commerce Controls, Inc.
      41069 Vincenti Ct.
      Novi, MI 48375
      TEL: (248) 476-1442

   d. Revere Control Systems
      2240 Rocky Ridge Rd.
      Birmingham, AL 35216
      TEL: (205) 824-0004

G. System Description

1. The responsibilities of the ISS shall include, but not be limited to, the following:

   a. Furnish and install all field devices and instrumentation as shown on the Contract Drawings and called out in Sections 13300 and 13315.

b. Furnish and install the new PLC panels, Remote I/O (RIO) panels, fiber optic converter panels, and other control panels (except those indicated as furnished by others), as shown on the Instrumentation Drawings. Provide modifications to existing control panels as required. Panels and panel components shall conform to the requirements of Sections 13300, 13310 and 13325.

c. Furnish and physically install the new PC Servers and Workstations, associated software, and related equipment, in accordance with the requirements of Sections 13310 and the Drawings. New PC equipment shall be installed in the same locations as existing equipment and utilize the same networking equipment.

    i. Furnish one (1) new Server for use as Secondary Web Server. Refer to the System Architecture drawing I-003.

d. Furnish fiber optic cable and appurtenances to connect to the fiber optic cable “backbone” for networking of plant areas. Furnish fiber optic patch panels and baying enclosures to replace fiber optic pull boxes where indicated on the Drawings. ISS shall be responsible for making and testing all fiber optic connections, ensuring all connections to control equipment are made properly, and that the system is functioning as called out on the Drawings and in the Specifications. Refer to Section 13320, the Control System Block Diagram, and the Electrical drawings for details.

e. Provide applications software programming, including PLC ladder logic, Human-Machine Interface (HMI) graphics, networking, redundancy, database, reports, and local panel HMI screen and database programming, as defined in Section 13305.

2. ISS shall refer to the Contract Drawings and the Specifications for complete information concerning all

equipment and services to be furnished under this contract.

3. Any disputes or conflicts over scopes of work shall be settled by the Engineer.

H. Delivery, Storage and Handling

1. Identification

a. Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.

b. A permanent plastic tag, black letters on white background, shall be firmly attached and permanently and indelibly marked with the instrument tag number, as given in the Drawings, to each piece of equipment supplied.

2. Storage

a. Equipment shall not be stored out of doors. Equipment shall be stored in dry permanent shelters including in line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be replaced by the ISS at his own cost and expense.

I. Project/Site Requirements

1. Environmental Requirements. Indoor, non-process areas require NEMA Type 12 painted enclosures. All other areas require NEMA Type 4X stainless steel enclosures. Refer to Division 16 for area environmental hazardous classifications. Outdoor areas require sun shields.

2. Elevation. Equipment shall be designed to operate at a ground elevation of approximately 15 to 20 feet above mean sea level. Equipment mounted below grade shall be NEMA Type 4X, 6, or 6P.

3. Temperature. Indoor areas' equipment shall be suitable for 10 to 40 C degrees ambient. Outdoor areas' equipment shall be suitable for -30 to 50 C degrees ambient. Storage temperatures will range from 0 to 50 C degrees ambient. Additional cooling or heating shall be furnished if required by the equipment furnished.

4. Relative Humidity. Air conditioned area equipment shall be suitable for 20 to 80 percent relative, non-condensing humidity. All other equipment shall be suitable for 0 to 100 percent relative, condensing humidity.

5. Power Supply. 120 volts AC sources of electric supply will be unregulated industrial panel boards.

J. Tools, Spare Parts and Expendables

1. In addition to those defined in related Specification Sections, furnish the following, or approved equals.

2. Tools

   a. Electro-Mechanical Tool Kit, JTK-88.

   b. LAN/PC Tool Kit, Jensen JTK-5000.

   c. Handheld multifunction calibrator, Fluke 725, with complete set of instrument modules, leads and clamps, belt holster, and spare batteries/battery charger.

   d. Handheld calibrator for Profibus instruments and networks, with complete set of instrument modules, leads and clamps, belt holster, and spare batteries/battery charger.

3. Spares and Expendables

a. Spare parts shall be as defined in the related specification sections. All spare parts shall be new and unused.

b. All spare parts shall be individually packaged and labeled, and packed in a manner suitable for long term storage and adequately protected against corrosion, humidity and temperature.

c. Provide one gallon of touch up paint, in one quart containers, for each type and color used for all cabinets, panels, consoles, etc.

K. Operational & Maintenance (O&M) Documentation

1. Prior to final acceptance of the system and owner training, operating and maintenance manuals covering instruction and maintenance on each type of equipment shall be furnished. The ISS shall submit the final documents after the review and acceptance of the Engineer as specified in Section 01300.

2. Provide at least the following documentation as a minimum:

a. A comprehensive index.

b. A complete "As Constructed" set of corrected and completed Shop Drawings.

c. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

d. Full specifications on each item.

e. System schematic drawings "As Constructed", illustrating all components, piping and electrical connections of the systems supplied under this Section.

f. Detailed service, maintenance and operation instructions for each item supplied.

g. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

h. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic Drawings and instructions.

i. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

3. The final documentation shall be new documentation written specifically for this project, but may include standard and modified standard documentation. Modifications to existing hardware or software manuals shall be made on the respective pages or inserted adjacent to the modified pages. All standard documentation furnished shall have all portions that apply clearly indicated. All portions that do not apply shall be lined out.

4. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

5. If the ISS transmits any documentation or other technical information which he considers proprietary, such information shall be so designated. Documentation or technical information which is designated as being proprietary will be used only for the design, construction, operation, or maintenance of the System and, to the extent permitted by law, will not be published or otherwise disclosed.

6. The requirements for the final documentation are as follows:

   a. As built documentation shall include all previous submittals, as described in this Specification, updated to reflect the as built system. Any errors in or modifications to the System resulting from the Factory and/or Field Acceptance Tests shall be incorporated in this documentation.

   b. The Hardware Maintenance Documentation shall describe the detailed preventive and corrective procedures required to keep the System in good operating condition. Within the complete Hardware Maintenance Documentation, all hardware maintenance manuals shall make reference to appropriate diagnostics, where applicable, and all necessary timing diagrams shall be included. A maintenance manual or a set of manuals shall be furnished for all delivered hardware, including peripherals. The Hardware Maintenance Documentation shall include, as a minimum, the following information:

      i. Operation Information This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

      ii. Preventative Maintenance Instructions These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.

      iii. Corrective Maintenance Instructions These instructions shall include guides for locating malfunctions down to the card replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the

probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.

iv. Parts Information This information shall include the identification of each replaceable or field repairable module. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross references between the Instrumentation System Supplier's part number and manufacturer's part numbers shall be provided.

7. Electronic O&M Information

a. In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals on CD-R or DVD-R. Electronic documents shall be supplied in PDF format or as specified below.

b. Provide electronic files for all custom-developed manuals. Text shall be supplied in both Microsoft Word and PDF format as applicable.

c. Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in Adobe Acrobat format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, and fonts into individual zip files along with the drawing file.

d. Each PLC and PC shall be backed up onto CD-R or DVD-R after Final Completion and shall be turned over to the Owner. Provide all final as-built PLC and HMI project files in their respective native formats. Each file must contain all instruction and rung comments.

PART 2 - PRODUCTS

A. General Equipment Requirements

1. Instrumentation

a. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals which are established standards for the water and wastewater industries.

b. Digital or discrete (on/off) control signals shall be 120VAC, 60Hz. Analog measurement signals shall be 24VDC, 4-20 mA. No zero based signals will be allowed.

c. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

d. Wall- or surface-mounted instruments that are exposed to direct sunlight shall be equipped with adequate sunshields. The sunshield shall consist of one or more pieces of stainless steel or other suitable material of sufficient size to cover the top, sides, and rear of the panel (where applicable), and to hang over the front of the panel to shade any instruments mounted there. Sunshield pieces shall be secured to the panel by bolts and shall have no less than 1 inch of clearance from the panel and from one another, to allow for air circulation over the sunshield surfaces and access to panel door(s).

e. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Electrical Drawings, to comply with the National Electrical Code.

f. All indicators and recorder read outs shall be linear in process units, unless otherwise noted.

g. All transmitters shall be provided with either integral indicators or conduit mounted indicators in process units, accurate to two percent.

h. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

i. All equipment, cabinets and devices furnished hereunder shall be heavy duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

j. The field mounted digital system equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

k. All electronic/digital equipment shall be provided with radio frequency interference protection and shall be FCC compliant.

2. Electrical

a. All equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 117 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplied required for compliance with the above

shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

b. Materials and equipment used shall be U.L. listed wherever available.

c. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

d. Existing signal and control wiring may be wired through intermediate junction boxes/termination cabinets. Note that all new wiring shall not utilize junction boxes or termination cabinets, but shall be connected directly between PLC or other control system panels, and field devices, equipment or motor control panels.

B. Lightning/Surge Protection

1. General

a. Lightning/Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Instruments shall be housed in a suitable metallic case, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate NEMA 4 junction box coupled to the enclosure. All contact points to be copper with nickel plating. The

transient response of units shall be less than 1 nanosecond.

b. The surge protector should meet UL 1449, NEMA LS-1, and IEEE C62.41 Standards, as applicable. This requirement can be met using UL itself or a Nationally Recognized Testing Lab (NRTL) testing to UL standards, in accordance with FTC rules.

c. The manufacturer shall be Current Technology/ Joslyn, Dehn, EDCO, or Surge Suppression Inc. (SSI).

2. Installation

a. The following standards shall be observed:

i. All analog signal lines, or Profibus “daisy chains”, that include an outdoor instrument and a control panel, shall be protected by surge suppressors at all termination points.

ii. All 120V power to outdoor instruments shall be protected with a local surge suppressor mounted at the instrument, as indicated above. Main power to a panel should be on a circuit breaker.

iii. Network cable (other than fiber optic) shall be protected at both ends if it runs beyond the walls of a structure.

C. Tubing and Fittings

1. All instrument air header takeoffs and branch connections less than 2-inch size shall be 316 stainless steel.

2. All instrument shut off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. Fittings shall be Swagelok 316 stainless steel or equal and valves shall be Whitney 316 stainless steel or equal.

3. All instrument tubing shall be fully annealed ASTM A269 Seamless 316 grade free of O.D. scratches having the following dimensional characteristics as required to fit the specific installation:

   a. 1/4 in to 1/2 in O.D. x 0.035 wall thickness.

   b. 5/8 in to 1 in O.D. x 0.049 wall thickness.

   c. 1 in O.D. x 0.065 wall thickness.

   d. 1 1/4 in O.D. x 0.065 wall thickness.

   e. 1 1/2 in O.D. x 0.083 wall thickness.

   f. 2 in O.D. x 0.095 wall thickness.

4. All process connections to instruments shall be annealed 1/2 in O.D. stainless steel tubing, Type 316.

5. All tube track shall be supported by stainless steel and installed as per manufacturer's installation instructions.

PART 3 - EXECUTION

A. General Installation

1. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as accepted by the Engineer during construction. Obtain in the field all information relevant to the placing of process control work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work.

2. The instrumentation loop diagrams indicate the intent of the interconnection between the individual instruments.

Any exceptions should be noted. Two complete sets of As Constructed shop drawings shall be kept at the job site during all on site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or start up. All markings shall be verified and initialed by the Engineer or his designated representative.

3. Following completion of installation and the operational readiness test, one set of the marked up drawings shall be provided to the Engineer, the other retained by the ISS for incorporation of the mark ups into final as built documentation. Record drawings shall be as called out in Section 01340 of these specifications.

4. The instrumentation installation details on the Contract Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the American Petroleum Institute (API) Recommended Practice 550 shall be followed as applicable.

5. All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the ISS shall bear full responsibility for such violations and assume all costs arising therefrom.

6. All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the ISS shall bear full responsibility for such violations and assume all costs arising there from.

7. Unless specifically shown in the Contract Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands as detailed on the installation detail drawings.

All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing, and blow down service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

8. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors, and shut off valves.

9. Field instruments requiring power supplies shall be provided with local electrical shutoffs and fuses as required.

10. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

11. The ISS shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the ISS shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The ISS shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).

12. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

13. Lifting rings from cabinets/assemblies shall be removed. Hole plugs shall be provided for the holes of the same color as the cabinet.

14. The ISS shall coordinate the installation, the placing and location of system components, their connections to

the process equipment panels, cabinets and devices, subject to the Engineer's review. He shall be responsible to insure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to insure a satisfactory functioning installation. The ISS hereunder shall schedule and coordinate his work under this section with that of the electrical work specified under applicable Sections of Division 16.

B. Tests (General)

1. The ISS shall test all equipment, hardware and software, to be furnished under this Contract at ISS's own facility before transporting it to the project site.

2. As a minimum, the testing shall include the following:

   a. Unwitnessed Factory Test (UFT).

   b. Witnessed Factory Test (WFT).

   c. Operational Readiness Tests (ORT).

   d. Functional Demonstration Tests (FDT).

   e. Performance Acceptance Test (PAT).

3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

4. All tests shall be conducted in accordance with prior Engineer reviewed procedures, forms, and check list. Each specific test to be performed shall be described and a space provided after it for sign off by the appropriate party after its satisfactory completion.

5. Copies of these sign off test procedures, forms, and check lists will constitute the required test documentation.

6. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.

7. The ISS shall coordinate all testing with the Engineer, the Applications Programming Supplier (APS), all affected Subcontractors, and the Owner.

8. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the previously accepted test procedures.

9. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

10. No equipment shall be shipped until the engineer has received all test results and the system is ready for shipment.

11. The ISS shall furnish the services of servicemen, all special calibration and test equipment and labor to perform the field tests.

C. Unwitnessed Factory Tests (UFT)

1. The entire system except for primary elements, final control elements, and field mounted transmitters shall be interconnected and tested to ensure the system will operate as specified. All control loops and programs shall be tested. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.

2. All panels and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, specifications, and Contract Drawings.

3. During the tests all digital system hardware and software shall be operated for at least five days continuously without a failure to verify the system is capable of continuous operation.

4. All PLC and HMI software programming, including the integration of Profibus DP and Modbus TCP networked devices, must be completed and debugged by the APS prior to the Unwitnessed Factory Test. UFT test results shall include full testing of software and programming.

D. Witnessed Factory Test (WFT)

1. Implicit in the scheduling of the Witnessed Factory Test is the assumption that the ISS has determined through his own tests and quality assurance programs that the equipment is ready for shipment.

2. Prior to start of the Witnessed Factory Test, all previous unwitnessed test results shall have been submitted to the Engineer for review and approval.

3. All system tests specified for the Unwitnessed Factory Test shall be repeated, including software and programming tests.

4. After the Unwitnessed Factory Test approval has been received by the ISS, the ISS shall notify the Engineer, the APS, and the Owner in writing that the system is ready for the Witnessed Factory Test, and allow the Engineer and/or Owner to schedule a test date within 30 days of receipt of the "Ready to Test" letter. At the time of notification, the ISS shall submit any revisions to the detailed test procedure previously approved by the Engineer.

5. The purpose of the test shall be to verify the functionality, performance, and stability of the hardware and software. The system must operate continually for 100 hours without failure before the test shall be judged successful. Successful completion of this test, as determined by the Engineer, shall be the basis for approval of the system to be shipped to the site.

6. The various tests performed during the Engineer and/or Owner witnessed factory demonstration test shall be designed to demonstrate that hardware and software fulfill all the requirements of the Specifications. The test conditions shall resemble, as closely as possible, the actual installed conditions. Any additional hardware or software that may be required to successfully verify system operation shall be supplied at no cost.

7. The test shall perform but not be limited to the following:

    a. Demonstrate operability, and conformance to Specifications and to approve Shop Drawings, of all equipment.

    b. 100 percent point check of all I/O including all wiring.

    c. Check of all Loops on a loop-by-loop basis, using the programs as installed on all provided equipment, including both OIPs and PC HMI.

    d. Demonstrate operability of the data communication network and all devices in it, under anticipated full load conditions.
    e. Demonstrate failure modes of all equipment, such as loss of network communications, loss of main power, and loss of CPU in a redundant pair.

8. During the test for a period of time equal to at least 20 percent of the test duration, the Engineer's and/or

Owner's representative shall have unrestricted access to the system.

9. All analog control panels shall be included in these tests.

10. All deficiencies identified during these tests shall be corrected and retested prior to completing of the Witnessed Factory Test as determined by the Engineer.

11. The following documentation shall be made available to the Engineer at the test site both before and during the Witnessed Factory Test:

    a. All Contract Drawings and Specifications, addenda, and change orders.

    b. Master copy of the test procedure.

    c. List of the equipment to be tested including make, model and serial number.

    d. Design related hardware submittal applicable to the equipment being tested.

12. The Witnessed Factory Test shall generally cover a period of no more than 5 days. The daily schedule during these tests shall be as follows:

    a. Testing and meetings: Nominally 8 hours per day; 10 hours per day if required to meet schedule.

    b. Morning meetings to review the day's test schedule.

    c. Evening meetings to review the day's test results and to review or revise the next day's test schedule.

    d. Unstructured testing period by the witnesses.

13. All test data and procedures followed during testing shall be logged, and certified copies of the logs shall be provided to the Engineer and Owner.

14. All costs associated with the Witnessed Factory Testing, including travel, parking, rental car, upscale accommodation and food for one Engineer and up to three of the Owners' representatives, shall be the responsibility of the ISS and shall be included in the Contract price.

15. Should the Witnessed Factory Test fail to perform as required, it shall be rescheduled as many times as necessary to provide a complete working system as specified herein. ISS shall be responsible for all costs associated with Factory Testing for Engineer and Owners' representatives as stated above for each additional test.

E. Operational Readiness Test (ORT)

1. General: Prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, tested, and documented) that it is READY for operation.

2. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop by loop and component by component basis to ensure that it is in conformance with related submittals and these Specifications.

   a. The Loop/Component Inspections and Tests shall be implemented using Engineer forms and check lists. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and checkoff items with spaces for sign off by the ISS:

      i. Project Name.

ii. Loop Number.

iii. Tag Number for each component.

iv. Checkoffs/sign offs for each component.
1) Tag/identification
2) Installation
3) Termination wiring
4) Termination tubing
5) Calibration/adjustment

v. Checkoffs/sign offs for the loop.
1) Panel interface terminations
2) I/O interface terminations
3) I/O signal operation
4) Inputs/outputs operational: received/sent, processed, adjusted
5) Total loop operation

vi. Space for comments.

b. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for sign off by the ISS:

i. Project Name.

ii. Loop Number.

iii. Component Tag Number of I/O Module Number.

iv. Component Code Number Analog System.
v. Manufacturer (for Analog system element).

vi. Model Number/Serial Number (for Analog system).

vii. Summary of Functional Requirements. For example:
1) For Indicators and Recorders: Scale and chart ranges

2) For Transmitters/Converters: Scale and chart ranges
3) For Computing Elements: Function
4) For Controllers: Action (direct/reverse) control Modes (PID)
5) For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
6) For I/O Modules: Input or output

viii. Calibrations. For example:
1) For Analog Devices: Required and actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
2) For Discrete Devices: Required and actual trip points and reset points.
3) For Controllers: Mode settings (PID).
4) For I/O Modules: Required and actual inputs or outputs for 0, 10, 50, and 100 percent of span, rising and falling.

ix. Space for comments.

x. Space for sign off by the ISS.

c. The ISS shall maintain the Loop Status Reports and Components Calibration sheets at the job site and make them available to the Engineer/Owner at any time.

3. These inspections and tests do not require witnessing. However, the Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot check their entries periodically and upon completion of the Operational Readiness Tests. Any deficiencies found shall be corrected.

F. Functional Demonstration Test (FDT)

1. Prior to startup and the Functional Demonstration Test, the entire installed instrument and control system shall be certified that it is ready for operation. All

preliminary testing, inspection, and calibration shall be complete as defined in the operational readiness tests.

2. Once the facility has been started up and is operating, a witnessed Functional Demonstration Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph by paragraph, loop by loop and site by site basis.

3. Loop specific and non-loop specific tests shall be the same as specified under Operational Readiness Test except that the entire installed system shall be tested and all functions demonstrated.

4. Updated versions of Shop Drawings shall be made available to the Engineer at the job site both before and during the tests. In addition, one copy of all O&M Manuals shall be made available to the Engineer at the job site both before and during testing.

5. The system shall operate for a continuous 100 hours without failure before this test will be considered successful.

G. Performance Acceptance Test (PAT)

1. After completion of the Operational Readiness and Functional Demonstration Tests, the ISS shall be responsible, with respect to all components and services provided under this Section, for operation of the entire system for a period of 5 consecutive days, under conditions of full plant process operation, meeting all process requirements, without a single non field repairable malfunction.

2. During this test, plant operating, ISS and APS personnel who have an intimate knowledge of the hardware and software of the system shall be present as required.

3. While this test is proceeding, the Owner shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes.

4. Any malfunction during the tests shall be analyzed and corrections made by the ISS and/or the APS as appropriate. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

5. Any malfunction during this test period, which cannot be corrected within 24 hours of occurrence by the ISS's personnel, or more than two similar failures of any duration, will be considered as a non-field repairable malfunction.

6. Upon completion of repairs by the ISS, the test shall be repeated as specified herein.

7. In the event of rejection of any part or function, the ISS shall perform repairs or replacement within 90 days.

8. The total availability of the system shall be greater than 99.0 percent during this test period. Availability shall be defined as "Avail. = (Total Time Down Time)/Total Time". Down times due to power outages or other factors outside the normal protection devices or back up power supplies provided, shall not contribute to the availability test times above.

9. Upon successful completion of the 5 day PAT and subsequent review and al of complete system final documentation, the system shall be considered complete and the one year warranty period shall commence.

H. Training

1. The cost of Owner training programs shall be included in the Contract price.

2. All Technicians, Operators, Engineers, and Managers of the Water Treatment Facility will require training on the System. The Instrumentation System Supplier shall be responsible for providing detailed Operation and Maintenance (O&M) Manuals and training courses.

3. The O&M Manuals shall include specific details of the equipment supplied and details of operations specific to this Project. The training courses will deal with fundamentals of Programmable Logic Controller (PLC) and Digital Equipment hardware and software, telemetry systems, field devices, and maintenance.

4. All instructors must be intimately familiar with the operation and control of the Owner’s facility.

5. The training shall be structured as follows:

    a. The system training program shall be structured such that the operating personnel will understand the system's operation, and the functions available in the system.

    b. The level and amount of training will be based on the understanding of the individual staff members. Preventive and corrective maintenance of system devices and hardware shall be presented.

    c. A number of basic theory courses shall be provided to give the operators an appreciation of how the system can help them perform their jobs.

6. The ISS shall provide detailed manuals and shall include specific details of equipment supplied and operations specific to the project.

7. The ISS shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.

8. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

9. On Site Training for operator personnel shall deal with fundamentals of system hardware and software, field devices, instrumentation calibration and maintenance. Training shall cover all aspects of the instrumentation and controls system. Training is expected to cover a period of not less than three (3) eight-hour days.

I. Warranty / Maintenance Requirement

1. A written maintenance contract executed by the ISS shall be provided to the Owner for onsite warranty services. This contract shall include all labor and emergency calls providing on site response within 24 hours, to provide complete system operability for a period of one year after the successful completion of the PAT.

2. The costs for the one year maintenance service contract shall be included as a separate line optional adder in the ISS's Contract Price.

J. Control System Diagrams and Details

1. To assist the ISS in determining the scope of work, a series of Process & Instrumentation Diagrams (P&IDs) and Details are provided. Unless specifically stated otherwise, the ISS shall be responsible for providing all instrumentation, control equipment and auxiliary devices necessary to perform the functions specified herein and as shown and described on these diagrams. Any auxiliary devices such as lightning/surge protectors, relays, timers, signal isolators, signal boosters, etc. which are necessary for operation shall be included, whether or not they are specifically shown or tabulated on the Loop Diagrams.

2. The intent of the P&IDs is to describe in as much detail as possible, the hardware, software and functional requirements of a process measurement and control

system. They are not intended to convey requirements for conduit and wiring between panels or system components. This information is included in appropriate Electrical Specifications and Drawings.

END OF SECTION

SECTION 13305 APPLICATION ENGINEERING SERVICES

PART 1 - GENERAL

A. Scope of Work

1. Refer to Section 13300.

2. The ISS, as defined in Section 13300, shall provide all applications programming and services required to achieve a fully integrated and operational system. The ISS shall coordinate the control system for proper operation with related equipment and materials under other sections of these specifications and with related existing equipment.

3. Auxiliary and accessory programming structures necessary for system operation or performance shall be included whether or not they are shown on the Contract Drawings.

4. All equipment shall be controlled in full conformity with detail Contract Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer.

5. To facilitate the Owner's future operation and maintenance, PLC programming and human interface development shall utilize standards as agreed upon by the Owner and Engineer.

6. Supplementing this section, the Contract Drawings and related specification sections provide additional details showing instrument device schedules, functional requirements of the system, and interaction with other equipment.

B. System Description

1. The ISS is responsible for providing all programming and configuration services to accomplish the control and monitoring functions as described in the contract specifications and drawings. The ISS shall provide all programming functions including but not limited to control strategies and communications, including the integration of controls using Ethernet TCP/IP, Modbus TCP, Profibus DP, Profibus PA, and DeviceNet networking protocols. The ISS shall also provide all programming and configuration services necessary to produce the operator interface (graphic displays, trends, historical

archive, reports, etc.) as described in the Specifications and Drawings.

2. The ISS shall develop and provide all graphic screens for the systems provided. The graphics shall be designed and function with the plant's existing Human Machine Interface (HMI) software. The developed graphic displays shall represent all existing and new process flow paths and all associated equipment. All processes and equipment shown on the P&ID drawings shall also be shown on the process graphics in a similar manner.

3. The following software packages are expected to be in use at the time of Contract execution. This information is provided only for the reference of the ISS, and does not relieve the ISS of the responsibility to confirm existing conditions before beginning work.

   a. GE Proficy iFIX, version 5.5
      i. Plus SCADA Node Runtime (IO Server) w/ Development and Synchronization, Unlimited Tags
      ii. Web Services (WebSpace Server and Client Licenses)
      iii. iHistorian, 5k tags
   b. XL Reporter

C. Programming and Configuration Guidelines and Deliverables

1. General

   a. Upon PC power on or reset, the system shall automatically boot to, and begin running, the HMI application. Alarms, displays, etc. shall be functional. User login shall be required for access to all runtime or development functions. Access levels shall be as defined elsewhere in this Section.

   b. The Windows environment shall be masked, and not normally available to the Operator. Login shall be required for access to the Windows environment.

   c. It is intended that the HMI computers only be used for the HMI applications software.

2. Real Variables Processing

   a. Real Variables shall represent process data for which there are analog signal inputs to the system. The system shall sample each of these input signals

at their selected scan frequency, and perform the proper conversions and scaling to obtain the instantaneous engineering values. These values shall be used to update real-time data on CRT displays, check for alarm conditions, and store for use in the historical files. Scan rate for all analog inputs shall be one minute.

b. The instantaneous values of all variable data shall be displayed on the appropriate CRT screen, and shall be added to the historical database whenever the present value exceeds a preprogrammed compression dead band. The compression dead band will be field adjusted to provide for maximum storage utilization.

c. Provide for storage of historical data for an adjustable file period of daily, weekly, monthly, quarterly, or yearly period for the purpose of trends or data analysis.

d. Variables such as rate of flow shall have their instantaneous values integrated with respect to time and their quantities totaled. The storage of each of these totals shall be done on an hourly basis into the historical file.

3. Calculated Variables Processing

a. Calculated variables shall represent process parameters for which there are no direct analog inputs to the system. These variables shall utilize Real Variables, and manually entered constants or laboratory data to compute their value. The computer system shall perform periodic real time calculations upon selected database parameters. Calculations shall be operator configurable, including: PLUS, MINUS, MULTIPLY, DIVIDE, EXTRACT ROOTS, INTEGRATE, DIFFERENTIATE, AND BOOLEAN LOGIC.

b. There shall be two types of calculated variables defined:

i. Calculated Variables which utilize one or more Real Variables and/or manually entered constants. These variables shall be treated in the same manner as Real Variables and shall have the same attributes as Real Variables (including alarming and control), with the

exception that the calculation shall be performed automatically every 5 seconds.

ii. Calculated Variables which are used only for the Daily, Monthly, and Annual Operation Summary reports, and which utilize laboratory input data shall be computed once a day for inclusion in the Daily report and stored for use in the Monthly and Annual reports. The capability to display these variables shall be provided.

4. Manual Input Data Handling

a. The application software shall provide the capability to manually enter data from any operator's CRT/keyboard. This data shall consist of additional values for the current data file (e.g., laboratory analyses), inserting alarm limits, setpoint changes, adjustments to process constants, control system setpoint changes, and system tuning parameter adjustments.

b. All manually entered data shall be entered and stored in the appropriate engineering units. All data entered shall be displayed for confirmation on the data entry device prior to incorporation to the database.

5. Graphic Displays

a. The HMI system shall support multiple display types including lists, graphics, trends, etc. Provide all HMI Screens necessary for the efficient operation of the system and process as described herein.

b. All displays shall contain and continuously update the displayed process variables, date and time of day. All process values shall be displayed in engineering units. All displays shall incorporate references to both instrumentation tag numbers and plant equipment numbers.

c. Generally, graphic displays shall consist of three parts, a menu bar, a process area, and an alarm summary area. The menu bar shall have shortcut buttons to a full page alarm summary, report viewers, HMI network status. It shall also provide a navigational device (such as a pull-down menu) that allows any screen to be called up. The Process

area shall show the overview, or more detailed displays. The Alarm area shall show the last four alarms and status. Design of the graphic displays shall maximize the area available for the process area section.

d. Graphic displays shall make maximum use of the colors available. Colors for status such as open/close, start/stop shall be the same as the indicators on the existing process control system.

e. All items that can be manipulated shall indicate this property by displaying some visual change, such as a bounding box, on mouse-over.

f. The system shall allow the operator to manually control the status of pumps, valves, etc. as indicated on the Drawings. Control shall be provided via a pop-up box, called by clicking on the device, which shall accept keyboard and GUI manipulation. There shall be no secondary acknowledgement required for any issued command. Equipment that is sensitive to rapidly changing start-stop commands shall be protected by timers in the PLC that enforce a minimum delay between commands. This delay condition shall be indicated, and shall not lock the control pop-up, or otherwise prevent navigation to other displays. Manually entered setpoints, or other variables shall have filters that refuse incorrect settings.

g. Index displays: Provide Index display(s) as a complete and logical listing of the names and number of all screens.

h. Graphics capability shall include conditional color (i.e., where the color of a symbol or value changes upon some condition), and dynamic graphics (i.e. vary symbol presentation based upon its analog value). A hierarchical structure for the displays with a maximum of four levels should be employed. Graphic displays provided shall include:

    i. Process Overview. This shall present the overall process in limited detail to allow the operator to view the complete plant process on a single display.
    ii. Individual process schematics. Each process area shall be indicated with a separate graphic. Each display shall depict all elements

involved in that particular process area (e.g. pumps, tanks, valves, flowmeters, etc.).

iii. System Status. Provide displays of this type for the Control System Architecture (based on Drawing I-2) and for the Electrical System (graphical and/or text screen). Indicate through color the status of each sub-system (e.g. PLC, communications links, etc.).

i. The Color Code for equipment status is the following: On – Red – Open; Off – Green – Close; Trouble – Yellow – Fail. Equipment that is in alarm shall be flashing until the alarm is acknowledged.

j. Unless specifically noted, all timers, setpoints, alarm actuation levels, etc., shall be operator adjustable from the operator interface, with the appropriate access.

k. Pop-ups shall provide the following features:

i. All status indications, in colored text, pertinent to the device.
ii. All interlocks and permissives, in colored text, pertinent to the device.
iii. All control buttons pertinent to the device.
iv. Process variable display or PID control pop-ups, where needed, shall be in graphical and numerical form. Provide bar graphs that indicate current value, the alarm limits, and if applicable, setpoint and output values.

l. Data Entry displays. Where required, provide pop-ups for manual data entry.

m. Trend control. The operator shall be able to define trends of any variable in the system database (real-time trending) or in the historical database (historical trending) as follows:

i. Trend displays shall present the operator with multiple options (e.g., with or without limits, time scale).
ii. A cursor line or point shall be provided which can be moved along the curve to obtain exact readings at any point.
iii. It shall be possible to overlay different trend curves to facilitate the comparison of related parameters.

iv. It shall be possible to trend up to four different parameters on the same scale, each parameter being represented by a different color.

6. Alarm/Equipment Status Reporting

a. Alarm and Event Logging

i. The alarm log shall display all alarms as they occur. The alarm message shall include the time of occurrence, tag name, tag number, and whether it is a low, high, or failure alarm. When the point in alarm returns to normal, the time, point identification number, and return to normal shall be displayed. All reports shall include the plant equipment number of the associated device.

ii. The equipment status shall be logged whenever a change in status occurs (i.e., start, stop). The status monitoring shall be capable of being disabled and/or suppressed from the operator's console. The equipment status log shall include the time, equipment name, tag number, and the particular change in status. The log file shall be in a readily readable format, such as CSV.

iii. The alarm and event log(s) shall be available in an open file format for viewing or printing on demand. Alarm information shall consist of point identification number, point name, time of occurrence, and type and priority of alarm.

b. Alarm and Status Reports

i. Equipment and Point Status Summary Report. This report shall list the status of all points in the system, including contact inputs, real variables with analog inputs, and calculated variables. This report will be initiated manually, and shall consist of the tag number, tag name, and its current status (i.e., Running, Off, High, Low, Active, Disabled, ON-scan, OFF-scan, etc.).

ii. Alarm Summary Reports
1) Provide the ability to generate reports listing alarm data for:
(a) the current day;
(b) the previous day;
(c) all points currently in alarm.

2) Normally, this report shall be initiated manually but provision shall be made so that it may be initiated automatically every day if desired.
3) The capability shall be provided to sort both daily and current alarm summary reports by operator defined groups. (i.e., print all power failure alarms, all suppressed alarms, etc.)

7. Control Standards

a. The following control standards shall be implemented in conjunction with all project drawings. Include these features where applicable as described herein, whether indicated directly in the P&IDs or not.

b. All programming and development functionality of each PLC shall be available via the Ethernet network. This capability shall be password protected to allow access by supervisory personnel who are given clearance by the Owner.

c. All instrument and equipment data registers that are available for a given device through a digital network (e.g. Modbus TCP, Profibus DP) shall be mapped to tags in the associated facility PLC, whether called out in the Drawings and Specifications or not. Only the points actually required on the Drawings shall be polled, displayed, recorded and/or trended. The other registers shall be left disabled for future use.

d. For all "package systems" provided by vendors other than the ISS, coordinate with the equipment submittals to verify the I/O and data points that are shown in the Loop Diagrams.

e. Disagreement Alarms

i. For all controlled devices such as pumps, valves, etc., if the device is commanded to Start or Stop (or Open or Close) by the PLC, and the device feedback state does not match the commanded state within a preset time delay, an equipment Disagreement Alarm is generated by the PLC for display and alarming at the HMI, and the device is commanded to Stop (valves shall remain in the last state).

ii. If a duty pump, or system, is commanded to start and does not start within the preset time, the standby pump, or system, shall be commanded to start.
iii. If a device feedback state does not match the commanded state at any time, excluding the change of state described above, an equipment Failure Alarm is generated by the PLC for display and alarming at the HMI and the device is commanded to Stop (valves shall remain in the last state).
iv. The default time delay for all equipment shall be 90 seconds.
v. After a Disagreement Alarm occurs the device cannot be started (or Opened/Closed) again until a Reset has been issued by the Operator at the HMI.
vi. All controlled devices with feedback shall indicate Failure alarms on the associated process graphic displays even if not shown on the Drawings.

f. All analog alarms generated in the PLC or at the HMI (such as a high level alarm) shall be generated as follows. If the analog point’s value exceeds or drops below the alarm limit value for a preset time period, then an alarm shall be generated. To eliminate excessive alarm reporting, the analog point shall remain in alarm until the analog point’s value returns beyond the limit set by the analog limit deadband. Only the alarms shown in the Loop Diagrams shall be configured; standard process limit alarms (i.e. low-low, low, high, high-high) that are not used shall be disabled in the software.

g. For analog measurement points (such as level, flow, pressure, etc.) where indicated on the Loop Diagrams, if the value of the analog point changes by more than a preset deadband since the last time the analog point was scanned, a Rate-of-Change Alarm shall be generated at the HMI. The alarms shall remain in effect until it is logged at the HMI and the change in value falls to less than the preset deadband the next time the analog point is scanned. All analog points shall indicate a Rate-of-Change Alarm on the associated process graphic displays even if not shown on the loop drawings.

h. For analog measurement points, an Out-of-Range alarm shall be generated when the signal exceeds its proper span, either below 3.6mA or above 20.4mA. All analog points shall indicate a Rate-of-Change Alarm on the associated process graphic displays even if not shown on the loop drawings.

i. For all process analyzers, store the last good value measured, and hold it for an adjustable period in the event the input signal goes out of range. This period shall be no less than 1 minute for all analyzers and no less than 10 minutes for all chlorine residual analyzers. Note that this "last good value" shall be distinguished from an actual good value by turning on the Out-of-Range alarm, and by changing the color of the value on the HMI screen.

j. For PID loops, if a pump or valve is commanded to maintain a specific process parameter, and the process feedback signal deviates from the setpoint by a preset deadband for a preset time period, a Setpoint Deviation Alarm is generated by the PLC for display and alarming at the HMI.

k. All tuning parameters for each PID in the PLC shall be available at the server/workstations for monitoring and adjustment even if not shown on the loop drawings. Tuning trends shall be provided to monitor the PID functions. However, these parameter settings shall be password protected to allow access by supervisory personnel who are given clearance by the Owner.

l. PID loop control shall be suspended whenever a process variable or final control element associated with that loop has lost power or signal, as determined either by the Disagreement Alarms described above, or by power monitoring data.

m. All automatic pump starts and stops in response to a PID loop shall include operator-adjustable time delays.

n. All alarm and control setpoints shall be adjustable by the Operator even if not shown on the drawings. However, these setpoints shall only be accessible by individuals logged in with appropriate access levels as defined herein.

o. Run times for all motorized equipment shall be totalized in the PLC, except where the total is available from the equipment electronics itself, and indicated at the HMI with one (1) hour resolution even if not shown on the loop drawings. The total runtime shall be resettable from the HMI; however, this reset shall be password protected to allow access by supervisory personnel who are given clearance by the Owner.

p. Start Counts for all motorized equipment shall be totalized in the PLC and indicated at the HMI even if not shown on the loop drawings. The start counts shall reset on a daily basis.

q. All analog points shall be historically logged. The hourly maximum, minimum and average values for that point shall be calculated and stored.

r. All flows shall be totalized in the PLC, except where totals are available from the flowmeter itself. Yesterday’s total flow and today’s flow shall be indicated at the HMI even if not shown on the loop drawings. The total flows shall be resettable from the HMI; however, this reset shall be password protected to allow access by only the Operators who are given clearance by the Owner.

s. Chemical usage shall be calculated on a daily basis for each chemical used. Current day usage and previous day usage shall be indicated and recorded at the HMI.

8. Reports

a. The final format of all reports shall be developed by the ISS and Owner following Contract Award. All reports shall be capable of automatic and on-demand printing. All reports shall be archived for future use.

b. All reports will utilize a web interface to the County’s existing SQL Server with Visual Studio, to enter data or otherwise access a report. Coordinate with Owner.

c. All reports shall include the ability to manually edit data in case of data loss, and for manual entry for equipment not connected to the HMI. Manual entries shall be flagged in the database,

and the spreadsheet cell shall be shaded in the printed report or otherwise clearly indicated.

d. Examples of some of the following reports will be included in Appendix A of this Section. Coordinate with Owner for full templates.

e. The following reports shall be provided:

i. Alarm Reports as described elsewhere in this Section.
ii. Flow Data Sheet. This is a daily report that includes today's daily flow total for every flowmeter in the plant. A "day" is defined as midnight to midnight. The report needs three columns: daily total, and the "stop point" for previous day and present day (the accumulated grand total of each flow at midnight). Refer to the sample provided in Appendix A.
iii. Daily Analyzer Report. Min/Max/Average for Day plus each of 24 Hours. All analyzers in the plant (plus temperature data associated with the pH analyzers).
iv. Daily Operational Lab Sheet. Min/Max/Average for Day plus each of 24 Hours. Column for "Influent Flow Rate" is average flow within that hour; Peak Flow is highest hourly. Column for each compliance analyzer. Refer to the sample furnished in Appendix A of this Section. Add to this sample all readings added in Phase V modifications, especially: Phase III pH, Phase V chlorine residual, Phase V disk filters turbidity, Temporary Disk filter turbidity.
v. Daily Chlorine Dosing Report. Provide this as a separate report from the Operational Lab Sheet provided in Appendix A.
vi. Chemical Usage. Provide both a daily report (total for the day plus each of 24 hours) and a monthly report (total for the month plus each day of the month), for each chemical for which there is HMI data.
vii. Solids Reports. Samples are provided in Appendix A for the "Mass Balance" and Daily/Monthly MLSS and RAS suspended solids reports. MLSS either shall be entered manually or shall reference existing probes. RAS values shall be populated by Phase V probes. The "Mass Balance" report template is existing and shall be modified for Phase V modifications.

viii. Electrical Power Usage. Provide both a daily and a monthly report. Daily: Min-Max Volts & Amps, Average Power Factor, Total Amps/kW/kVA, by hour and total, for each power feed/each MCC. Monthly: kW, by day and total, for each power feed/each MCC. For any given day in any given location on the site, if the sample equals the recorded maximum (kW) for 15 or more consecutive minutes, flag that time period as "Surcharge." This corresponds to the rules for power company surcharging.

ix. Network Uptime Report. Monthly report. 0-100% uptime for each distinct SCADA node (Server, Workstation, PLC, etc.) and for each Profibus device.

9. System Database

a. The structure of the system database shall be hierarchical, and initial configuration of the database shall be performed by the ISS. The database shall have the following features:

i. Analog Inputs: Point identification number; point name; current value; scan period assigned; the type of raw input either linear or non-linear, and if nonlinear, the linearization used; instrument input range (reasonability limits); high and low emergency and advisory alarm limit pairs; instantaneous and sustained rate of change alarm limits, flags for Return-to-Normal alarms; and physical termination point information.

ii. Contact Inputs: Point identification number; point name; current status; normal state; scan period assigned; and physical termination point information.

iii. Analog Outputs: Point identification number; point name; current status; and physical termination point information.

iv. Contact Outputs: Point identification number; point name; current status; period of actuation if momentary; and physical termination point information.

b. Historical Data Management. The following features shall be provided for processing and storage of system historical data:

i. Data Processing. The real time application for calculations shall pass averages accumulated totals (as applicable) for all Control System variables to the Historical data base. The primary server shall transfer the averages to the redundant machine.
ii. Data Storage. Historical data and Maintenance Management data shall be retained on the Network Attached Storage (NAS) device for a minimum of 1 year.
iii. Data archiving. Hourly and daily data, laboratory data, logs, and administrative data, shall be automatically archived to the NAS as they are generated.

10. Security

a. Primary login to HMI Workstations shall be via fingerprint scanners. Coordinate with Owner to issue a username and password to each employee, as a backup to the fingerprint access.

b. Access levels shall be as follows, with each succeeding level having all the capabilities of the prior levels as well as its own as described.

i. Guest. Guest is the default login mode. Guest can view all operational screens (process, alarms, trends), but is strictly view only.
ii. Operator. Operator can start/stop equipment, open/close valves, set equipment auto/manual, make setpoint changes, and manage alarms. Operator cannot perform certain functions restricted to Lead Operator.
iii. Lead Operator. Lead Operator can modify setpoints related to compliance instruments. Coordinate with Owner for more Lead Operator restricted functions.
iv. Administrator. Administrator can reset flow or equipment totals, change PID parameters or analog scaling.

c. Workstations shall logout after being idle for 10 minutes, and default to Guest login.

d. All HMI login and logout activity shall be recorded. The log file shall be in a readily readable format, such as CSV.

e. When configuring Ethernet switches, close all traffic on ports not in use or designated for development.

PART 2 - PRODUCTS

A. Supplementary Control Narratives

1. The following control narratives are provided as supplements to the schematic and written information provided in the Instrumentation Drawings. Not all controls are represented in this Section. All questions and proposed alternatives should be coordinated with the Engineer and/or the Owner.

2. Reject Pump Station (Process Area 560)

a. Automatic operation of the Reject Pump Station shall consist of two modes: Pump to Reject Pond (which is “Normal” mode), and Pump to Pretreatment (which is “Off-Normal” mode). The mode shall be selected by the operator with a pushbutton-style command on the HMI screen. If any instrument or control element required for automatic operation is out of service or in manual, then automatic mode shall be disengaged and made unavailable until the condition is corrected.

b. Each step in the sequence of either mode shall be confirmed by the appropriate status data (e.g. pump running, valve open) before proceeding to the next step, unless specifically noted otherwise. Any confirmation failure shall produce a “Reject Pump Station ____ Mode Sequence Fail Step ___” alarm.

c. For each mode, provide a detailed HMI screen (either a pop-up or a full screen) that lists the steps of that mode’s sequence, along with live indication of status, interlocks/permissives, alarms, and screen links associated with each step, such that the progress of the sequence can be tracked by the operator.

d. Mode 1: Pump to Reject Pond (“Normal”)

i. Upon engaging Mode 1, stop all Reject Pumps.
ii. Close 560-V-15 (Loop 430). Provide for an operator-adjustable time delay after this step.
iii. Close 560-V-17 (Loop 450). Provide for an operator-adjustable time delay after this step.

iv. Open 560-V-16 (Loop 440).
v. Pause for operator action, and issue an HMI alarm at the lowest priority level.
vi. Operator shall then perform the following manual operations in order:
1) Set a flow rate setpoint at one or more Diversion Structures (Process Area 561 thru 564). The condition of diverting flow to the Reject PS wetwell while all pumps are off is called “equalization.”
2) Start a Reject Pump at a selected minimum speed (default: 30 MHz/50%). The pump so started shall be designated the Lead pump. There shall be a pre-defined pump sequence (Lead-Lag1-Lag2-Lag3) associated with each Lead selection that shall be automatically followed thereafter. If any pump in this sequence fails when called, the next in order shall be started in its place.
vii. The Reject Pump Station will then begin automatic control based on level in the wetwell. Level control shall be PID type. There shall be operator-adjustable time delays on all pump starts and stops. If the low water line is reached, stop all pumps without delay. If the high water line is reached, issue an alarm. Default values: SP, 84.00’; LWL, 82.00’; HWL, 93.00’.
viii. Upon the start of the Lead pump, begin calculating a total of the flow measured by 560-FIT-2. Stop totalizing once all pumps are off. Archive all totals generated in this way.
ix. If a running total should exceed a preset maximum value (default: 25 MG), then issue an HMI alarm at the highest priority level, “Reject PS Max Flow Reached”; stop all Reject Pumps; and close all diversion gates in structures 561 thru 564. Provide a second flow total setpoint, lower than the maximum, that will issue a warning alarm.

e. Mode 2: Pump to Pretreatment (“Off-Normal”)

i. Upon engaging Mode 2, stop all Reject Pumps.
ii. Close 560-V-16 (Loop 440). Provide for an operator-adjustable time delay after this step.
iii. Open 560-V-17 (Loop 450) to a preset intermediate position (default: 2% open).

iv. Once the wetwell level has reached an operator-adjustable setpoint, open 560-V-17 (Loop 450) fully. Provide for an operator-adjustable time delay after this step.
v. Open 560-V-15 (Loop 430).
vi. Pause for operator action, and issue an HMI alarm at the lowest priority level.
vii. Operator shall then perform the following manual operations in order:
1) Select a flow rate setpoint for the Reject Pumps which is within the range of 560-FIT-1.
2) Designate whether the PID loop shall seek the flow rate setpoint itself, or the difference between this setpoint and the sum of plant influent flows (500-FIT-3 plus 500-FIT-4) at any given moment.
viii. The Reject Pump Station will then begin automatic control based on flow. Flow control shall be PID type. There shall be operator-adjustable time delays on all pump starts and stops. If the low water line is reached, stop all pumps without delay. If the high water line is reached, issue an alarm. Default values: LWL, 82.00’; HWL, 93.00’.

3. Phase III Effluent Reject (Process Area 390)

a. In the event that the compliance instruments detect out-of-compliance effluent, the Phase III effluent valves shall send water to reject until the problem is corrected and the operator intervenes.

b. The Phase III Effluent Valves shall have two automatic modes: Normal and Reject. The mode may be selected by the operator with a pushbutton-style command on the HMI screen. Additionally, Reject mode may be initiated automatically upon conditions described herein. If any instrument or control element required for automatic operation is out of service or in manual, then automatic mode shall be disengaged and made unavailable until the condition is corrected.

c. Each step in the sequence involved in entering either mode shall be confirmed by the appropriate status data (e.g. valve open) before proceeding to the next step, unless specifically noted otherwise. Any confirmation failure shall produce a “Phase

III Effluent Valves ____ Mode Sequence Fail Step ___" alarm.

d. For each mode, provide a detailed HMI screen (either a pop-up or a full screen) that lists the steps of that mode's sequence, along with live indication of status, interlocks/permissives, alarms, and screen links associated with each step, such that the progress of the sequence can be tracked by the operator.

e. Upon engaging Reject Mode, issue an intermediate-priority HMI alarm. Upon engaging Normal Mode, issue a low-priority HMI alarm.

f. Reject Mode

i. Any of the following conditions will engage Reject Mode:
   1) Phase III Effluent pH (390-AIT-1/2) high or low alarm.
   2) Temporary Disk Filter Effluent Turbidity (470-AIT-1/2) high alarm.
   3) Phase V Effluent Turbidity (570-AIT-1/2) high alarm.
   4) Phase V Chlorine Residual (580-AIT-1/2) high or low alarm.
   5) The placing of any process train out of service. ISS shall coordinate with Owner to define this condition precisely.
   6) Operator initiation.
ii. Upon engaging Reject Mode, stop all Phase I/II Effluent Pumps.
iii. Simultaneously:
   1) Open valve YP-V-2.
   2) Close valve YP-V-1.
iv. Close valve YP-V-3.
v. Open valve YP-V-4.

g. Normal Mode

i. Normal Mode shall be engaged by operator selection only. Reject Mode may not be disengaged and Normal Mode engaged, until all adverse conditions have been cleared, and an HMI manual reset performed by the operator.
ii. Upon engaging Normal Mode, stop all Phase I/II Effluent Pumps.
iii. Close valve YP-V-4.
iv. Open valve YP-V-3.

v. Simultaneously:
1) Open valve YP-V-1.
2) Close valve YP-V-2.

4. Phase III Effluent Pumping (Process Area 390)

a. In Auto mode, the Phase III Effluent Pumps shall be controlled according to the level in the wetwell. PID control shall be used to govern the number of pumps running, and the speed of all variable speed pumps that are running.

b. Pumps shall start in a particular sequence as additional capacity is needed, and shall stop in the reverse order. The operator may manually assign each pump to a place in the sequence, or, the pump sequence may be set by the operator to rotate automatically every day at a selected time.

c. The pump sequence shall be as follows:

i. The first two pumps to start shall be Jockey pumps. Effluent Pump Nos. 1, 2 and 3, which are constant speed, are the Jockey pumps. One of these shall be selected as Jockey Lead, another as Jockey Lag, and the last as Jockey Standby.
ii. If two Jockey pumps are not sufficient, then a Main pump shall be started, and after it is confirmed started, all Jockey pumps shall be stopped. Effluent Pump Nos. 4 thru 8, which are variable speed, are the Main pumps. These pumps shall be assigned as Main Lead, Main Lag1, Main Lag2, Main Lag3, and Main Standby.

PART 3 - EXECUTION

A. Tests (General)

1. The ISS shall test all programming, configuration and networking services to be furnished under this Contract. The ISS shall conduct its testing as an integral part of, and in coordination with, the Instrumentation System Supplier’s required testing as defined in Section 13300.

B. Training

1. The cost of Owner training programs shall be included in the Contract price.

2. All Technicians, Operators, Engineers, and Managers of the Water Treatment Facility will require training on the System. The ISS shall be responsible for providing detailed Operation and Maintenance (O&M) Manuals and training courses.

3. The O&M Manuals shall include specific details of the equipment supplied and details of operations specific to this Project. The training courses will deal with fundamentals of the software and networks utilized in the project, and the specific application programming developed for it.

4. All instructors must be very familiar with the operation and control of the Owner’s facility.

5. The training shall be structured as follows:

   a. The system training program shall be structured such that the operating personnel will understand the system's operation, and the functions available in the system.
   b. The level and amount of training will be based on the understanding of the individual staff members. Preventive and corrective maintenance of system devices and hardware shall be presented.

   c. A number of basic theory courses shall be provided to give the operators an appreciation of how the system can help them perform their jobs.

6. The ISS shall provide detailed manuals and shall include specific details of equipment supplied and operations specific to the project.

7. The ISS shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.

8. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

9. On Site Training for operator personnel shall deal with fundamentals of system hardware and software, field devices, instrumentation calibration and maintenance. Training shall cover all aspects of the instrumentation and controls system. Training is expected to cover a period of not less than three (3) eight-hour days.

C. Warranty / Maintenance Requirement

1. A written maintenance contract executed by the ISS shall be provided to the Owner for on-site warranty services. This contract shall include all labor and emergency calls providing on-site response within 24 hours, to provide complete system operability for a period of one year after the successful completion of the Performance Acceptance Test.

2. The costs for the one-year maintenance service contract shall be included as a separate line optional adder in the ISS's Contract Price.

END OF SECTION

APPENDIX A

SAMPLE REPORTS

Eastern Service Area
Daily Operational Lab Sheet

DATE	11/1/2012				CHLORINE RESIDULE			TURBIDITY		CHLORINE DOSING RATES AND LOCATIONS							
time	Influent Hourly Flow Rate	pH								Phase 2 CCC		Phase 2 A B W		Phase 3 CCC		Phase 3 A B W	
		Phase 2	CC 3	CC 4	Phase 2	CC 3	CC 4	Phase 2	Phase 3	Speed	Stroke	Speed	Stroke	Speed	Stroke	Speed	Stroke
1:00	23.0	7.8	7.6	7.4	4.0	1.1	2.8	1.5	4.9	40	40	30	30	75	75	40	40
2:00	16.0	7.8	7.6	7.5	4.9	1.4	4.1	1.4	2.2	40	40	30	30	75	75	40	40
3:00	16.0	7.8	7.6	7.7	4.9	1.1	5.0	1.1	2.2	40	40	30	30	75	75	40	40
4:00	14.0	7.8	7.7	7.7	4.9	1.9	5.0	1.3	2.9	40	40	30	30	60	60	40	40
5:00	14.0	7.8	7.7	7.7	4.9	4.0	5.0	1.4	2.7	40	40	30	30	50	50	40	40
6:00	17.0	7.8	7.7	7.7	4.9	4.2	5.0	1.2	2.6	40	40	30	30	50	50	40	40
7:00	26.0	7.8	7.7	7.6	4.9	4.1	5.0	1.1	2.0	40	40	30	30	60	60	40	40
8:00	30.0	7.8	7.7	7.5	4.9	3.9	0.8	1.4	2.3	40	40	30	30	70	70	40	40
9:00	28.0	7.8	7.9	7.5	4.8	1.6	3.5	1.5	1.6	40	40	30	30	80	80	40	40
10:00	27.0	7.7	7.6	7.5	3.7	2.0	3.1	1.5	4.5	40	40	30	30	90	90	40	40
11:00	27.0	7.7	7.6	7.7	3.2	4.5	3.2	1.6	1.3	40	40	30	30	90	90	40	40
12:00	27.0	7.7	7.6	7.7	3.7	4.9	3.3	1.3	1.6	40	40	30	30	90	90	40	40
13:00	29.0	7.7	7.6	7.7	4.8	4.1	3.3	1.4	1.4	40	40	30	30	90	90	40	40
14:00	28.0	7.7	7.7	7.7	4.8	4.6	3.1	1.5	1.4	40	40	30	30	90	90	40	40
15:00	24.0	7.7	7.7	7.8	4.5	4.8	3.1	1.3	4.9	40	40	30	30	90	90	40	40
16:00	26.0	7.7	7.7	7.8	4.5	4.9	3.4	1.3	2.9	40	40	30	30	80	80	40	40
17:00	27.0	7.7	7.7	7.8	4.5	4.8	3.5	1.4	1.7	40	40	30	30	80	80	40	40
18:00	28.0	7.7	7.7	7.8	4.5	4.7	3.4	1.4	1.6	40	40	30	30	80	80	40	40
19:00	28.0	7.7	7.7	7.7	4.3	4.6	3.0	1.4	1.5	40	40	30	30	80	80	40	40
20:00	31.0	7.7	7.6	7.7	3.5	2.8	3.1	1.5	1.9	40	40	30	30	100	100	40	40
21:00	31.0	7.7	7.6	7.5	3.1	1.0	4.2	1.5	3.0	40	40	30	30	140	100	40	40
22:00	31.0	7.7	7.5	7.5	2.9	1.0	4.1	1.5	1.9	40	40	30	30	140	100	40	40
23:00	25.0	7.7	7.5	7.4	3.0	1.3	3.7	1.5	2.0	40	40	30	30	140	100	40	40
0:00	23.0	7.7	7.6	7.3	3.0	1.3	2.8	1.6	1.8	40	40	30	30	140	100	40	40
TOTAL	596.0	185.7	183.6	182.9	101.1	74.6	86.5	33.6	56.8	960.0	960.0	720.0	720.0	2115.0	1955.0	960.0	960.0
AVERAGE	24.8	7.7	7.7	7.6	4.2	3.1	3.6	1.4	2.4	40.0	40.0	30.0	30.0	88.1	81.5	40.0	40.0
Min	14.0	7.7	7.5	7.3	2.9	1.0	0.8	1.1	1.3	40.0	40.0	30.0	30.0	50.0	50.0	40.0	40.0
Max	31.0	7.8	7.9	7.8	4.9	4.9	5.0	1.6	4.9	40.0	40.0	30.0	30.0	140.0	100.0	40.0	40.0

Chlorine Useage

	Phase 2				Phase 3			
	start	stop	used		start	stop		used
1	1800	1550	250	1	1800	1550		250
			0					0
2	1800	1550	250	2	1800	1550		250
			0					0
3	1800	1550	250	3	1800	1550		250
			0		1800	1550		250

Total by Phase

Phase 2	750	Phase 3	1000
Total Chlorine Usage (day total)			1750

Phase 2					Phase 3					
Month:	Daily MLSS	7Day Avg. MLSS	Daily RAS	7Day Avg. RAS	Month:	Daily MLSS	7Day Avg. MLSS	Daily RAS	7Day Avg. RAS	Month:
	2900	2900	6400	6400		3300	3300	8200	8200	
	3000	2950	7600	7000		3500	3400	9900	9050	
	3400	3100	9300	7767		4200	3667	9900	9333	
	3200	3125	8500	7950		3700	3675	8800	9200	
	3500	3200	8900	8140		3800	3700	8700	9100	
	3600	3267	6800	7917		4000	3750	8800	9050	
	3600	3314	7000	7786		4000	3786	8700	9000	
1/29/00	3600	3414	6500	7800	1/29	4000	3886	8700	9071	1/29
1/30/00	3500	3486	6700	7671	1/30	3900	3943	8800	8914	1/30
1/31/00	3800	3543	7700	7443	1/31	3900	3900	8800	8757	1/31
2/1/00	3600	3600	7800	7263	2/1	3800	3914	8900	8771	2/1
2/2/00	3500	3600	6700	7029	2/2	3900	3929	8800	8786	2/2
2/3/00	3800	3629	7700	7157	2/3	3900	3914	8800	8786	2/3
2/4/00	3600	3629	7800	7271	2/4	3800	3886	8900	8814	2/4
2/5/00	2700	3500	5800	7171	2/5	2900	3729	7600	8657	2/5
2/6/00	2900	3414	5400	6986	2/6	3000	3600	7600	8486	2/6
2/7/00	2800	3271	5700	6517	2/7	2900	3457	7500	8300	2/7
2/8/00	2900	3171	6100	6457	2/8	3000	3343	7600	8114	2/8
2/9/00	2700	3057	6000	6357	2/9	3000	3214	7800	7971	2/9
2/10/00	2800	2914	7000	6257	2/10	3000	3086	7200	7743	2/10
2/11/00	2800	2800	5800	5971	2/11	2900	2957	7800	7586	2/11
2/12/00	3100	2857	7800	6257	2/12	3300	3014	7600	7586	2/12
2/13/00	3500	2943	7000	6486	2/13	3300	3057	7700	7600	2/13
2/14/00	3400	3029	7400	6729	2/14	3300	3114	7700	7629	2/14
2/15/00	3600	3129	7400	6914	2/15	3400	3171	7800	7657	2/15
2/16/00		3200		7067	2/16		3200		7633	2/16
2/17/00		3280		7080	2/17		3240		7720	2/17
2/18/00		3400		7400	2/18		3325		7700	2/18
2/19/00		3500		7267	2/19		3333		7733	2/19
2/20/00		3500		7400	2/20		3350		7750	2/20
2/21/00		3600		7400	2/21		3400		7800	2/21
2/22/00		#DIV/0!		#DIV/0!	2/22		#DIV/0!		#DIV/0!	2/22
2/23/00		#DIV/0!		#DIV/0!	2/23		#DIV/0!		#DIV/0!	2/23
2/24/00		#DIV/0!		#DIV/0!	2/24		#DIV/0!		#DIV/0!	2/24
2/25/00		#DIV/0!		#DIV/0!	2/25		#DIV/0!		#DIV/0!	2/25
2/26/00		#DIV/0!		#DIV/0!	2/26		#DIV/0!		#DIV/0!	2/26
2/27/00		#DIV/0!		#DIV/0!	2/27		#DIV/0!		#DIV/0!	2/27
2/28/00		#DIV/0!		#DIV/0!	2/28		#DIV/0!		#DIV/0!	2/28
avg.	3256	#DIV/0!	6794	#DIV/0!	avg.	3400	#DIV/0!	8089	#DIV/0!	avg.
min	3800	#DIV/0!	5400	#DIV/0!	min	4000	#DIV/0!	7200	#DIV/0!	min
max	3800	#DIV/0!	7800	#DIV/0!	max	4000	#DIV/0!	8900	#DIV/0!	max

Phase 4

Daily MLSS	7Day Avg. MLSS	Daily RAS	7Day Avg. RAS
3600	3600	7900	7900
4050	3825	9900	8900
4200	3950	9900	9233
3800	3913	8700	9100
3900	3910	8300	8940
4100	3942	8200	8817
4100	3964	7700	8657
3900	4007	7900	8657
3900	3986	8000	8386
4300	4000	8200	8143
3700	3986	8000	8043
3900	3986	8386	8055
3900	3957	8200	8055
3700	3900	8000	8098
3000	3771	7800	8084
3100	3657	7200	7969
3000	3471	7600	7884
3200	3400	7400	7798
3100	3286	7500	7671
3400	3214	6000	7357
3300	3157	7900	7343
3300	3200	8100	7386
3300	3229	6800	7329
3400	3286	7000	7243
3600	3343	7500	7257
	3383		7217
	3380		7460
	3400		7350
	3433		7100
	3500		7250
	3600		7500
	#DIV/0!		#DIV/0!
	#DIV/0!		#DIV/0!
	#DIV/0!		#DIV/0!
	#DIV/0!		#DIV/0!
	#DIV/0!		#DIV/0!
	#DIV/0!		#DIV/0!
	#DIV/0!		#DIV/0!
3500	#DIV/0!	7638	#DIV/0!
4300	#DIV/0!	6000	#DIV/0!
4300	#DIV/0!	8386	#DIV/0!

EWRF					
Mass Balance					
Phase II					
Base Numbers					
Fermentation	499784	gallons	Flow	0	MGD
1st Anoxic	912,500	gallons	Avg MLSS	0	mg/l
Air Bays	3015218	gallons	Settleometer	0	
2nd Anoxic	501669	gallons	Avg Raw TSS	0	mg/l
Re-Aeration	55741	gallons	Avg Raw CBOD	0	mg/l
Total	4984912	gallons	WAS Flow	0	MGD
			RAS concentration	0	mg/l
			WAS Pounds	0	
Calculations					
Pounds of solids within biological treatment tankages				**0**	
Pounds of solids in raw sewage				**0**	
Pounds of CBOD in raw sewage				**0**	
Waste pounds				**0**	
Sludge Age (days)				**#DIV/0!**	
SRT (days)				**#DIV/0!**	
SVI				**#DIV/0!**	
F/M Ratio				**#DIV/0!**	
Desired waste pounds		Desired MLSS	3000	**124722**	
Desired waste rate		Based on pounds under air		**#DIV/0!**	(MGD)
Phase III					
Base Numbers					
Fermentation	593278	gallons	Flow	0	MGD
1st Anoxic	1,070,296	gallons	Avg MLSS	0	mg/l
Air Bays	3769300	gallons	Settleometer	0	
2nd Anoxic	584644	gallons	Avg Raw TSS	0	mg/l
Re-Aeration	92416	gallons	Avg Raw CBOD	0	mg/l
Total	6109934	gallons	WAS Flow	0	MGD
			RAS concentration	0	mg/l
			WAS Pounds	0	
Calculations					
Pounds of solids within biological treatment tankages				**0**	
Pounds of solids in raw sewage				**0**	
Pounds of CBOD in raw sewage				**0**	
Waste pounds				**0**	
Sludge Age (days)				**#DIV/0!**	
SRT (days)				**#DIV/0!**	
SVI				**#DIV/0!**	
F/M Ratio				**#DIV/0!**	

Desired waste pounds		Desired MLSS	3000	**152871**	
Desired waste rate		Based on pounds under air		**#DIV/0!**	(MGD)
	=	Calculated formulas	10	10	

Phase II 10 day SRT needed waste #DIV/0! Phase III 10 day SRT needed waste #DIV/0!

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SECTION 13310 PROGRAMMABLE LOGIC CONTROLLER (PLC) AND DIGITAL EQUIPMENT

PART 1 - GENERAL

A. Scope of Work

1. The General Provisions of Section 13300 apply to this Section.

2. All the Work in this Section shall be the product of the Instrumentation System Supplier (ISS). Components and enclosures may be provided to the ISS by sub-suppliers and/or manufacturers, but the packaging of these components and the production of the final product shall conform to this specification and shall be the sole responsibility of the ISS.

B. Submittals

1. Refer to Section 13300.

C. Delivery, Storage and Handling

1. Refer to Section 13300.

D. Spare Parts

1. In addition to the spare parts listed in other instrumentation sections, provide the following:

2. Programmable Logic Controller (PLC) and associated equipment:

   a. Provide one (1) spare plus one for every ten (10) of any given component supplied.

   b. Provide one (1) spare CPU battery for each CPU supplied.

   c. Provide a spare removable nonvolatile memory card for each new and modified PLC, pre-loaded with the as-built program for that PLC.

3. Networking equipment: one (1) spare plus one for every ten (10) of each type of Ethernet and Profibus communications device supplied.

4. Ethernet patch cables, CAT-6: One (1) per every five (5) furnished.

5. Storage media: a minimum of twenty-five (25) of each type of media used by the PCs, such as CD-Rs and DVD+Rs, with storage cases.

6. Printer: Two (2) of each type of ink/toner cartridge used, and a 500-page ream each of 20lb laser printer paper in Letter and 11″x17″ size.

PART 2 - PRODUCTS

A. Personal Computer (PC) Servers and Workstations: General Requirements

1. The ISS shall use these specifications as a guide to determine the cost of the equipment required. The exact PC hardware shall be the latest proven technology available at the time of actual purchase of equipment.

2. All control system computers shall be personal computer (PC) based. All PCs and related hardware shall be as specified herein or the minimum recommended and approved by the manufacturer of all software packages required to run on them, whichever is greater.

B. SCADA Server, Rack Mounted

1. Servers shall be configured for installation in rack environment occupying 5U of rack space or less, set-up to run HMI server software as shown.

2. 2 Quad-Core Xeon Processors, 3.00 GHZ or greater, minimum of 12 MB L3 cache on each chip die.

3. 4 GB of RAM if 32 bit Operating System, 8 GB of RAM if 64 bit Operating System, fully buffered with ECC and 1333 MHz speed minimum.

4. Hot pluggable cooling fans with N+1 redundancy

5. Media Drive: Dual-layer DVD Drive with both Read/Write Capability

6. Expansion slots:

   a. One x 8 PCI Express slot

   b. Three x 4 PCI Express slots minimum

c. Two PCI-X 64-bit/133 MHz slots minimum

7. Internal Disk Array

   a. 300 GB of usable storage minimum, consisting of four 146 GB SAS, 15,000 RPM hard drives configured in a RAID 5 array with hot spare.

   b. Array controller shall be able to expand RAID array without the need for reformatting of the entire array.

   c. Hard drives shall be hot swappable.

   d. Array controller shall utilize the SAS 6 Gbit/s technology to connect to all hard drives.

   e. Hard drive controller shall reside in a PCI Express slot within the server.

8. Video graphics: capable of 1280 x 1024 pixels, 70 Hz refresh rate and 32 bit true color minimum. VGA output. 8 MB of dedicated video RAM minimum.

9. I/O Ports & devices: Minimum of four USB 2.0 ports.

10. Interface devices: The rack mounted servers will connect to the rack mounted monitor/keyboard/mouse furnished under the 19” rack specifications.

11. Networking

    a. Two network cards in addition to any on-board network interface.

    b. All network interfaces shall have the following features:
       i Support for latest Microsoft server operating system
       ii Gigabit Ethernet port, copper connection accepting standard CAT-5 cables for Ethernet communications
       iii Support for PCI-X or PCI bus in the server
       iv IEEE 802.3ab support for gigabit networking standard
       v Support for Ethernet port teaming across network adapter cards for increased bandwidth and fault tolerance of both adapter and attached Ethernet switch

vi IEEE 802.3ad Link aggregation support
vii IEEE 802.Q VLAN support
viii Auto sensing 10/100/1000 Mbps
ix SNMP manageable
x TCP/IP offload engine to minimize use of computer CPU for networking tasks

12. Redundant power supplies each with separate power cord. Power supplies must operate from the voltage specified in Section 13300 and be auto switching.

13. Operating System

    a. Latest release of Windows Server Standard Edition operating system: Windows Server 2008 R2 Standard Edition with SP1 (x64). Provide all CD or DVD media required to reinstall operating system and system drivers from bare metal server configuration. Also, include downgrade rights and installation media to previous version of operating system: Windows Server 2008SP2 Standard Edition including both x86 and x64 (32 bit and 64 bit) versions.

    b. Furnished operating system must be compatible with the HMI, PLC programming, and any other system software furnished on the project.

    c. Enough Client Access Licenses (CALs) to connect all computers shown on Drawings and specified herein, plus 25 percent spare. 15 CALs shall be provided at minimum for Windows Server.

14. Backup hardware: NAS or Tape drive shall be provided as specified.

15. Backup Software: Backup software is required above the default Microsoft Windows Backup utility included with the operating system. The backup software shall have the following features:

    a. Support the Windows operating system installed on server

    b. Support tape drive if specified

    c. Support NAS drive if specified later in this section

    d. Perform full system backups including all open files, system state and open database files without

the need to stop any services or applications running on the server.

e. Full restore of server from bare metal state.

f. Restore individual files from tape to original locations or to alternative locations on the server

g. Backup data from server to both the tape drive and hard drive disks. Software shall support backup routines such as disk to disk to tape. Disk containing backup data may be a local disk or a network storage location.

h. Backup job scheduler capable of supporting multiple schedules for full, incremental and partial backup jobs

i. Backup software shall keep a log file of the status of all backup and restore activities. Log file shall easily export to a text file.

j. Provide Acronis or Symantec back-up software or equal.

16. Other Software:

a. HMI software: coordinate with Owner.

b. Microsoft Office Professional 2010

c. Adobe Acrobat Reader (Latest Edition)

d. Virus scan and protection software: either McAfee Virus Scan Enterprise or Symantec Norton AntiVirus Business Pack (Latest Edition)

e. Microsoft Internet Explorer (Latest Edition)

f. WinZip Professional (Latest Edition)

17. Manufacturers/Models:

a. Dell PowerEdge R610 Series

b. HP ProLiant DL300 Series

c. IBM System server

C. Network Attached Storage

1. The Network attached storage (NAS) drive shall be placed in the server rack. The drive will provide critical file system backup by having networked access to all computers on the local area network. USB connected drives are not acceptable.

    a. The drive shall include a minimum of one USB 2.0 and one Gigabit Ethernet connectivity.

    b. Minimum total raw storage of 4TB.

    c. The drive shall have a minimum of 4 bays and a RAID 5 configuration with a hot swappable drive.

2. Manufacturers/Models:

    a. Buffalo Technologies TeraStation Pro Quad

    b. Dell PowerVault NX200

    c. Netgear ReadyNAS Pro

    d. Or acceptable equal

D. 19" Rack Enclosure and Accessories

1. General: The 19” network rack shall be full height, enclosed on all four sides, with door access in the front and rear and removable panels on each side. The contractor shall furnish and install any and all appurtenances required for a fully functional network rack.

2. Features/Performance:

    a. The network rack shall be furnished with the following appurtenances:
        i Roof fans and tray
        ii Combination lock handles
        iii Door switch
        iv Mounting rail brush strip(s)
        v Cable ring set(s) [number as required]
        vi Cable management rings (s) [number and size as required]
        vii Horizontal cable organizer [number as required]

    b. The contractor shall coordinate the location of all devices in the rack with the Owner/Engineer at the

time of installation.

c. Furnish and install a power distribution unit (PDU) in the network rack. The PDU shall be fed from a dedicated 20A raw power feeder (not on UPS) and shall be provided for miscellaneous equipment for which UPS power is not required.

3. Monitor/Keyboard Tray/KVM Switch

a. The monitor/keyboard tray shall be a 19″ rack mounted drawer with 17″ built in Monitor and Keyboard with a pointer device.

b. The keyboard shall fit within the drawer and be equipped with a built in pointing device.

c. Monitor shall be 17″ diagonal size and capable of 1280 x 1024 pixel resolution minimum.

d. Drawer shall be 1U height and include hardware for mounting the monitor and keyboard. Monitor hardware shall allow the monitor to lay flat in drawer or fold up when the drawer is opened.

e. All necessary cables and power supplies shall be provided for operation and interface with the KVM switch.

f. The KVM shall allow sharing of the keyboard, video, and mouse between all servers mounted within the rack.

4. Manufacturer:

a. Dell

b. Or acceptable equal

E. Uninterruptible Power Supply (UPS) for PC Servers, Workstations, and Control Room Equipment

1. The power supplied to all PC Servers, PC Workstations, and related equipment in control room areas, shall be protected by an Uninterruptible Power Supply (UPS). UPS shall prevent spikes, sags, surges, noise, and harmonics from adversely affecting equipment. UPS input and output shall be galvanically isolated from one another. Input and output power shall be 120 VAC, 60 Hz.

2. UPS shall contain internal backup batteries sufficient to allow all connected equipment to run continuously for no less than 30 minutes at full load. Provide load calculations which show these requirements to be met.

3. UPS shall be a true online UPS with zero switch time, using a continuous no-break connection to ensure no momentary power interruptions.

4. UPS shall include Ethernet connectivity, to enable HTTP or SNMP monitoring of all available status and diagnostics over the network.

5. The UPS unit covering the Servers shall be mounted in the 19-inch rack.

6. UPS shall be Eaton Powerware Series 9, or acceptable equal.

F. SCADA Workstation

1. Workstations shall be set up to run HMI development and client applications, PLC & HMI development software, and Reporting & Analysis software depending on their use as shown.

2. Tower workstation form factor

3. 1 Intel Quad-Core processor, 3.0 GHz or greater, minimum of 8 MB L3 cache on chip die, 1333 MHz front side bus minimum.

4. 4 GB of RAM, 1333 MHz speed minimum, 2 DIMMS maximum.

5. Media Drive: DVD ± Dual-layer Drive with both Read and Write Capability

6. Expansion slots: two full height PCI slots; one full height PCI Express slot

7. Internal Disk: 300 GB of usable storage minimum, consisting of one 300 GB SATA, 10,000 RPM hard drive.

8. Video graphics capable of 1920 x 1200 pixels, 70 Hz refresh rate and 32-bit true color minimum. VGA, DVI, and HDMI or Display Port outputs. 512MB of dedicated video RAM minimum. Card must be dual monitor capable.

9. I/O Ports & devices: minimum of four USB 2.0 ports.

10. Interface devices

    a. Generic USB 104 key (Windows) keyboard, no hot keys onboard

    b. Two button USB optical mouse with scroll wheel

    c. Monitor: LCD 20-inch nominal size minimum, support for 1680 x 1050 resolution at 70 Hz minimum, with soundbar

    d. Fingerprint scanner for HMI system login (refer to Section 13305)

11. Networking

    a. The network interface shall have the following features:
       i Support for latest Microsoft server operating system
       ii Gigabit Ethernet port, copper connection accepting standard CAT-5 cables for Ethernet communications
       iii Support for PCI-X or PCI bus in the server
       iv IEEE 802.3ab support for gigabit networking standard
       v Support for Ethernet port teaming across network adapter cards for increased bandwidth and fault tolerance of both adapter and attached Ethernet switch
       vi IEEE 802.3ad Link aggregation support
       vii IEEE 802.Q VLAN support
       viii Auto sensing 10/100/1000 Mbps
       ix SNMP manageable
       x TCP/IP offload engine to minimize use of computer CPU for networking tasks

12. Power supplies must operate from the voltage specified in Section 13300.

13. Operating system: Latest release of 32-bit Windows 7 Ultimate, currently Windows 7 Ultimate SP1.

14. Backup Software: Backup software is required above the default Microsoft Windows Backup utility included with the operating system. The backup software shall have the following features:

    a. Support the Windows operating system installed on server

b. Support tape drive if specified

c. Support NAS drive if specified later in this section

d. Perform full system backups including all open files, system state and open database files without the need to stop any services or applications running on the server.

e. Full restore of server from bare metal state.

f. Restore individual files from tape to original locations or to alternative locations on the server.

g. Backup data from server to both the tape drive and hard drive disks. Software shall support backup routines such as disk to disk to tape. Disk containing backup data may be a local disk or a network storage location.

h. Backup job scheduler capable of supporting multiple schedules for full, incremental and partial backup jobs

i. Backup software shall keep a log file of the status of all backup and restore activities. Log file shall easily export to a text file.

j. Provide Acronis or Symantec back-up software or equal.

15. Other Software:

a. HMI software: coordinate with Owner.

b. Development Workstation: PLC programming and configuration software, as specified in this Section

c. Microsoft Office Professional 2010

d. Adobe Acrobat Reader (Latest Edition)

e. Virus scan and protection software: either McAfee Virus Scan Enterprise or Symantec Norton AntiVirus Business Pack (Latest Edition)

f. Microsoft Internet Explorer (Latest Edition)

g. WinZip Professional (Latest Edition)

16. Manufacturers/Models:

    a. Dell T3500

    b. HP Z600

    c. Or acceptable equal.

G. Laptop

1. Laptops shall be setup to run HMI development and client applications, PLC & HMI development software, and Reporting & Analysis software depending on their use as shown.

2. 1 Intel Core i7 processor , 2.2 GHz or greater, minimum of 6 MB L2 cache on chip die, 1333 MHz front side bus minimum.

3. 4 GB of RAM, 1333 MHz speed minimum.

4. Media Drive: DVD ± Dual-layer Drive with both Read and Write Capability

5. Internal Disk: 320 GB of usable storage minimum, consisting of one 320 GB, 7,200 RPM hard drive.

6. Discrete video graphics card with minimum native resolution screen of 1366 x 768 , 70 Hz refresh rate and 32 bit true color minimum. VGA and DVI or HDMI output. 512 MB of dedicated video RAM minimum.

7. I/O Ports & devices: Minimum of four USB 2.0 ports.

8. Interface devices

    a. Generic USB 104 key (Windows) keyboard, no hot keys onboard

    b. Two button USB optical mouse with scroll wheel

    c. Monitor: LCD 20-inch nominal size minimum, support for 1680 x 1050 resolution at 70 Hz minimum, with soundbar

    d. Compatible docking station

    e. Fingerprint scanner for HMI system login (refer to Section 13305)

9. Networking
    a. The network interface shall have the following features:
        i Support for latest Microsoft server operating system
        ii Gigabit Ethernet port, copper connection accepting standard CAT-5 cables for Ethernet communications
        iii Support for PCI-X or PCI bus in the server
        iv IEEE 802.3ab support for gigabit networking standard
        v Support for Ethernet port teaming across network adapter cards for increased bandwidth and fault tolerance of both adapter and attached Ethernet switch
        vi IEEE 802.3ad Link aggregation support
        vii IEEE 802.Q VLAN support
        viii Auto sensing 10/100/1000 Mbps
        ix SNMP manageable
        x TCP/IP offload engine to minimize use of computer CPU for networking tasks

10. Power supplies must operate from the voltage specified in Section 13300.

11. Operating system: Latest release of 32-bit Windows 7 Ultimate, currently Windows 7 Ultimate SP1.

12. Backup Software: Backup software is required above the default Microsoft Windows Backup utility included with the operating system. The backup software shall have the following features:

    a. Support the Windows operating system installed on server

    b. Support tape drive if specified.

    c. Support NAS drive if specified later in this section.

    d. Perform full system backups including all open files, system state and open database files without the need to stop any services or applications running on the server.

    e. Full restore of server from bare metal state.

f. Restore individual files from tape to original locations or to alternative locations on the server.

g. Backup data from server to both the tape drive and hard drive disks. Software shall support backup routines such as disk to disk to tape. Disk containing backup data may be a local disk or a network storage location.

h. Backup job scheduler capable of supporting multiple schedules for full, incremental and partial backup jobs.

i. Backup software shall keep a log file of the status of all backup and restore activities. Log file shall easily export to a text file.

j. Provide Acronis or Symantec back-up software or equal.

13. Other Software:

a. HMI software: coordinate with Owner.

b. PLC programming and configuration software, as specified in this Section

c. Microsoft Office Professional 2010

d. Adobe Acrobat Reader (Latest Edition)

e. Virus scan and protection software: either McAfee Virus Scan Enterprise or Symantec Norton AntiVirus Business Pack (Latest Edition)

f. Microsoft Internet Explorer (Latest Edition)

g. WinZip Professional (Latest Edition)

14. Manufacturers/Models:

a. Dell Latitude E6420

b. HP EliteBook series

c. Lenovo ThinkPad T420 series

H. Panel Mounted Industrial Workstations

1. Panel Mounted Industrial Workstations shall be mounted on control panels where indicated on the Drawings, and shall be set up to run the HMI software applications and other software.

2. Performance

   a. CPU: Core2 Duo P8400 2.26 GHz or Atom N270 1.6 GHz.

   b. RAM: 2GB minimum

   c. Storage: SATA SSD, 80GB minimum

   d. Ports (minimum): 1 serial (RS-232), 1 Ethernet 10/100/1000Mbit (RJ-45), 2 USB 2.0, 1 DVI.

   e. Display: 19-inch TFT touchscreen color LCD, 1280x1024 resolution.

   f. Operating System: Windows 7 Ultimate 32-bit.

3. Physical

   a. Environment: NEMA 4; Class I Division 2.

   b. Operating Temperature: 0-50˚C with 10-85% RH.

   c. Power: 120vac, 130W max consumption.

4. Software. In addition to the operating system, the following software shall be installed on each unit:

   a. HMI software: coordinate with Owner.

   b. Microsoft Internet Explorer

   c. Virus scan and protection software, as specified in this Section

   d. Adobe Acrobat Reader

   e. WinZip Professional

5. Manufacturer: Proface (Xycom), Model 4800; or equal.

I. Ethernet Switch

1. General: Provide managed Ethernet switch(es) for the control network as shown in the Drawings and specified herein.

2. Physical Features:

    a. Fiber uplinks: 100/1000 FX ports, as required plus 25 percent

    b. Copper ports: 10/100/1000 TX RJ45 ports, as required plus 25 percent

    c. Operating temperature: 32 to 130 degrees F

    d. Power: 120VAC, 60Hz

    e. Enclosure: Metal case. Provide 19” rack form factor, or DIN-rail mounted for industrial environments, as required for the location.

3. Network Features:

    a. Fault tolerant for use in a ring topology if shown on drawings

    b. Full duplex on all ports

    c. Auto negotiation and manual configurable speed and duplex

    d. Wire speed switching fabric

    e. IEEE 802.1w RSTP

    f. IGMP snooping

    g. IGMP filtering

    h. Configuration password protected

    i. Configuration backup capability required

    j. SNMP V3

4. Manufacturers:

    a. Siemens Stratix

    b. Or acceptable equal

J. Printer

1. Printer shall be laser type, capable of color or black printing, up to 11″x17″ size paper, double-sided. Printer shall include USB 2.0 port and built-in Ethernet connected print server. Processor and memory shall be sufficient to provide 1200 x 1200 dpi quality and up to 35 Letter-sized pages per minute.

2. Provide all necessary paper trays, cables, and driver software. Install latest firmware updates prior to delivery.

3. Manufacturer/Model: Hewlett-Packard LaserJet 5200dtn, acceptable or equal.

K. Programmable Logic Controller (PLC)

1. ISS shall furnish and install PLC equipment as required by the Drawings and the following Specification and in accordance with the attached data sheets, including all necessary auxilary equipment, in order to provide a fully integrated and working system.

2. Components shall be chosen from the list in this Section and assembled such that the intended function is achieved. In general, each PLC shall be equipped with one (1) CPU, one (1) SINAUT module, and one (1) Power Supply per rack, input/output modules as needed, and any communication modules needed to interface with a redundant CPU, the existing plant network, or other network devices. Furnish all cables, connectors, and ancillary devices necessary for the complete functioning of each PLC. Any components needed that are not listed shall be by Siemens or those recommended by Siemens or its authorized representative in writing.

3. Provide a minimum of twenty-five percent (25%) active spare I/O points of each type, and twenty-five percent (25%) room for future I/O modules in each PLC. All new, existing, and future I/O points, as shown on the Drawings or discovered in field investigation, shall be included in the total count for the purpose of determining the quantity of spares required.

4. CPU usage shall be tested, and shall not exceed 50% of capacity under full load conditions. ISS shall coordinate with APS (Application Programming Supplier) to ensure that the CPU and RAM selected are adequate to the application needs.

5. Distribute series of I/O points across multiple modules and racks so as to eliminate a single point of failure. For example, if there are two identical pumps, terminate the I/O for each pump in a different card and a different rack with separate power supply where possible.

6. Components used should be selected from the following list:

Product	Description	Part Number
CPU 317-2PN/DP	512 KB RAM processor 170k statements 65536 channels of DIO 4096 channels of AIO	
Micro Memory Card	8MB	6ES7 953-8LP20-0AA0
SINAUT TIM 3V-IE Advanced	10/100 Mbit/s Ethernet	6NH7 800-3CA00
Digital Input Card	24VDC inputs 16 channels, optically isolated includes diagnostics no filters / chatter will be prevented with time delays Relays must be employed to convert 24VDC to 120VAC.	6ES7 321-7BH00-0AB0
Digital Output Card	Relay Outputs: 5A @ 24VDC, 120VAC, 230VAC 8 outputs, individually isolated	6ES7 322-1HF20-0AA0
Analog Input Module	8 channels, 16-bit resolution, optically isolated	6ES7 331-7NF00-0AB0
Analog Output Module	4 channels, 16-bit resolution, isolated	6ES7 332-7ND00-0AB0
Thermocouple Module	8 channels, optically isolated	6ES7 331-7PF10-0AB0
Remote I/O Interface Module	IM 153-2, ET 200M, SM & FM only	6ES7 153-2AA03-0XB0
SIMEAS P Profibus Power Meter	Measurements include: power, voltage, current and power factor; total power; average voltage and current; line frequency; percent unbalanced voltage and current. 120VAC, Profibus DP communications.	7KG7 800-8AB10-0BA0

PS 307 Load Power Supply	115/230VAC, 24VDC, 2A	6ES7 307-1BA00-0AA0
PS 307 Load Power Supply	115/230VAC, 24VDC, 5A	6ES7 307-1EA00-0AA0
PS 307 Load Power Supply	115/230VAC, 24VDC, 10A	6ES7 307-1KA00-0AA0
Mounting Rail	19 inch cabinets	6ES7 390-1AE80-0AA0
Mounting Rail	530 mm	6ES7 390-1AF00-0AA0
Mounting Rail	830 mm	6ES7 390-1AJ00-0AA0
Mounting Rail	2000 mm	6ES7 390-1BC00-0AA0
Active DIN Rail	483 mm	6ES7 195-1GA00-0XA0
Active DIN Rail	530 mm	6ES7 195-1GF30-0XA0
Active DIN Rail	620 mm	6ES7 195-1GG30-0XA0
Active DIN Rail	2000 mm	6ES7 195-1GC00-0XA0
Active Bus Unit	PS/IM	6ES7 195-7HA00-0XA0
Active Bus Unit	2 x 40 mm	6ES7 195-7HB00-0XA0
Active Bus Unit	1 x 80 mm	6ES7 195-7HC00-0XA0
Active Bus Cover Plates	-	6ES7 195-1JA00-0XA0
Profibus Cable	Fast Connect Standard	6XV18300EH10
Communications Module - RS232C	CP341-1A Point-to-Point RS232C Interface	6ES7 341-1AH01-0AE0
Communications Module - 20 mA	CP341-1B Point-to Point 20 mA TTY Interface	6ES7 341-1BH01-0AE0
Communications Module - RS422/RS485	CP341-1C Point-to-Point RS422/485 Interface	6ES7 341-1CH01-0AE0
Communications Module - Industrial Ethernet	CP343-1 10/100 Mbit/s	6ES7 343-1EX10-0EX0
Communications Module – Profibus DP	IM 157	6ES7 157-0AA82-0XA0
Profibus DP/PA Coupler	IM 157 companion module	6ES7 157-0AC80-0XA0 & 6ES7 157-0AC81-0XA0
BM DP/PA Coupler Bus Module	Bus module	6ES7 195-7HF80-0XAO

PC Network Interface Card	CP1613 PCT Ethernet Card TCP/IP	6GK1 161-3AA00
PC Ethernet Interface Card	CP5611 for desktop PCs	6GK1 561-18A00
PC Ethernet Interface Card	CP5511 for laptops (PCMCIA)	6GK1 551-18A00
PC Ethernet Interface Cable	Cable used to provide communications between the CP5611 or CP5511 PC cards to the MPI port on the PLC	6ES7 901-0BF00-AA0
Industrial Ethernet Switch	2 x 100 Mbit/s FO interfaces 6 x 10/100 Mbit/s autosensing TP interfaces (RJ45) Integrated Redundancy Manager functions SNMP and web-based management	OSM TP62
PC Network Interface Software	S7-1613 Win NT 4.0-V.2.0	6GK1 716-1CB20-3AA0
PLC Programming Software	SIMATIC Step 7 Professional	ISFL-00129-0100
PLC MMC USB prommer		6ES7 792-0AA00-0XA0

L. Profibus DP Media Converter

1. Where indicated on the Drawings, provide a solid-state media converter. The device shall convert Profibus DP copper to 850nm fiber optic cable with ST converters (as specified in Section 13320), for point-to-point communication over fiber. The device shall also act as the terminating resistor for the Profibus DP bus where required. The media converter shall be 24VDC powered and rail mounted.

2. Manufacturer: Siemens OLM series, models as required.

M. Uninterruptible Power Supply (UPS) for Control Panels

1. Unless otherwise indicated on the Drawings, the power supplied to all microprocessor-based equipment within a PLC control panel shall be protected by an Uninterruptible Power Supply (UPS) mounted within the panel. The UPS shall prevent spikes, sags, surges, noise, and harmonics from adversely affecting digital equipment.

2. UPS input and output shall be galvanically isolated from one another. Input power shall be 120 VAC, 60 Hz. Output power may be 120VAC, 24VDC, or as needed to support connected equipment.

3. UPS shall contain internal backup batteries sufficient to allow all connected equipment to run continuously for no less than 15 minutes at full load. Provide load calculations which show these requirements to be met.

4. UPS shall include normally closed contact outputs for “On Battery” and “Low Battery/Fault”, which shall be picked up by the PLC for operator notification.

5. UPS units shall be UL1778 labeled and capable of being mounted within UL508 approved cabinets without derating.

6. UPS shall be Allen-Bradley 1609U, or acceptable equal.

7. Furnish and install a UPS maintenance bypass switch that will permit removal of the UPS for service while maintaining 120VAC power to all panel components. Provide a contact output indicating “UPS Bypassed” to the PLC for operator notification.

N. PLC Software

1. ISS shall purchase, and turn over to the APS for use in application development, the following software. The software licenses shall be in the Owner’s name, and shall be turned over to the Owner upon conclusion of the project.

   a. Two (2) licenses of SIMATIC Step 7 Professional.

   b. Two (2) licenses of the Profibus configuration software utilized.

PART 3 - EXECUTION

Refer to Section 13300.

END OF SECTION

SECTION 13315 FIELD INSTRUMENTATION

PART 1 - GENERAL

A. Scope of Work

1. The General Provisions of Section 13300 apply to this Section.

2. Furnish all labor, materials, equipment and incidentals required, to install, complete and ready for operation, the panels depicted on the Drawings and on the Instrumentation Details provided.

B. Related Work

1. Refer to Section 13300.

C. Submittals

1. Refer to Section 13300.

D. Reference Standards

1. Refer to Section 13300.

E. Quality Assurance

1. Refer to Section 13300.

F. Spare Parts

1. Furnish one year's supply of items recommended by the Manufacturer of the equipment for each component.

2. Provide other spare parts as indicated on the individual device specifications.

PART 2 - PRODUCTS

A. Magnetic Flow Meter

1. Flow Element:

a. Type: Pulsed DC electromagnetic induction type and shall provide a signal which is linear to the liquid flow rate.

b. Functional/Performance:

i. Power requirements: Match to converter/transmitter.
ii. Accuracy: Plus or minus 0.25 percent of reading, or +/- 1 millimeter per second, whichever is greater, irrespective of flow direction (including converter/transmitter).
iii. Temperature rating: Suitable for process liquid temperature up to 70°C and an ambient of 65°C.
iv. RFI protection: Provide RFI protection.
v. Pressure rating: 240 psi if 150 lb flanges are used, 700 psi if 300 lb flanges are used.
vi. Additional: Meter shall be capable of running empty indefinitely without damage to any component.
vii. Additional: Meter shall be able to measure flowrate and flow total in both the forward and reverse directions.

c. Physical:

i. Metering Tube: Carbon steel unless otherwise indicated.
ii. Flanges: ANSI 150 lb, carbon steel unless otherwise indicated. Flangeless wafer type may be used if compatible with adjacent piping.
iii. Liner: Teflon unless noted otherwise.
iv. Electrodes: Type 316 stainless steel, bullet nosed or elliptical self-cleaning type unless otherwise noted.
v. Housing: Meters in below grade vaults, basements, etc., shall be designed for accidental submergence in 30-ft of water for 24 hours. Meters above grade shall be of splashproof/dripproof design unless otherwise noted. Where hazardous areas are indicated on the contract drawings, the equipment shall be rated for that area.
vi. Painting: All external surfaces shall be painted with a chemical and corrosion resistant epoxy finish.

d. Options/Accessories Required:

i. Factory calibration: All meters shall be factory calibrated. A copy of the report shall be in the O&M manual.
ii. Grounding: Meter shall be grounded per the manufacturer’s recommendation. Provide grounding electrodes, ground ring, ground wires, gaskets, etc., as required or as otherwise noted. All

materials shall be suitable for liquid being measured.

2. Flow Converter/Transmitter:

    a. Functional/Performance:

        i. Power requirements: 120 VAC plus or minus 10 percent.
        ii. Accuracy: As defined for flow element.
        iii. Output: Either 4-20mA DC, or Profibus DP serial connection transmitting measured flow rate and all available diagnostic data, as required for each unit.

    b. Physical:

        i. Housing: NEMA 4X wall mount.
        ii. Temperature: -25 to 65°C.

    c. Options/Accessories Required:

        i. Cable: Provide signal cable between magmeter and signal converter.
        ii. Indicator: provide local digital indicator with scale in engineering units which indicates actual flow rate.
        iii. Password Protection: Meter software shall incorporate dual password features to prevent inadvertent program or unit changes.

3. Manufacturer:

    a. ABB Instrumentation

    b. Endress + Hauser

    c. Krohne

    d. Siemens SITRANS

    e. Or approved equal.

4. Units To Be Supplied By ISS:

    a. 02A FE/FIT 101 (500-FE/FIT-3): Plant Influent Flow No. 1
        i. Meter Size: 36 inch
        ii. Flow Range: 0-40 MGD
        iii. Output Type: Profibus

b. 02A FE/FIT 102 (500-FE/FIT-4): Plant Influent Flow No. 2
   i. Meter Size: 36 inch
   ii. Flow Range: 0-80 MGD
   iii. Output Type: Profibus

c. 02A FE/FIT 103 (500-FE/FIT-1): Onsite Lift Station Flow to Pretreatment
   i. Meter Size: 20 inch
   ii. Flow Range: 0-3600 gpm
   iii. Output Type: Profibus

d. 02A FE/FIT 271 (500-FE/FIT-2): Phase I/II Treatment Flow
   i. Meter Size: 30 inch
   ii. Flow Range: 0-33 MGD
   iii. Output Type: Profibus

e. 02A FE/FIT 272 (500-FE/FIT-5): Phase III Treatment Flow
   i. Meter Size: 36 inch
   ii. Flow Range: 0-80 MGD
   iii. Output Type: Profibus

f. 06A FE/FIT 397 (352-FE/FIT-2): Clarifier No. 9 WAS Flow
   i. Meter Size: 6 inch
   ii. Flow Range: 0-700 gpm
   iii. Output Type: Profibus

g. 06A FE/FIT 399 (352-FE/FIT-1): Clarifier No. 9 RAS Flow
   i. Meter Size: 10 inch
   ii. Flow Range: 0-4000 GPM
   iii. Output Type: Profibus

h. 07A FE/FIT 129 (450-FE/FIT-3): Clarifier No. 11 RAS Flow
   i. Meter Size: 16 inch
   ii. Flow Range: 0-4000 gpm
   iii. Output Type: Profibus

i. 08A FE/FIT 318 (395-FE/FIT-1): In-Plant Reuse Pump Station Flow
   i. Meter Size: 8 inch
   ii. Flow Range: 0-4,000 GPM
   iii. Output Type: Profibus

j. 09A FE/FIT 221 (251-FE/FIT-1): Clarifier No. 1 RAS Flow
   i. Meter Size: 8 inch
   ii. Flow Range: 0-2000 gpm
   iii. Output Type: Profibus

k. 09A FE/FIT 222 (251-FE/FIT-2): Clarifier No. 2 RAS Flow
   i. Meter Size: 8 inch
   ii. Flow Range: 0-2000 gpm
   iii. Output Type: Profibus

l. 09A FE/FIT 227 (251-FE/FIT-3): Clarifier No. 1/2 WAS Flow
   i. Meter Size: 4 inch
   ii. Flow Range: 0-600 gpm
   iii. Output Type: Profibus

m. 08A FE/FIT 430 (560-FE/FIT-1): Secondary Effluent Flow to Pretreatment
   i. Meter Size: 24 inch
   ii. Flow Range: 0-40 MGD
   iii. Output Type: Profibus

n. 08A FE/FIT 440 (560-FE/FIT-2): Secondary Effluent Flow to Reject Storage Pond
   i. Meter Size: 30 inch
   ii. Flow Range: 0-40 MGD
   iii. Output Type: Profibus

o. 09A FE/FIT 252 (252-FE/FIT-1): Clarifier No. 3 RAS Flow
   i. Meter Size: 8 inch
   ii. Flow Range: 0-2000 gpm
   iii. Output Type: Profibus

p. 09A FE/FIT 253 (252-FE/FIT-2): Clarifier No. 4 RAS Flow
   i. Meter Size: 8 inch
   ii. Flow Range: 0-2000 gpm
   iii. Output Type: Profibus

q. 09A FE/FIT 256 (252-FE/FIT-3): Clarifier No. 3/4 WAS Flow
   i. Meter Size: 4 inch
   ii. Flow Range: 0-600 gpm
   iii. Output Type: Profibus

r. 09A FE/FIT 311 (253-FE/FIT-2): Clarifier No. 7/8 WAS Flow

i. Meter Size: 3 inch
ii. Flow Range: 0-600 gpm
iii. Output Type: Profibus

B. Venturi Flow Element

1. Type:

a. Pressure differential producing type utilizing true static pressure. Flow tube devices that employ entire or partial Pitot effects to magnify differential pressure are not allowed.

b. Venturi shall be insert type with static high pressure tap installed in upstream pipe by others.

2. Functional/Performance:

a. Coefficient of Discharge: Greater than 0.98 and constant for pipe Reynolds numbers as low as 75,000.

b. Pressure: Each flow meter shall withstand hydrostatic pressure equal to that specified for the piping system in which the flow tube is to be installed.

c. Accuracy: ± 0.50% of the specified flow rate. The total overall error of each flow measurement loop, including venturi meter, transmitter, receiver and totalizer, shall not exceed ± 2.0% of actual rate of flow.

d. Differential: Minimum and maximum differential shall be suitable for the differential pressure transmitter and/or indicator provided, for the range specified.

e. Unrecovered Head Loss: Maximum permanent headloss shall be less than 10 percent of maximum differential pressure.

f. Tolerances: Tolerance shall not exceed twice the standard deviation by the procedure described in ASME “Fluid Meters,” Sixth Edition. Documentation tabulating at least 30 different venturi tubes of the same type which have been tested at a recognized hydraulic laboratory, and conforming to the twice standard deviation procedure, shall be accepted in lieu of actual lab calibrations.

3. Physical:

   a. Materials: The center flange shall be constructed of 316 Stainless Steel. The inlet and outlet cones shall be made of polyester resin reinforced with glass, 30% by weight. The throat section shall be made of 304 Stainless Steel. High and low pressure tap passages shall be lined with 316 Stainless Steel.

   b. External Taps: The insert venturi meter manufacturer shall provide the contractor with two (2) 304 Stainless Steel high pressure taps for his installation in the upstream pipe. The Manufacturer shall also provide complete installation instructions, including a detailed drawing showing clearly the correct installation point referenced from the inlet face of the insert venturi meter center flange.

   c. Throat Liner: 316 Stainless Steel.

   d. End Connections: Center flange shall fit between 150# flanges on the mating pipe sections.

   e. Mounting Hardware: as required for process conditions.

   f. Construction: Internal cross sections shall be circular with no debris collecting cavities or annular chambers, but shall have static pressure connections at the inlet and throat. Inlet section shall be a cylindrical section of the same nominal diameter of the pipe in which it is installed. Throat section shall be cylindrical with a minimum length equal to half its diameter.

4. Accessories/Options Required:

   a. Documentation: The Manufacturer shall provide documentation as follows.
      i. Curve showing flow versus differential pressure values.
      ii. Coefficient values and tolerances.
      iii. Headloss as a function of velocity head expended.
      iv. All welds must meet certified ASME standards for pressure vessel welding.

   b. Warranty: 5 years from date of installation of venturi meter.

c. Special Materials - where indicated on Drawings, furnish Venturi and all valves and appurtenances in materials that are resistant to chemicals injected upstream.

5. Manufacturers:

a. Primary Flow Signal, Model HVT-PS.

b. Or approved equal.

6. Units To Be Supplied By ISS:

a. 06A FE 211 (325-FE-1):Phase III Process Air Flow
i. Meter Size: 8 inch
ii. Flow Range:0-3750 SCFM

b. 06A FE 214 (325-FE-4):Phase III Process Air Flow
i. Meter Size: 8 inch
ii. Flow Range:0-3750 SCFM

c. 06A FE 215 (326-FE-1):Phase III Process Air Flow
i. Meter Size: 8 inch
ii. Flow Range:0-3750 SCFM

d. 06A FE 218 (326-FE-4):Phase III Process Air Flow
i. Meter Size: 8 inch
ii. Flow Range:0-3750 SCFM

e. 09A FE 301 thru 304 (221, 222, 223, 224-FE-1): Phase I/II Process Air Flow
i. Meter Size: 6 inch
ii. Flow Range: 0-3750 scfm

C. Flow Switch

1. Type:

a. Vane sensor, SPDT switch, 316 stainless steel body. For detecting no-flow condition in supply water lines.

b. Insert or inline body type, as required.

2. Functional/Performance:

a. Output - Form C (SPDT) snap action switch, rated for 10 amps, 125/250 volts AC.

3. Physical:

a. Wetted Parts - All 316 stainless steel for air or water service. Teflon coated 316SS for chemical service.

b. Body (Insert) - 316 stainless steel with a 1/2-inch conduit connection. 1-inch NPT mounting.

c. Body (Inline) – Stainless Steel tee, 1/2-inch NPT or as required, and wetted parts.

4. Options/Accessories:

a. Precast, corrosion resistant junction box with ½" NPT ports.

b. Spare Parts. Furnish one (1) complete spare unit for each type/range of units provided.

5. Manufacturer:

a. Dwyer, Flo-tect models

b. IMO Gems, Model FS-550

c. Or approved equal.

6. Units To Be Supplied By ISS:

a. 02A FSL 251: Grit Pump No. 1 Seal Water Flow

b. 02A FSL 252: Grit Pump No. 2 Seal Water Flow

c. 02A FSL 253: Grit Pump No. 3 Seal Water Flow

d. 02A FSL 254: Grit Pump No. 4 Seal Water Flow

e. 02A FSL 255: Grit Pump No. 5 Seal Water Flow

f. 06A FSL 395: Clarifier 9 WAS Pump 1 Seal Water Flow

g. 06A FSL 396: Clarifier 9 WAS Pump 2 Seal Water Flow

h. 07A FSL 123: Clarifier 11 RAS Pump 3 Seal Water Flow

i. 09A FSL 221: Clarifier 1/2 RAS Pump 1 Seal Water Flow

j. 09A FSL 223: Clarifier 1/2 RAS Pump 2 Seal Water Flow

k. 09A FSL 225: Clarifier 1/2 RAS Pump 3 Seal Water Flow

l. 09A FSL 227: Clarifier 1/2 WAS Pump 1 Seal Water Flow

m. 09A FSL 229: Clarifier 1/2 WAS Pump 2 Seal Water Flow

n. 09A FSL 251: Clarifier 3/4 RAS Pump 1 Seal Water Flow

o. 09A FSL 253: Clarifier 3/4 RAS Pump 2 Seal Water Flow

p. 09A FSL 255: Clarifier 3/4 RAS Pump 3 Seal Water Flow

q. 09A FSL 256: Clarifier 3/4 WAS Pump 1 Seal Water Flow

r. 09A FSL 257: Clarifier 3/4 WAS Pump 2 Seal Water Flow

s. 09A FSL 311: Clarifier 7/8 WAS Pump 1 Seal Water Flow

t. 09A FSL 313: Clarifier 7/8 WAS Pump 2 Seal Water Flow

D. Pressure Gauge / Pressure Switch

1. Type:

a. Bourdon tube or diaphragm actuated pressure gauge.

b. Pressure limit switches as needed per Loop Diagrams.

c. Gauge, differential or absolute pressure type as needed per Loop Diagrams.

2. Functional/Performance:

a. Accuracy: Plus or minus 2.0 percent of span or better.

b. Switch Rating – DPDT relay, 10A @ 120VAC.

c. Switch Setpoint – Fully adjustable over entire span, accurate to 1.0 percent of span. Provide dual setpoint switch where indicated.

3. Physical:

a. Case: Phenolic shock resistant or Type 316 stainless steel for surface/stem mounting with a pressure relieving back. The case shall be vented for temperature/ atmospheric compensation. Gauge shall be capable of being liquid filled in the field or at the factory.

b. Window: Clear acrylic or shatter proof glass.

c. Bourdon Tube: Type 316 stainless steel.

d. Connection: 1/2 in NPT.

e. Gauge size: 4-1/2" diameter minimum.

f. Pointer travel: 270 degree arc.

g. Range: As indicated in the instrument device schedule.

4. Options/Accessories Required:

a. Shutoff valve: Each gauge shall have a process shutoff valve which can also be used as an adjustable pressure snubber.

b. For each differential pressure device, provide 5-valve manifold and mounting brackets as required. The manifold shall be 316 stainless steel and provide the following modes of operation:
i. Normal Mode
ii. Zeroing Mode
iii. Isolation Mode
iv. Calibration Mode
v. Blowdown Mode

c. Where required by the process and/or shown on the Process & Instrumentation Diagrams, provide a diaphragm seal between the process fluid and the instrument(s). Diaphragm seal shall be welded metal type, threaded connection, 316SS construction.

d. Spare Parts. Furnish one (1) complete spare unit for every ten (10) or less of each type/range of units

provided. Spares shall be fully assembled and calibrated with diaphragm seals, ready for installation.

5. Manufacturers:

   a. Ametek/U.S. Gauge

   b. Dresser/Ashcroft

   c. Dwyer/Mercoid

   d. Wika

6. Units To Be Supplied By ISS:

   a. 06A PI 133 thru 135 (335-PI-1 thru 3) Phase III Process Air flow to Reaeration
      i. Differential Pressure Type
      ii. Range:0-15 psig

   b. 06A PI 136 thru 138 (336-PI-1 thru 3) Phase III Process Air flow to Reaeration
      i. Differential Pressure Type
      ii. Range:0-15 psig

   c. 06A FI 211 (325-FI-1): Phase III Process Air Flow
      i. Differential Pressure Type
      ii. Range: 0-3750 scfm

   d. 06A FI 214 (325-FI-4): Phase III Process Air Flow
      i. Differential Pressure Type
      ii. Range: 0-3750 scfm

   e. 06A FI 215 (326-FI-1):Phase III Process Air Flow
      i. Meter Size: 8 inch
      ii. Flow Range:0-3750 SCFM

   f. 06A FI 218 (326-FI-4):Phase III Process Air Flow
      i. Meter Size: 8 inch
      ii. Flow Range:0-3750 SCFM

   g. 06A PI 211 thru 218 (325-PI-1 thru 4, 326-PI-1 thru 4): Phase III Process Air Flow
      i. Gauge Pressure Type
      ii. Range: 0-15 psig

   h. 06A PI 395: Clarifier 9 WAS Pump 1 Discharge Pressure
      i. Gauge Pressure type with diaphragm seal.
      ii. Range: 0-30 psi

i. 06A PI 397: Clarifier 9 WAS Pump 2 Discharge Pressure
   i. Gauge Pressure type with diaphragm seal.
   ii. Range: 0-30 psi

j. 06A PI 394: Clarifier 9 WAS Pump 1 Suction Pressure
   i. Gauge Pressure type with diaphragm seal.
   ii. Range: 0-15 psi

k. 06A PI 396: Clarifier 9 WAS Pump 2 Suction Pressure
   i. Gauge Pressure type with diaphragm seal.
   ii. Range: 0-15 psi

l. 07A PI/PSH 112: Clarifier 11 Scum Pump Discharge Pressure/High Pressure (BID ALTERNATE)
   i. Gauge Pressure type.
   ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

m. 07A PI 113: Clarifier 11 Scum Pump Suction Pressure/High Pressure (BID ALTERNATE)
   i. Gauge Pressure type.
   ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

n. 07A PI 123: Clarifier 10/11 RAS Pump 3 Discharge Pressure
   i. Gauge Pressure type with diaphragm seal.
   ii. Range: 0-30 psi

o. 07A PI 126: Clarifier 10/11 RAS Pump 3 Suction Pressure
   i. Gauge Pressure type with diaphragm seal.
   ii. Range: 0-15 psi

p. 08A PI 421, 422, 423, 424 (560-PI-1, 2, 3, 4): Secondary Effluent Reject Pump 1 thru 4 Pressure
   i. Gauge Pressure type.
   ii. Range: 0-30 psi

q. 09A FI 301 thru 304 (221, 222, 223, 224-FI-1): Phase I/II Process Air Flow
   i. Differential Pressure Type
   ii. Range: 0-3750 scfm

r. 09A PI 301, 302, 307, 308 (221, 222, 223, 224-PI-1): Phase I/II Process Air Pressure
   i. Differential Pressure Type
   ii. Range: 0-15 psig

s. 09A PI/PSH 205: Clarifier 1 Scum Pump Discharge Pressure/High Pressure (BID ALTERNATE)

i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

t. 09A PI/PSH 214: Clarifier 2 Scum Pump Discharge Pressure/High Pressure (BID ALTERNATE)
i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

u. 09A PI 204: Clarifier 1 Scum Pump Suction Pressure (BID ALTERNATE)
i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

v. 09A PI 214: Clarifier 2 Scum Pump Suction Pressure/High Pressure (BID ALTERNATE)
i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

w. 09A PI 222: Clarifier 1/2 RAS Pump 1 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-40 psi

x. 09A PI 224: Clarifier 1/2 RAS Pump 2 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-40 psi

y. 09A PI 226: Clarifier 1/2 RAS Pump 3 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-40 psi

z. 09A PI 228: Clarifier 1/2 WAS Pump 1 Discharge Pressure
i. Gauge pressure type with diaphragm seal
ii. Range:0-30 psi

aa. 09A PI 230: Clarifier 1/2 WAS Pump 2 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-30 psi

bb. 09A PI 234: Clarifier 3 Scum Pump Suction Pressure/High Pressure (BID ALTERNATE)
i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

cc. 09A PI 235: Clarifier 3 Scum Pump Discharge Pressure/High Pressure (BID ALTERNATE)

i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

dd. 09A PI 244: Clarifier 4 Scum Pump Suction Pressure/High Pressure (BID ALTERNATE)
i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

ee. 09A PI/PSH 245: Clarifier 4 Scum Pump Discharge Pressure/High Pressure (BID ALTERNATE)
i. Gauge Pressure type.
ii. Range/Setpoint: 0-60 psi/Setpoint 39 psi

ff. 09A PI 332: Clarifier 3/4 RAS Pump 1 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range:0-40 psi

gg. 09A PI 333: Clarifier 3/4 RAS Pump 2 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range:0-40 psi

hh. 09A PI 334: Clarifier 3/4 RAS Pump 3 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-40 psi

ii. 09A PI 335: Clarifier 3/4 WAS Pump 1 Discharge Pressure

i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-30 psi

jj. 09A PI 336: Clarifier 3/4 WAS Pump 2 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-30 psi

kk. 09A PI 221: Clarifier 1/2 RAS Pump 1 Suction Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-15 psi

ll. 09A PI 223: Clarifier 1/2 RAS Pump 2 Suction Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-15 psi

mm. 09A PI 225: Clarifier 1/2 RAS Pump 3 Suction Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range: 0-15 psi

nn. 09A PI 227: Clarifier 1/2 WAS Pump 1 Suction Pressure
    i. Gauge pressure type with diaphragm seal
    ii. Range:0-15 psi

oo. 09A PI 251: Clarifier 3/4 RAS Pump 1 Suction Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range:0-15 psi

pp. 09A PI 253: Clarifier 3/4 RAS Pump 2 Suction Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range:0-15 psi

qq. 09A PI 255: Clarifier 3/4 RAS Pump 3 Discharge Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range:0-15 psi

rr. 09A PI 257: Clarifier 3/4 WAS Pump 1 Suction Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range: 0-15 psi

ss. 09A PI 259: Clarifier 3/4 WAS Pump 2 Suction Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range: 0-15 psi

tt. 09A PI 311: Clarifier 7/8 WAS Pump 1 Suction Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range: 0-15 psi

uu. 09A PI 313: Clarifier 7/8 WAS Pump 2 Suction Pressure
    i. Gauge Pressure type with diaphragm seal.
    ii. Range: 0-15 psi

vv. 09A PI 351 (231-PI-1) Phase I/II Process Air flow to Reaeration
    i. Differential Pressure Type
    ii. Range:0-15 psig

ww. 09A PI 352 (231-PI-2) Phase I/II Process Air flow to Reaeration
i. Differential Pressure Type
ii. Range:0-15 psig

xx. 09A PI 353 (232-PI-1) Phase I/II Process Air flow to Reaeration
i. Differential Pressure Type
ii. Range:0-15 psig

yy. 09A PI 312: Clarifier 7/8 WAS Pump 1 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-30 psi

zz. 09A PI 314: Clarifier 7/8 WAS Pump 2 Discharge Pressure
i. Gauge Pressure type with diaphragm seal.
ii. Range: 0-30 psi

E. Pressure Transmitter

1. Type:

a. Microprocessor based, intelligent type.

b. Gauge or differential pressure type as required.

2. Function/Performance:
a. Range: Range of the transmitter shall be the standard range of the manufacturer closest to the pressure range to be metered.

b. Accuracy: 0.075 percent of span.

c. Operating Temperature: -20 to 80 degrees C.

d. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change.

e. Output: 4-20 mA DC linear with pressure or level, with HART protocol. Zero adjustable over the range of the instrument provided calibrated span is greater than the minimum calibrated span.

f. Stability: 0.10% for 2 years.

g. Display: Digital indicator displaying pressure or level in the engineering units indicated in the

Instrument Device Schedule.

h. Diagnostics:
   i. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
   ii. Simulation capability for inputs and loop outputs.
   iii. Test terminals available to ease connection for test equipment without opening the loop.
   iv. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
   v. Run-time clock available to determine usage for warranty purposes. 5-year warranty on this clock reading is included.

i. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.

j. If required to meet the range or suppression/elevation requirements, a differential pressure transmitter shall be provided.

3. Physical:
   a. Enclosure: NEMA 4X (IP66), explosion proof, approved for Class I, Division 1, Groups C and D (EEx d IIC T5).

   b. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O-rings shall be Teflon.

   c. Power Supply: 24 VDC loop power.

   d. Sensor Fill Fluid: Silicone.

4. Accessories Required:
   a. Provide span and zero adjustment at each transmitter and through the handheld programming unit. Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device.

b. For each transmitter provide a 316 stainless steel block & bleed shut off valve. Valves may be mounted directly to the instrument or separately mounted. Valves shall be by the instrument manufacturer or by D/A Manufacturing or Anderson Greenwood.

5. Manufacturer:
   a. Rosemount

6. Units To Be Supplied By ISS

   a. 08A PIT 311 (390-PIT-1): Phase III Effluent Pump Station Pressure
      i. Range: 0-60 psi

   b. 08A PIT 318 (395-PIT-1): In-Plant Reuse Pump Station Pressure
      i. Range: 0-200 psi

F. Ultrasonic Level or Open Channel Flow Meter

1. Sensor:

   a. Type: The transducer generates an ultrasonic signal and receives an echo from the liquid or solid surface.

   b. Operational/Functional:
      i. Sensor shall be potted/encapsulated in a chemical and corrosion resistant PVC or CPVC housing. Sensors shall be capable of being completely submersed without damage.
      ii. Temperature limits: minus 22 to plus 150 degrees F.
      iii. Relative humidity: 0 to 100 percent.
      iv. Sensors shall be provided with automatic air temperature and density compensation.

   c. Physical:
      i. Sensors located in areas where freezing condensation may occur shall be provided with special heaters or other type of transducer protection designed to prevent sensor icing.
      ii. Sensors shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings or instrument device schedule.

   d. Options/Accessories Required:

i. The ISS shall be responsible for coordinating all sensor mounting requirements and shall furnish dimensional and elevational drawings to ensure a proper and satisfactory installation.

2. Transmitter:

a. Type: Microprocessor based device which coverts the sensor output signal to a selectable volume, flow, or level output.

b. Functional/Performance:
   i. Temperature limits: Units shall be rated 30 to 120 degrees F. Units installed in unheated areas shall be provided with internal space heaters and thermostats and shall be suitable for temperatures of minus 15 to plus 120 degrees F.
   ii. Accuracy: Shall be plus or minus 1.0 percent for the transducer and converter.
   iii. Transmitter shall ignore momentary loss of echo signals and shall indicate loss of echo on the transmitter unit.
   iv. Output: Either 4-20mA DC, or Profibus DP serial connection transmitting measured flow rate and all available diagnostic data, as required for each unit.
   v. Power requirements: 120 VAC, 60 Hz.
   vi. Display: 4 digit LCD, scaled to read in engineering units of flow, level, or volume as indicated on the instrument flow device schedule.

c. Physical:
   i. Provide NEMA 4X enclosures.
   ii. Provide sunshields on all units mounted outside.
   iii. Provide freeze protection on all units mounted outside.

d. Options/Accessories Required:
   i. Provide a six digit non reset flow totalizer where indicated on the instrument device schedule.
   ii. Provide sensor interconnecting cable between sensor and transmitter.
   iii. Where required, furnish a unit capable of accepting two level sensor inputs, and converting them to a differential level signal for indication and transmission.

3. Manufacturer

a. Siemens Milltronics

b. Endress + Hauser

4. Units To Be Supplied By ISS

a. 02A LE/LIT 200 (500-LE/LIT-1): Screening Influent Channel Level
   i. Range: 0-10 feet
   ii. Output Type: Profibus

b. 02A LE/LIT 210 (500-LE/LIT-2): Grit Influent Channel Level
   i. Range: 0-10 feet
   ii. Output Type: Profibus

c. 08A LE/LIT 001 (360-LE/LIT-1): Filter Splitter Box Level
   i. Range: 0-10 feet (elevation 80’-88’)
   ii. Output Type: Profibus

d. 08A LE/LIT 104 (580-LE/LIT-1): Phase V Chlorine Contact Flow
   i. Level Range: 0-15 feet (elevation 69’-82’)
   ii. Flow Range: 0-40 MGD
   iii. Output Type: Profibus

e. 08A LE/LIT 400 (560-LE/LIT-1): Phase I/II Secondary Effluent Reject PS Level
   i. Range: 0-20 feet (elevation 71’-91’)
   ii. Output Type: Profibus

f. 09A LE/LIT 401 (561-LE/LIT-1): Phase I/II Secondary Effluent Diversion Structure No. 1 Level
   i. Range: 0-20 feet
   ii. Output Type: Profibus

g. 09A LE/LIT 405 (562-LE/LIT-1): Phase I/II Secondary Effluent Diversion Structure No. 2 Level
   i. Range: 0-20 feet
   ii. Output Type: Profibus

h. 08A LE/LIT 416 (563-LE/LIT-1): Phase III Secondary Effluent Diversion Structure No. 3 Level
   i. Range: 0-20 feet
   ii. Output Type: Profibus

i. 08A LE/LIT 417 and 419 (564-LE/LIT-1 and 2): Phase III/IV Secondary Effluent Diversion Structure Level Side A & B
   i. Range: 0-20 feet
   ii. Output Type: Profibus

j. 02B LE/LIT 501 and 502 (520-LE/LIT-1 and 2): Supplemental Carbon Tank 1 & 2 Level
i. Range: 0-12 feet
ii. Output Type: Profibus
iii. Local Displays should read in percent (%) full.

G. Float Switch

1. Type: Ball float switch.

2. Functional/Performance:

a. Differential: Less than one inch.

b. Switch Rating: Form C, 20 amps at 120V AC, 10 amps at 240V AC.

3. Physical:

a. Float: 316 stainless steel or PVC, 5½-inch diameter.

b. Switch: Totally encapsulated “environmentally friendly” non-mercury switch.

c. Cable: Heavy duty, PVC jacketed, integral to float.

4. Options/Accessories Required:

a. Provide 316 stainless steel mounting hardware.

b. The floats shall be mounted on hooks inside the wetwell, to be provided and installed by the Contractor. Refer to detail on Drawing D-110-101 for typical installation.

c. The lead wire shall be a waterproof cable of sufficient length so that no splice or junction box is required in the wetwell.

d. Provide a NEMA 4X junction box outside the wetwell with terminals for all floats and tapped as required for conduit connections.

5. Manufacturer:

a. Anchor Scientific

b. US Filter (Consolidated Electric Co.)

c. Warrick Controls

6. Units To Be Supplied By ISS:

a. 02A LSH 200 (500-LSH-2): Screening Influent Channel High Alarm Level
   i. Elevation: 6.5’

b. 02A LSH 210 (500-LSH-1): Grit Influent Channel High Alarm Level
   i. Elevation: 7.67’

c. 07A LSHH 303: Clarifier 11 Scum Wetwell High Alarm Level
   i. Elevation: TBD

d. 07A LSH 303: Clarifier 11 Scum Wetwell Pump Start Level
   i. Elevation: TBD

e. 09A LSHH 204: Clarifier 1 Scum Wetwell High Alarm Level
   i. Elevation: TBD

f. 09A LSH 204: Clarifier 1 Scum Wetwell Pump Start Level
   i. Elevation: TBD

g. 09A LSHH 214: Clarifier 2 Scum Wetwell High Alarm Level
   i. Elevation: TBD

h. 09A LSH 214: Clarifier 2 Scum Wetwell Pump Start Level
   i. Elevation: TBD

i. 09A LSHH 234: Clarifier 3 Scum Wetwell High Alarm Level
   i. Elevation: TBD

j. 09A LSH 234: Clarifier 3 Scum Wetwell Pump Start Level
   i. Elevation: TBD

k. 09A LSHH 244: Clarifier 4 Scum Wetwell High Alarm Level
   i. Elevation: TBD

l. 09A LSH 244: Clarifier 4 Scum Wetwell Pump Start Level

i. Elevation: TBD

H. Sludge Blanket Interface Level Detector

1. Type: Sludge blanket interface is detected by a Near Infrared (NIR) sensor mounted on a cable, which travels through thin or fluff layers until it finds the desired blanket concentration.

2. Functional/Performance:

a. Power Requirements – 120VAC/60Hz, 20 VA during measuring cycle (250VA with optional heater).

b. Process Output – Profibus DP serial connection transmitting measured sludge interface level, and all available diagnostic data.

c. Range – 0-33 ft (10 m).

3. Physical:

a. Enclosure – NEMA 4X.

b. Operating Temperature – 32 to 122 F (14 to 122 F with heater).

c. Sensor Material – 316SS with BK7 glass lenses.

d. Cable – Shielded 4-wire polyurethane cable, length 36 ft (11 m).

4. Options/Accessories Required:

a. Provide 316 stainless steel hardware for handrail mounting.

b. Provide environmental controls as necessary to maintain proper operating temperature, including but not limited to heater, cooling fan, and sunshield.

c. Provide automatic cleaning system, including solenoid valve and all necessary piping, to be installed in accordance with Manufacturer's recommendations. Solenoid valve shall be as specified in Section 15100. Coordinate with Contractor to provide a plant water source.

d. Provide rake guard limit switch and motor actuator for temporary retraction of probe as clarifier arm passes.

Transmitter shall hold reading while probe is retracted. Limit switch shall be turret-head lever arm type, NEMA 6P rated, utilizing a normally open contact.

e. Coordinate with Contractor for proper mounting. Install in accordance with Manufacturer's recommendations.

5. Manufacturers:

a. Cerlic, Model CAT-μP.

b. Or approved equal.

6. Units To Be Supplied By ISS:

a. 07A LE/LIT 102 (540-LE/LIT-1): Clarifier 11 Sludge Blanket Interface Level
i. Range: 0-14 feet

b. 09A LE/LIT 203 (241-LE/LIT-1): Clarifier 1 Sludge Blanket Interface Level
i. Range: 0-14 feet

c. 09A LE/LIT 213 (242-LE/LIT-1): Clarifier 2 Sludge Blanket Interface Level
i. Range: 0-14 feet

d. 09A LE/LIT 233 (243-LE/LIT-1): Clarifier 3 Sludge Blanket Interface Level
i. Range: 0-14 feet

e. 09A LE/LIT 243 (244-LE/LIT-1): Clarifier 4 Sludge Blanket Interface Level
i. Range: 0-14 feet

I. Suspended Solids Analyzer

1. Type:

a. Microprocessor-based MLSS or TSS suspended solids analyzer.

b. Multi-sensor transmitter where required.
i. In some locations, multiple probes shall be connected to multiple channels of a single transmitter. Note transmitter may have dual functions (i.e measure NO3 and pH). Functions are listed separately in this specification. Refer to

the Drawings for specific requirements per location.

c. Inline probe sensor.

2. Functional/Performance:

a. Operation: Phased-array light source and photo detector combination measures suspended solids content of process water, which is indicated and transmitted by the analyzer.

b. Accuracy: ± 5% of reading or ± 100 mg/L, whichever is greater.

c. Repeatability: ± 1% of reading or ± 20 mg/L, whichever is greater.

d. Output: Profibus DP serial connection transmitting measured suspended solids concentration, and all available diagnostic data.

e. Display: Backlit LCD display for local operation. The reading shall be displayed in engineering units.

f. Calibration: User-selectable linearization curves and auto-ranging.

g. Diagnostics: Built-in diagnostics will detect at least the following faults: sensor light detector failure, abnormal calibration, internal program failure.

h. Power: 120VAC, 60 Hz.

3. Physical:

a. Sensor Pressure/Temperature: 0-50 psig / 0-50 deg. C.

b. Sensor Mounting: Furnish hot-tap ball valve assembly and strapping for inline mounting, as required.

c. Analyzer Enclosure: NEMA 4X / IP65 rated.

d. Analyzer Mounting: Provide brackets as needed for wall or pipe mounting.

e. Cable: Furnish connector cable between sensor and analyzer, length as needed.

4. Manufacturer:

    a. Cerlic ITXIL / BB2

    b. Or approved equal.

5. Units To Be Supplied By ISS:

    a. 06A AE/AIT 397 (352-AE/AIT-1): Clarifier 9 Sludge Suspended Solids
        i. Range: 0-1.5% / 0-15,000 mg/L

    b. 07A AE/AIT 127 and 128 (450-AE/AIT-1): Clarifier 10/11 Sludge Suspended Solids
        i. Range: 0-1.5% / 0-15,000 mg/L

    c. 09A AE/AIT 224 and 225 (251-AE/AIT-1): Clarifier 1/2 Sludge Suspended Solids
        i. Range: 0-1.5% / 0-15,000 mg/L

    d. 09A AE/AIT 254 and 255 (252-AE/AIT-1): Clarifier 3/4 Sludge Suspended Solids
        i. Range: 0-1.5% / 0-15,000 mg/L

    e. 09A AE/AIT 312 (253-AE/AIT-1): Clarifier 7/8 Sludge Suspended Solids
        i. Range: 0-1.5% / 0-15,000 mg/L

J. Dissolved Oxygen Analyzer

1. Sensing Element

    a. Type:
        i. Luminescent sensor technology.
        ii. Solid state electronics.
        iii. Suitable for continuous submergence.

    b. Functional/Performance:
        i. Range: 0-10 mg/L
        ii. Temperature compensation (0-50 degrees C).
        iii. Accuracy - Plus or minus 0.2 ppm at 1.5 ft/sec flow within D.O. range of 0-5 ppm.

    c. Physical:
        i. Sensor shall be constructed of non-corrosive materials suitable for the monitored liquid train.
        ii. Heavy duty construction suitable for unattended use in municipal wastewater treatment facilities.
        iii. Mounting bracket shall be provided to hold the sensing probes in the process fluid. Bracket shall

permit easy withdrawal from service for inspection and maintenance.

iv. Interconnecting cable shall be furnished by the MANUFACTURER for connection to the indicating transmitter unit.

d. Accessories:
   i. One (1) spare sensor for every four (4) units provided.

e. Manufacturer:
   i. Hach LDO

2. Analyzer Indicating Transmitter

a. Type:
   i. Multipurpose analytical transmitter suitable for multiple sensor types.
   ii. In some locations, multiple probes shall be connected to multiple channels of a single transmitter. Note transmitter may have dual functions (i.e measure NO3 and pH). Functions are listed separately in this specification. Refer to the Drawings for specific requirements per location.
   iii. Profibus DP communication.

b. Functional/Performance:
   i. Compensate for temperature variations.
   ii. Digital LCD display of engineering units.
   iii. Output: Profibus DP serial connection transmitting measured values, and all available diagnostic data.
   iv. Power Requirements - 120 volt, 60 Hz.

c. Physical:
   i. NEMA 4X/IP65 enclosure.
   ii. Stainless steel hardware.
   iii. Surface or horizontal/vertical piping mount.

d. Manufacturer:
   i. Hach sc1000

3. Units To Be Supplied By ISS:

a. 06A AE/AIT 121 (317-AE/AIT-1): Phase III First Anoxic 1 Dissolved Oxygen

b. 06A AE/AIT 122(325-AE/AIT-1): Phase III BNR Basin 5 Dissolved Oxygen

c. 06A AE/AIT 124 (318-AE/AIT-1): Phase III First Anoxic 2 Dissolved Oxygen

d. 06A AE/AIT 125 (326-AE/AIT-1): Phase III BNR Basin 6 Dissolved Oxygen

e. 06A AE/AIT 133 (335-AE/AIT-2): Phase III Reaeration 1 Dissolved Oxygen

f. 06A AE/AIT 137 (336-AE/AIT-2): Phase III Reaeration 2 Dissolved Oxygen

g. 09A AE/AIT 113 (217-AE/AIT-1): Phase I First Anoxic Dissolved Oxygen

h. 09A AE/AIT 111 (221-AE/AIT-1): Phase I BNR Basin 1 Dissolved Oxygen

i. 09A AE/AIT 114 (222-AE/AIT-1): Phase I BNR Basin 2 Dissolved Oxygen

j. 09A AE/AIT 117 (218-AE/AIT-1): Phase II First Anoxic Dissolved Oxygen

k. 09A AE/AIT 118(223-AE/AIT-1): Phase II BNR Basin 3 Dissolved Oxygen

l. 09A AE/AIT 121(224-AE/AIT-1): Phase II BNR Basin 4 Dissolved Oxygen

m. 09A AE/AIT 126 (231-AE/AIT-2): Phase I Reaeration Dissolved Oxygen

n. 09A AE/AIT 128(232-AE/AIT-1): Phase II Reaeration Dissolved Oxygen

K. pH Analyzer

1. Sensing Element

a. Type:
   i. pH sensitive glass membrane electrode, double junction gel-filled reference cell and ground electrode with preamplifier in one pH sensor.
   ii. For submersion or flow through application, as required.

b. Functional/Performance:
   i. Range: 4-10.
   ii. Accuracy: 1/2% of span.

c. Physical:
   i. Body Material: Polymer or Schedule 80 ABS.
   ii. Completely sealed, chemical resistant.
   iii. 5 wire unit with signal preamplifier.
   iv. Dome Shaped Bulb Glass.

d. Accessories:
   i. One (1) spare sensor for every four (4) units provided.

e. Manufacturer:
   i. Hach/GLI pHD

2. Analyzer Indicating Transmitter

a. Type:
   i. Multipurpose analytical transmitter suitable for multiple sensor types.
   ii. In some locations, multiple probes shall be connected to multiple channels of a single transmitter. Note transmitter may have dual functions (i.e measure NO3 and pH). Functions are listed separately in this specification. Refer to the Drawings for specific requirements per location.
   iii. Profibus DP communication.

b. Functional/Performance:

   i. Compensate for temperature variations.
   ii. Digital LCD display of engineering units.
   iii. Output: Profibus DP serial connection transmitting measured values, and all available diagnostic data. Note that both pH and process temperature are expected.
   iv. Power Requirements - 120 volt, 60 Hz.

c. Physical:
   i. NEMA 4X/IP65 enclosure.
   ii. Stainless steel hardware.
   iii. Surface or horizontal/vertical piping mount.

d. Manufacturer:
   i. Hach sc1000

3. Units To Be Supplied By ISS:

a. 06A AE/AIT 123 (325-AE/AIT-1): Phase III BNR Basin 5 pH/Temp

b. 06A AE/AIT 126(326-AE/AIT-1): Phase III BNR Basin 6 pH/Temp

c. 06A AE/AIT 134(335-AE/AIT-2): Phase III Reaeration 1 pH/Temp

d. 06A AE/AIT 138(336-AE/AIT-2): Phase III Reaeration 2 pH/Temp

e. 08A AE/AIT 309 (390-AE/AIT-1): Effluent Pump Station

f. 08A AE/AIT 310 (390-AE/AIT-2): Effluent Pump Station

g. 09A AE/AIT 112 (221-AE/AIT-1): Phase I BNR Basin 1 pH/Temp

h. 09A AE/AIT 115 (222-AE/AIT-1): Phase I BNR Basin 2 pH/Temp

i. 09A AE/AIT 119 (223-AE/AIT-1): Phase II BNR Basin 3 pH/Temp

j. 09A AE/AIT 122 (224-AE/AIT-1): Phase II BNR Basin 4 pH/Temp

k. 09A AE/AIT 125 (231-AE/AIT-2): Phase I Reaeration pH/Temp

l. 09A AE/AIT 128 (232-AE/AIT-2): Phase II Reaeration pH/Temp

L. Nitrate Analyzer

1. Sensing Element

a. Type:
   i. Potentiometric ion-selective electrodes for ammonium, potassium, nitrate and chloride, reference system and temperature sensor.
   ii. In-situ mounting, suitable for continuous submergence.

b. Functional/Performance:
   i. Measurement Range: 0-1000 mg/L NO_3-N or 0-1000 mg/L NH_4-N.
   ii. Process Range: 0-30 mg/L

iii. Accuracy – 5% of measured value ±0.2 mg/L.
iv. Response time – under 3 minutes.
v. Operating Temperature - -4 to 113 deg F.

c. Physical:
i. Cartridge Materials – Stainless steel, PVC, POM, ABS, NBR.
ii. Sensor Materials – Stainless steel, ASA+PC, silicon, PVC, PU
iii. Environmental rating – fully submersible.
iv. Mounting bracket shall be provided to hold the sensing probes in the process fluid. Bracket shall permit easy withdrawal from service for inspection and maintenance.
v. Interconnecting cable shall be furnished by the MANUFACTURER for connection to the indicating transmitter unit.

d. Accessories:
i. One (1) spare sensor for every four (4) units provided.

e. Manufacturer:
i. Hach AN-ISE sc

2. Analyzer Indicating Transmitter

a. Type:
i. Multipurpose analytical transmitter suitable for multiple sensor types.
ii. In some locations, multiple probes shall be connected to multiple channels of a single transmitter. Note transmitter may have dual functions (i.e measure NO3 and pH). Functions are listed separately in this specification. Refer to the Drawings for specific requirements per location.
iii. Profibus DP communication.

b. Functional/Performance:

i. Compensate for temperature variations.
ii. Digital LCD display of engineering units.
iii. Output: Profibus DP serial connection transmitting measured values, and all available diagnostic data.
iv. Power Requirements - 120 volt, 60 Hz

c. Physical:
i. NEMA 4X/IP65 enclosure.

ii. Stainless steel hardware.
iii. Surface or horizontal/vertical piping mount.

d. Manufacturer:
i. Hach sc1000

3. Units To Be Supplied By ISS:

a. 06A AE/AIT 131 (325-AE/AIT-2): Phase III Pre Second Anoxic 1 Nitrate

b. 06A AE/AIT 132 (335-AE/AIT-1): Phase III Post Second Anoxic 1 Nitrate

c. 06A AE/AIT 135 (326-AE/AIT-2): Phase III Pre Second Anoxic 2 Nitrate

d. 06A AE/AIT 136 (336-AE/AIT-1): Phase III Post Second Anoxic 2 Nitrate

e. 06A AE/AIT 162 (421-AE/AIT-1): Phase IV-C Post Second Anoxic 2 Nitrate

f. 06A AE/AIT 163 (421-AE/AIT-1): Phase IC-C Post Second Anoxic 2 Nitrate

g. 06A AE/AIT 165 (422-AE/AIT-1): Phase IV-C Post Second Anoxic 2 Nitrate

h. 06A AE/AIT 166 (422-AE/AIT-1): Phase IV-C Post Second Anoxic 2 Nitrate

i. 09A AE/AIT 326(222-AE/AIT-2): Phase I Pre Second Anoxic Nitrate

j. 09A AE/AIT 123 (231-AE/AIT-1): Phase I Post Second Anoxic Nitrate

k. 09A AE/AIT 124 (232-AE/AIT-1): Phase II Post Second Anoxic Nitrate

l. 09A AE/AIT 120 (223-AE/AIT-2): Phase II Pre Second Anoxic Nitrate

M. Turbidity Analyzer

1. Type: Micro processor based, continuously flowing, 90 degree light refractive type turbidimeter.

2. Functional/Performance:

   a. Accuracy : +/-2% of reading or +/-0.020 NTU (whichever is greater) from 0 to 40 NTU; +/-5% of reading from 40 to 100 NTU. The repeatability of the unit shall be +/-1% of the reading.

   b. Resolution - The resolution shall be 0.001 NTU

   c. Range - the instrument shall be capable of measuring turbidity from 0 to 100 NTU.

   d. Output – Profibus DP serial connection transmitting measured suspended solids concentration, and all available diagnostic data.

   e. Stability - The device shall be able to operate within 0 to 40 degrees Celsius and shall produce accurate readings under 0-95 % non condensing humidity conditions.

   f. Power Requirements - 120 Vac with internal surge protection.

3. Physical:

   a. The turbidimeter shall have a 1/4" female inlet with a 1/4" compression fitting. The drain shall be 1/2" NPT female with a 1/2" hose barb.

   b. Provide a complete handrail mounting system or flow through tee mounting system as required to meet the application. The handrail mounting system shall include PVC mounting pipe (length as required) and stainless steel mounting hardware. The flow through tee mounting system shall include all flow regulators, pressure regulators, shutoff valves, sample pumps, etc, as detailed or required for complete operational system.

   c. Provide sensor cable of sufficient length for installation without splices between the sensor and transmitter.

4. Manufacturers:

   a. Hach Solitax sc Turbidity sensor and sc1000 transmitter

5. Units To Be Supplied By ISS

   a. 08A AE/AIT 440 (570-AE/AIT-1): Phase V Disk Filters Effluent Turbidity
      i. Scale: 0-10 NTU

   b. 08A AE/AIT 103 (470-AE/AIT-1): Temporary Disk Filter Turbidity
      i. Scale: 0-10 NTU

   c. 08A AE/AIT 441 (570-AE/AIT-2): Phase V Disk Filters Effluent Turbidity
      i. Scale: 0-10 NTU

   d. 08A AE/AIT 107 (470-AE/AIT-2): Temporary Disk Filter Turbidity
      i. Scale: 0-10 NTU

N. Chlorine Residual Analyzer

1. Type:

   a. Microprocessor based electronic transmitter/ converter with a submersible membrane type sensor. Total or Free chlorine measurement as required.

2. Functional/Operation:

   a. Power Requirements: 120 V, 60 Hz supply.

   b. Operating Range: Selectable 0 to 1; 0 to 5; 0 to 10 ppm chlorine; or as required for specific instrument. Internal battery will maintain sensor polarization in the case of power failure.

   c. Output: 4-20 mA

   d. Accuracy: 3 percent full scale.

   e. Response: 90 percent in 20 seconds.

   f. Repeatability: 0.05 ppm CL.

   g. Display: LCD with .7 in high characters.

   h. Diagnostics: Shall have built in self diagnostics and display operational errors and equipment malfunctions.

3. Physical:

a. Enclosure: Wall/rack mount. If mounted outdoors, provide NEMA 4X enclosure.

4. Options/Accessories Required:

a. Provide a complete flow through tee mounting system as required to meet the application. The flow through tee mounting system shall include all flow regulators, pressure regulators, shutoff valves, sample pumps, etc, as detailed or required for complete operational system.

b. Provide one full year's supply of any expendable items such as reagents, chemicals, membranes, etc, as required for the analyzer furnished.

5. Manufacturers:

a. Hach, Model CL 17

6. Units To Be Supplied By ISS:

a. 08A AE/AIT 444 (580-AE/AIT-1): Phase V Filtered Water Total Chlorine
i. Scale: 0-10 ppm

b. 08A AE/AIT 445 (580-AE/AIT-2): Phase V Filtered Water Total Chlorine
i. Scale: 0-10 ppm

O. Combustible Gas Detector

1. Type:

a. Continuous lower explosive limit (LEL) detector utilizing infrared (IR) technology, unaffected by poisoning or low-oxygen conditions.
b. Remote transmitter and calibration cup.

2. Functional/Performance:

a. Range – 0-100% LEL as Methane.

b. Setpoint – Default 10% LEL, adjustable.

c. Response Time – T90 < 30 seconds.

d. Repeatability/Linearity - ± 2.0% FS or better.

e. Stability - ± 5.0% FS or better per year.

f. Output – 4-20mA proportional to gas concentration, and 3 internal relay outputs: 2 limit alarms and 1 device failure alarm.

g. Power – 120VAC.

3. Physical:

a. Temperature - -40 to 185 degrees F, humidity 0-99% non-condensing.

b. Classification - FM certified Class I, Division 1, Group B, C, D.

c. Enclosure – NEMA 4X.

4. Options/Accessories Required:

a. Remote Sensor - Sensor and transmitter shall be no more than 450 feet apart and shall be connected by shielded cable, of a type recommended by the Manufacturer, supplied by ISS. Sensor shall be mounted in a location as required by NFPA.

b. Remote Calibration Cup - Each sensor shall be supplied with a permanently installed cup that allows ambient air to be detected under normal operation, but includes a connector for the direct feed of calibration gas to the sensor from a remote location. ISS shall supply plastic tubing of appropriate length to allow calibration of each sensor from the location of its associated remote transmitter.

c. Calibration Kit. Furnish one (1) calibration kit, complete with electronic handheld controller and calibrator device.

5. Manufacturer:

a. MSA Ultima XIR.

b. Or approved equal.

6. Units To Be Supplied By ISS:

a. 02A AE/AIT 281 (500-AE/AIT-1): Pretreatment Biofilter Odor Control System Combustible Gas Detector

P. Flame Detector

1. Type: Optical sensor utilizing IR or UV wavelengths to detect fire and provide remote notification of readings.

2. Function/Performance:

   a. Wavelengths: Simultaneous infrared and ultraviolet.

   b. Field of View: Minimum of 90 degrees.

   c. Performance Standard: 50 feet distance for a 1 sq.ft. heptane fire.

   d. Typical Response Time: < 3 seconds @ 50 ft.

   e. Input Power: 24vdc, 150mA maximum.

   f. Outputs: one (1) 4-20mA output; three (3) relay contacts, 8A @ 30vdc resistive. Analog output shall indicate at minimum the following conditions at preset current output levels: device ready, device fault, warning, alarm.

   g. Local indication: LED status and alarm indication.

3. Physical

   a. Enclosure: NEMA 4X, stainless steel.

   b. Hazardous Area Classification: Class I Division 1 & 2, Groups B/C/D.

   c. Wall-mounted. Furnish all required hardware in stainless steel.

   d. Operating Temperature: –40°C to +75°C.

4. Accessories/Options:

   a. Provide one (1) test lamp suitable to the detectors provided.

5. Manufacturer:

   a. Det-Tronics, Model X5200.

   b. General Monitors, Model FL3100H.

c. Or approved equal.

6. Units to be Furnished by ISS:

a. 02A XS 281(500-BT-1): Pretreatment Biofilter Odor Control System Flame Detector

Q. Beacon Light and Alarm Horn

1. Furnish an alarm station, consisting of a beacon light and an alarm horn mounted in a small wall-mounted NEMA 4X enclosure, along with Silence pushbutton and all relays, breakers, and wiring necessary for proper function. Refer to Section 13325.

2. Beacon Light

a. Type: Heavy-duty 360-degree rotating or strobe light beacon.

b. Functional/Performance:
i. Power - 120VAC.

c. Physical:

i. Mounting - Panel/surface or pipe mount. Rating - NEMA 4X.
ii. Color - Red.

3. Alarm Horn

a. Type:
i. Heavy-duty grille-type multi-tone alarm horn.

b. Functional/Performance:
i. Power - 120VAC.
ii. Sound Volume - Minimum 80dB, adjustable.

c. Physical:
i. Mounting - Panel/surface or pipe mount.
ii. Rating - NEMA 4X.

4. Manufacturer:

a. Federal Signal

b. Or equal.

R. Limit Switch

1. Type:

    a. Direct-opening two-position snap action.

2. Function/Performance:

    a. Minimum 2 double pole single throw (DPST) NO contacts or 2 double pole double throw (DPDT) contacts.

3. Physical:

    a. Lever style with spring return.

    b. Contact rating for 120 VAC/30 VDC, 100VA minimum.

4. Accessories/Options Required:

    a. Non-corrosive, NEMA 4X.

    b. If a sealed pre-wired switch is used, a separate connection or junction box of equal environmental protection rated will be supplied and installed.

5. Manufacturer(s):

    a. Allen-Bradley.

    b. Square D.

    c. Or equal.

6. Units to be Furnished by ISS:

    a. 07A ZS 102: Clarifier No.11 Scum Spray Wash Limit Switch

    b. 07A ZS 103: Clarifier No.11 Sludge Blanket Limit Switch

    c. 09A ZS 201: Clarifier No.1 Scum Spray Wash Limit Switch

    d. 09A ZS 203: Clarifier No.1 Sludge Blanket Limit Switch

    e. 09A ZS 213: Clarifier No.2 Sludge Blanket Limit Switch

f. 09A ZS 211: Clarifier No.2 Scum Spray Wash Limit Switch

g. 09A ZS 233: Clarifier No.3 Sludge Blanket Limit Switch

h. 09A ZS 231: Clarifier No.3 Scum Spray Wash Limit Switch

i. 09A ZS 243: Clarifier No.4 Sludge Blanket Limit Switch

j. 09A ZS 241: Clarifier No.4 Scum Spray Wash Limit Switch

PART 3 - EXECUTION

A. Sunshields

1. Electronic transmitter or converter boxes that are exposed to direct sunlight shall be equipped with adequate sunshields. The sunshield shall consist of one or more pieces of stainless steel or other suitable material, of sufficient size to cover the top, sides, and rear of the device (where applicable), and to hang over the front of the device to shade any indicators or displays located there. Sunshield pieces shall be secured by bolts and shall have no less than 1 inch of clearance from the device and from one another, to allow for air circulation over the sunshield surfaces and access to device panel door(s).

END OF SECTION

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SECTION 13320 FIBER OPTIC DATA HIGHWAY NETWORK

PART 1 - GENERAL

A. Scope Of Work

1. Refer to Section 13300.

B. Submittals

1. Submit to the Engineer, in accordance with Section 13300, the following:

2. Complete manufacturer’s product data. Product data shall be provided for the data highway cables, connectors, patch panels, spares and test equipment. Product data sheets shall include the manufacturer's name and catalog number for each item, the manufacturer's descriptive literature, catalog cuts and any power supply requirements.

3. Installation Test reports as specified.

4. The ISS shall provide a fiber optic power budget for each cable run in excess of 500 feet. The budget shall include transmitter power, receiver sensitivity, connector losses, cable losses and a 3db aging margin. Fiber optic transmission line shall maintain a minimum of 3db safety margin.

5. Manufacturer's Instructions.

C. Reference Standards

1. National Fire Protection Association (NFPA)

   a. NFPA-70 - National Electrical Code (NEC) Article 770.

2. Underwriters Laboratories, Inc. (UL)

   a. UL 1581 VW-1 - Vertical Tray Cable Flame Test

   b. UL 1666 - UL Standard for Safety Test for Flame-Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical Shafts.

c. UL 910 - UL Standard for Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air.

3. Institute of Electrical and Electronics Engineers (IEEE)

a. IEEE Standard 383 - Flame Retardancy.

4. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

a. EIA-STD-RS-455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices

5. National Electrical Code Article 770, Optical Fiber Cable and Raceways

a. NFPA 70

6. Fiber Optic Test Method and Instrumentation

a. DOD-STD-1678

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

D. Quality Assurance

1. The fiber optic cabling system materials furnished under this Section shall be provided by Fiber Optic suppliers who have been providing these types of materials for the past three years. The Fiber Optic suppliers shall provide personnel capable of providing technical assistance and fiber testing during installation.

2. The installation of fiber optic cabling system materials furnished under this Section shall be performed by the fiber manufacturers certified installation contractor who has been installing these types of materials for the past three years.

3. All cabled optical fibers shall be 100% attenuated tested. The attenuation of each fiber shall be provided with each cable reel.

4. The cable manufacturer shall be ISO 9001 registered.

5. The Engineer shall determine whether a product is an "Acceptable Equal" based upon the information listed herein and the manufacturer's data sheets regarding the models specified. Alternate equipment must meet the criteria listed herein and any additional information in the manufacturer's data sheets in order to be accepted as an "Acceptable Equal." Supplier must furnish five (5) working installation references for any alternate equipment along with owner, contact, and telephone number.

E. Delivery, Storage and Handling

1. The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

2. When the length of an order requires a large wooden reel the cable will be covered with a three (3) layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.

3. Test tails shall be at least two (2) meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Reels shall be permanently marked with an identification number that can be used by the manufacturer to trace the manufacturing history of the cable and fiber.

4. Wooden reels shall be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

5. The attenuation shall be measured at 850 nm and 1300 nm for multimode fibers. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacture shall ship the test results along with the fiber.

6. Packaging

a. The completed cable shall be packaged for shipment on non-returnable wooden reels. It is the responsibility of the Contractor to determine all required cable lengths.

b. Top and bottom ends of the cable shall be available for testing.

c. Both ends of the cable shall be sealed to prevent the ingress of moisture.

d. Each reel shall have a weather proof reel tag attached identifying the reel and cable.

e. Each cable shall be accompanied by a cable data sheet.

PART 2 - PRODUCTS

A. Manufacturers

1. Corning Cable Systems

2. Or acceptable equal.

B. Fully Water Blocked Fiber Optic Cable (Outdoor/Indoor)

1. General Considerations

a. The cable shall meet all requirements stated in the specification. Refer to the Control System Block Diagram to determine cabling requirements.

b. Furnish cable containing no fewer than twenty-four (24) fibers.

c. Provide stainless steel ST style connectors for all fiber optic connections. The connectors shall be designed for use with 62.5/125 micron cable, and shall be capable of operating in a range of 0 to 80 degrees C. Each connector shall cause a maximum signal attenuation of 1.6 dB. Connectors shall be provided by Siecor. All fiber optic cables shall be tested for performance and loss after termination and installation to verify that at least a 3 dB power safety margin is obtained between all transmitters and receivers. Test data for each fiber and safety margin calculations for each fiber path shall be provided to the Owner and Engineer after installation to verify conformance with this specification.

2. Fiber Characteristics

a. All fibers in the cable must be usable fibers and meet required specifications.

b. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.

c. Multimode: The multimode fiber utilized in the cable specified herein shall meet EIA/TIA-492A-1989, "Detail Specification for 62.5 µm Core Diameter/125 µm Cladding Diameter Class la Multimode, Graded Index Optical Waveguide Fibers."
   i Core diameter: 62.5 $\pm$ 3.0 µ.
   ii Cladding diameter: 125.0 $\pm$ 2.0 µm.
   iii Core-to-Cladding offset: $\leq$ 3.0 µm.
   iv Cladding non-circularity: $\leq$ 2.0 %.
      Defined as: [1 - (min. cladding dia./ max. cladding dia.)] x 100
   v Core non-circularity: $\leq$ 5.0 %.
      Defined as: [1 - (min. core dia. / max. core dia.)] x 100
   vi Coating diameter: 245 $\pm$ 10 µm.
   vii Colored fiber diameter: nominal 250 µm.
   viii Graded index.
   ix Numerical Aperture: 0.275 $\pm$ 0.015 µm.

d. Single-mode: The single-mode fiber utilized in the cable specified herein shall conform to the following specifications:
   i Cladding diameter: 125.0 $\pm$ 1.0 µm.
   ii Core-to-Cladding offset: $\leq$ 0.8 µm.
   iii Cladding non-circularity: $\leq$ 1.0 %.
      Defined as: [1 - (min. cladding dia. / max. cladding dia.)] x 100
   iv Coating diameter: 245 $\pm$ 10 µm.
   v Colored fiber diameter: nominal 250 µm.
   vi Attenuation uniformity: No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.
   vii Attenuation at the Water Peak: The attenuation at 1383 $\pm$ 3 nm shall not exceed 2.1 dB/km.
   viii Cutoff wavelength: The cabled fiber cutoff wavelength (λ_{ccf}) shall be < 1260 nm.
   ix Mode-Field diameter: 9.30 $\pm$ 0.50 µm at 1310 nm; 10.50 $\pm$ 1.00 µm at 1550 nm.
   x Zero dispersion wavelength (λ_0): 1301.5 nm $\leq$ λ_0 $\leq$ 1321.5 nm.

xi Zero dispersion slope (S_0): $\leq$ 0.092 ps/(nm^2•km).
xii Fiber polarization mode dispersion (PMD): $\leq$ 0.5 ps / $km^{1/2}$.

e. The coating shall be a dual layered, UV-cured acrylate applied by the fiber manufacturer.

f. The coating shall be mechanically strippable.

3. Fiber Specification Parameters

a. Required Fiber Grade - Maximum Individual Fiber Attenuation.

b. (Multimode only) The minimum normalized bandwidth of multimode optical fibers shall be $\geq$ 160 MHZ•km at 850 nm and $\geq$ 500 MHZ•km at 1300 nm.

c. (Single-mode only) The maximum dispersion shall be $\leq$ 3.2 ps/(nm•km) from 1285 nm to 1330 nm and shall be < 18 ps/(nm•km) at 1550 nm.

d. The fiber manufacturer shall proof-test 100% of the optical fiber to a minimum load of 100 kpsi.

4. Specifications for Cables

a. Cable shall be flame-retardant, UV stabilized, fully water blocked for use in indoor/outdoor applications. Cable shall be suitable for installation in duct, aerial, and riser environments. Cable shall meet UL OFNR specifications and not require transition splicing upon building entry in order to meet fire codes. The cable shall be the FREEDM series as manufactured by Siecor or acceptable equal.

b. Optical fibers shall be placed inside a buffer tube.

c. Each buffer tube shall contain up to 12 fibers.

d. Each fiber shall be distinguishable by means of color coding according to TIA/EIA-598-A, "Optical Fiber Color Coding."

e. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors according to TIA/EIA-598-A, "Optical Fiber Color Coding."

f. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

g. Buffer tubes shall be kink resistant within the specified minimum bend radius.

h. Fillers may be included in the cable core to lend symmetry to the cable cross-Section where needed.

i. The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

j. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents. Cable shall contain water blocking threads between tubes.

k. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

l. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns.

m. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.

n. All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene (MDPE). The minimum normal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

o. Armored cables shall have armor composed of a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and shall be applied with on an overlapping seam with the corrugations in register. All armor splices shall be recoated with plastic to maintain the armor's corrosion resistance. The outer

jacket shall be applied over the corrugated steel tape armor. The outer jacket shall be a medium density polyethylene with a minimum nominal jacket thickness of 1.25 mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

p. The jacket or sheath shall be free of holes, splits and blisters.

q. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

r. Cable jackets shall be marked with manufacturers' name, sequential meter or foot markings, the year of manufacture, and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within ± 1 % of the length markings. The marking shall be in contrasting color with the cable jacket. The height of the marking shall be approximately 2.5 mm.

s. The maximum pulling tension shall be 2700 N (608 lbf) during installation (short term) and 600 N (135 lbf) long term installed.

t. The shipping, storage, and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be -30°C to +70°C.

u. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the average change in attenuation at extreme operational temperatures (-40°C to +70°C) shall not exceed 0.05 dB/km at 1550 nm for single-mode fiber. The magnitude of the maximum attenuation change of each individual fiber shall not be greater than 0.15 dB/km at 1550 nm. For multimode fiber, the average change in attenuation shall not exceed 0.50 dB/km with 80% of the measured fibers not exceeding 0.25 dB/km.

5. General Cable Performance Specifications

a. When a one meter static head or equivalent continuous pressure is applied at one end of a one meter length

of unaged cable for 24 hours, no water shall leak through the open cable end. When a one meter static head or equivalent continuous pressure is applied at one end of a one meter length of aged cable of one hour, no water shall leak through the open cable end. The aging cycle is defined as exposing the cable to +85 ± 2°C for 168 hours and two cycles of -40°C to +70°C with cable held at these temperatures for 24 hours. The water penetration test is completed at the end of the 24-hour hold. Testing shall be performed in accordance with the industry standard test, FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable."

b. When testing in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at +65°C.

c. The cable shall withstand a minimum compressive load of 440 N/cm (250 lbf/in) for armored cables and 220 N/cm (125 lbf/in) for non-armored cables applied uniformly over the length of the compression plate. The cable shall be tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for ten minutes. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater the 0.1 dB at 1550 nm (SM). The average increase in attenuation for the fibers shall be ≤ 0.20 dB at 1300 nm (MM). The repeatability of the measurement system is typically ± 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.

d. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute around a sheave diameter not greater than 20 times the cable diameter. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (SM). The repeatability of the measurement system is typically ± 0.05 dB or less. The average increase in

attenuation for the fibers shall be ≤ 0.20 dB at 1300 nm (MM). For armored cables, the inside or outside of the armor surface shall be inspected for fractures. Any visible cracks causing separation of the armor shall not have propagated more than 5 mm. The outer cable jacket shall not exhibit evidence of cracking or splitting when observed under 5x magnification.

e. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand 25 impact cycles. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (SM). The repeatability of the measurement system is typically ± 0.05 dB or less. The average increase in attenuation for the fibers shall be ≤ 0.40 dB at 1300 nm (MM). The cable jacket shall not exhibit evidence of cracking or splitting at the completion of the test.

f. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N (608 lbf) applied for one hour (using "Test Condition II" of the procedure). In addition, the cable sample, while subjected to a minimum load of 2660 N (600 lbf), shall be able to withstand a twist of 360 degrees in a length of less than 3 meters (9.9 feet). The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm (SM). The repeatability of the measurement system is typically ± 0.05 dB or less. The average increase in attenuation for the fibers shall be ≤ 0.40 dB at 1300 nm (MM). The cable shall not experience a measurable increase in attenuation when subjected to the rated residual tensile load, 890 N (200 lbf).

g. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 2 meters will withstand 10 cycles of mechanical twisting. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation

change greater than 0.1 dB at 1550 nm (SM). The repeatability of the measurement system is typically ± 0.05 dB or less. The average increase in attenuation for the fibers shall be ≤ 0.40 dB at 1300 nm (MM). For armored cables, the inside or outside of the armor surface shall be inspected for fractures. The cable jacket will exhibit no cracking or splitting when observed under 5x magnification after completion of the test.

h. When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 105 kA. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15 µs (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half-value of the waveform envelope shall be from 40 - 70 µs.

C. Patch Cables, Fiber Connectors

1. Manufacturers

a. Corning Cable Systems

b. Or acceptable equal.

2. Connectors

a. Provide ceramic or composite style connectors for all fiber optic fibers. The connectors shall be designed for use with 62.5/125 micron cable, and shall be capable of operating in a range of minus 40 to 75 degrees F. Each connector shall cause a maximum signal attenuation of 1.6 dB. Connector specifications shall be as follows:

b. Insertion loss (typical): 0.5 dB

c. Durability (mating cycles): 1000 (minimum)

d. Repeatability: Less than 0.2 dB

e. Operating Temperature: minus 40 to plus 75 degrees F

3. Fiber Optic Patch Cables and Connectors

   a. Fiber optic patch cable shall be 2 fiber zipcord 62.5/125 core/clad micron multimode riser rated cable.

   b. Installation of patch cables shall include all spares and observe the minimum fiber bend radius and strain relief.

D. Patch Panels and Splices

1. Patch Panels: Suitable for wall mounting, comprised of internal mounting plate, cable holders, slack cable take up/organizer blocks, patch block with connectors and ground lugs as indicated. Panels shall be NEMA 1 or 12 construction for use in indoor, air-conditioned areas, or NEMA 4X construction for outdoor and process areas, and shall be lockable. Patch panels shall be suitable for multimode system operation at 800 and 1300 nm. The Patch panels shall be sized to handle the number of fibers indicated on the drawings. All fibers shall be terminated in the patch panel. Manufacturer shall be Corning Cable Systems or acceptable equal.

2. Pigtail Splicing

   a. For termination of fiber cables at a termination or connector panel (patch panel), with one end of a piece of cable preconnectorized and the other end unterminated for splicing to the cable that needs to be terminated. Splicing and connectors shall meet the requirements listed in this Section.

   b. A splice/termination tray shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure. Splice tray shall be compatible with the selected patch panel and installed for easy access to the spliced cable sections.

   c. Pigtail assemblies shall match fiber cable type and model.

   d. Manufacturer shall be Corning Cable Systems or acceptable equal.

3. Baying Enclosure

a. Where indicated on the Drawings, provide dual baying enclosures for fiber optic patch panels at distribution points.

b. Each enclosure shall be a Special TS8 Baying Enclosure by Rittal, with two component enclosures mounted back-to-back. Combined size shall be 2.2 m height, 1.6 m width, 0.6 m depth. Colors shall be RAL 7035 structure standard.

c. The component enclosures shall be TS8 enclosures, part number 8806540, rated NEMA 4, solid front door (each unit 130° hinged on the appropriate side), no rear wall or door, roof internally and externally fastened, solid base with plinth of height 200mm.

d. Accessories for each baying enclosure shall include the following, plus any additional parts necessary to make a complete unit:
   i P/N 8612180, Qty. 4, TS SYSTEM CHASSIS F/800MM HOR
   ii P/N 8612100, Qty. 4, TS SYSTEM CHASSIS F/1000MM HOR
   iii P/N 8106500, Qty. 4, SIDEWALL TS ASSY TY2006
   iv P/N 8800885, Qty. 4, TS BAYING COVER, TOP
   v P/N 8602060, Qty. 4, 0200H0600D TS PLINTH SIDE TRIM RAL7022T
   vi P/N 8602800, Qty. 4, 0200H0800W TS PLINTH ELEMENTS RAL7022T
   vii P/N 8611290, Qty. 2, TS COMFORT HANDLE RAL7035
   viii P/N 8611190, Qty. 2, TS LOCK INSERT-PUSHBUTTON
   ix P/N 8108504, Qty. 2, 2000H0800D TS SUITING KIT
   x P/N 2340700, Qty. 2, EMC SWING FRAME 40HU
   xi P/N 1994835, Qty. 2, HDWR KIT F/600MM WIDE SWING
   xii P/N 8800500, Qty. 6, TS BAYING QUICK WEDGE
   xiii P/N 8800430, Qty. 4, TS BAYING BRACKET F/TS-TS

E. Spare Parts and Test Equipment

1. Spare Parts

a. Provide twenty (20) spare ST style connectors.

b. Provide ten (10) spare patch cables with ST connectors (both ends) terminated.

2. Test Equipment

a. One (1) complete fiber optic connector termination tool kits. The kit shall be UNICAM by Corning Cable Systems or acceptable equal.

b. Optical Test Meter. Single and multi-mode capability with ST and SC style connectors. Provide data storage, Windows based software and necessary cabling for report printouts. Meter shall be OTS series as manufactured by Corning Cable Systems or acceptable equal.

c. Optical Power Source. 850/1300 nm single and multi-mode with Visual Fault Locator (VFL). Unit shall be compatible with the Optical Test Meter and be OS series as manufactured by Corning Cable Systems or acceptable equal.

PART 3 - EXECUTION

A. General

1. Provide all material, equipment and labor to install and test the fiber optic cables as indicated and as specified.

2. Installation shall be in accordance with the National Electrical Code.

3. Installation shall comply with EIA/TIA Standards 568 and 569.

4. Fiber optic cables shall be continuous from component to component as shown on the Drawings. Intermediate fiber splices shall not be allowed.

5. Provide delivery, storage, and handling of materials and equipment in accordance with Section 01600.

B. Installation

1. All cable shall be installed in conduit.

2. Direct buried cable shall be installed in conduit within one (1) foot of turning up or entering a structure.

3. An outdoor patch panel shall be provided for transitioning from direct buried cable to cable in conduit at each building entrance.

4. Inspect raceway prior to pulling cables. Notify the Engineer of any conditions which would prevent installation of the specified cables, before proceeding with the installation. Rod and swab out ducts prior to installing cables.

5. Install non-breakout cables in conduit systems inside buildings and structures.

6. Pull cables prior to attachment of connectors.

7. Pull cables by directly pulling only on the strength member.

8. Lubricate cables with lubricants specially formulated for fiber cabling jackets during installation. Do not exceed cable manufacturers specifications for tensile strength and bending radius. Pulleys used to aid in the installation of the fiber optic cable must be sized according to the minimum bending radius. The pulling tension of all fiber cables during installation shall be recorded using a strip recorder. The printout of the strip recorder shall be submitted to the Engineer.

9. Ground outer sheath and steel armor before entering building. Remove outer sheath and steel armor from indoor installation.

10. Do not make splices in cable unless approved by the ENGINEER. Splices shall be made in designated enclosures above ground only. Provide adequate put-up lengths on cable reels to make termination-to- termination runs without splices. Where splices are unavoidable, subject to the approval of the ENGINEER, provide fusion splices with attenuation losses of 0.3 dB or less. Make splices watertight and provide mechanical protection equal to the cable jacket, or better.
11. Provide breakout kits, signal transceivers, power supplies, patch panels, pigtails and jumpers as required and as indicated to install a complete data highway communications network. Patch panels and splice enclosures shall be wall mounted.

12. Support cables in riser conduits at intervals as required by National Electric Code.

13. Installation tools and materials shall be approved by the cable manufacturer.

14. If the Siecor Unicam connector system is not used, the polishing process of terminal connectors shall be a two stage wet process using 3.0 micron lapping film for an initial polish followed by 0.3 micron lapping film for the final polish.

15. Within manholes, protect cable by providing flexible, corrugated, polyethylene slit duct. Connect slit duct to duct bank by using hose clamps. Support duct at ten (10) foot intervals.

C. Identification

1. Label each termination point.

2. Tag each cable in junction boxes, manholes and hand holes. Provide permanent nylon/plastic tie-wrap type tags with waterproof markings.

3. Label each cable, buffer tube and fiber with permanent waterproof typewritten tags.

D. Physical Checkout

1. General Procedures:

a. Conduct physical checkout of the fiber optic data highway network.

b. Physical checkout shall be performed prior to functional testing.

2. Check Procedures:

a. Verify that fiber optic cable reels have been off-loaded from truck carefully and not damaged.

b. Submit to the Engineer all test data provided by the fiber manufacture.

c. Verify that the optical fibers of the cable assembly are the type and quantity as specified and as recommended by the Instrumentation System Supplier.

d. Verify that cable construction is the type specified.

e. Verify that fiber optic patch panels have been installed plumb and level at locations indicated.

f. Verify that optical fiber connections or terminations within patch panels and splice closures are in accordance with cable manufacturer's recommendations.

E. Field and Functional Testing

1. Make the following site tests *before* removing cable from cable reels:

a. Determine attenuation losses of each fiber from end to end. Use an optical time domain reflectometer (OTDR) to capture and record. Provide a printout of the captured data.

b. Submit to the Engineer all test data and models of test equipment, calibration standards and tests.

2. Make the following field tests *after* cable and connector installation:

a. All fiber optic cables shall be tested for performance and loss after cable installation and connector termination to certify that at least a 3dB power safety margin is obtained between all transmitters and receivers. Test data for each fiber and safety margin calculations for each fiber path shall be provided to the Owner and Engineer after installation to verify conformance with this specification. The following tests shall be performed as a minimum:
   i Visually, inspect terminal connectors for out-of-round condition and surface defects such as micro-chips and cracks using a 200X (minimum) inspection microscope.
   ii Check optical continuity of each fiber from terminal to terminal. Use test equipment as specified herein and provide typewritten report certifying each fiber in every cable.
   iii Verify the calculated attenuation power losses of each fiber from both the transmit and receive terminals of each data communications loop (both directions). The light source and operating wavelength of the test equipment shall be representative of the actual operating equipment. Use an OTDR.

b. Submit to the Engineer all test data and models of test equipment, calibration standard and tests.

3. Owner or Engineer may observe testing. Inform Owner/ Engineer of testing schedule at least one week prior to start of testing.

F. Training

1. Provide half day training for up to three (3) students on termination techniques and testing prior to installation.

2. Provide training as soon as possible following submittal of proposed fiber optic cable.

G. Warranty

1. The Contractor shall submit a warranty certificate from the equipment manufacturer. The manufacturer's warranty period shall be concurrent with the Contractor's for twenty (20) years, commencing at the time of final acceptance by the Owner.

END OF SECTION

SECTION 13325 CONTROL PANELS AND PANEL MOUNTED EQUIPMENT

PART 1 - GENERAL

A. Scope of Work

1. The General Provisions of Section 13300 apply to this Section.

2. Furnish all labor, materials, equipment and incidentals required, to install, complete and ready for operation, the panels depicted on the Drawings and on the Instrumentation Details provided.

B. Submittals

1. Refer to Section 13300.

C. Delivery, Storage and Handling

1. The panels shall be mounted on wood skids four inches high. Adequate crating will be provided for the panel being shipped where a transfer from one truck to another is planned.

2. Instruments shall be blocked and tied to prevent damage during shipment. Front-panel mounting instruments shall be removed and prepacked in their original containers for shipment.

3. Accessories, drawings, instruction bulletins, etc., shall be packed and shipped with the panel.

4. Refer to Section 13300.

D. Spare Parts

1. In accordance with Section 13300, provide the following spares and consumables:

   a. Fuses: 20 percent of each size and type used, but no less than ten of each size and type.

   b. DC Power Supplies: 20 percent of each size and type used, but no less than two of each size and type.

   c. Relays: One (1) spare unit for every ten (10) of each type installed, minimum one.

d. Panel-Mounted Lights and Switches: One (1) spare mechanism for every ten (10) of each type installed, minimum one; plus 10 units or 20 percent of bulbs and colored lenses installed, whichever is more.

e. Corrosion Inhibiting Vapor Capsules: Provide 10 of each type and size used.

E. Warranty

a. Refer to Section 13300.

PART 2 - PRODUCTS

A. General

1. Refer to Section 13300.

B. Lightning/Surge Protection

1. Refer to Section 13300.

C. Control Panel - General Requirements

1. Furnish and install the panels per Specifications and Drawings.

2. The construction and wiring shall be in accordance with this Specification and applicable panel drawings. The panel drawings will specify the arrangement of instruments to be mounted on the front, rear, and sides of the panels.

3. Unless otherwise specified on applicable panel drawings, all panels shall be of the fully enclosed type designed for use with high-density instrumentation mounting.

4. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for each local panel provided under this Contract shall be keyed alike.

5. The instruments designated for rear-of-panel mounting shall be arranged within the panel according to respective panel drawings and in a manner to allow for ease of maintenance and adjustment.

6. Conductors running from the field to the panels shall be continuous without splices, except at junction boxes. The junction boxes shall have terminal blocks with 20 percent spare terminals. Special care shall be exercised to carry

grounding lines through such junction boxes with the least possible resistance. Cables entering panels shall be multiconductor. Conduit and multiconductor cables entering panels shall be sealed to prevent the intrusion of gas and moisture.

7. Multiconductor cable shall be used between junction boxes and the panels.

8. All components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates, and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Mounting orientation shall be in accordance with the requirements of each component. Components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the Drawings, Specifications, and ISS's data.

9. The internal framework of each panel shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging and lifting of the control panels during installation. Plugs shall be provided and shall unobtrusively fill the panel lifting ring holes when substituted for the lifting rings after installation is complete.

10. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.

11. All panels shall be supplied with suitable nameplates which identify the panel and individual devices as required. Nameplates shall be provided for all flush mounted equipment in the interior and exterior of each panel. Nameplates shall be approximately 1-in x 3-in constructed of white and black laminated, phenolic material having engraved Micarta letters approximately 1/8-in high, extending through the white face into the black layer. Nameplates shall be beveled and attached to panels with epoxy glue.

D. Control Panel - Materials and Construction

1. General

a. All panels located in indoor climate-controlled areas shall be of NEMA 12 construction and shall be labeled by Underwriters Laboratories. Freestanding panels shall be constructed of 12 gauge or thicker sheet steel, suitably braced internally for structural rigidity and strength. Wall or Unistrut mounted panels shall be 14 gauge or better steel. All exposed welds, seams, or edges shall be ground smooth. Front panels or panels containing instruments shall be 10 gauge or thicker sheet steel, reinforced to prevent warping or distortion. All doors shall be lockable, mounted with strong, continuous, piano type hinges and be provided with door handles and three point latches.

b. All panels located in outdoor areas, or in indoor areas that are not air conditioned, and where otherwise specified in the Contract Documents, shall be of NEMA 4X construction and shall be labeled by Underwriters Laboratories. NEMA 4X panels, whether wall or Unistrut mounted panels or freestanding panels, shall be of all 316 Stainless Steel construction. Minimum thickness shall be 12 gauge for freestanding panels, 14 gauge for wall or Unistrut mounted panels. All doors shall be lockable, mounted with strong, continuous, piano type hinges and be provided with door handles and three-point latches. Panels with door clamps instead of three-point latching will not be accepted. Interior panels of 10 gauge steel construction shall be provided where necessary for instrument mounting.

c. Provide explosion-proof enclosures where required in hazardous areas.

d. Panels shall be provided with full length, fully gasketed rear doors or front access doors as shown on the panel details. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments. All doors shall open a minimum of 90 degrees.

e. Refer to panel details and other Drawings for approximate panel size and equipment layout.

f. The panel shall be suitable for top or bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry the panel top shall be provided with nominal one foot square removable access plates which may be drilled to accommodate conduit and cable

penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, or other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.

g. Support Structures. Do not use expansive screw anchors, shields, or other fastening items containing lead or other material that might loosen or melt under fire conditions. Do not use power-actuated fasteners and devices.

2. Finish Requirements

a. All sections shall be descaled, degreased, filled, ground and finished. The enclosure, when fabricated of carbon steel, shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels will not require a paint finish.

b. Panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.

c. Immediately after cleaning, one coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and top coat of a two-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.

d. All FRP panels located in direct sunlight shall be provided with a protective coating to prevent discoloration and cracking.

e. Apply a minimum of two coats of flat white lacquer on the panel interior after priming.

f. Panel exterior color shall be ANSI 61 Gray.

3. Manufacturer. All panels shall be by Hoffman or acceptable equal.

E. Control Panel - Temperature Control

1. The internal temperature of all panels shall be regulated so as not to exceed 100 degrees Fahrenheit. Should sufficient heat be generated within a panel where dissipation cannot be adequately accomplished with natural convection, an air conditioner shall be provided. Under no circumstances shall the panel cooling equipment compromise the NEMA rating of the panel.

2. NEMA 4X rated panels that are exposed to sunlight shall be equipped with adequate sunshields. The sunshield shall consist of one or more pieces of stainless steel or other suitable material of sufficient size to cover the top, sides, and rear of the panel (where applicable), and to hang over the front of the panel to shade any instruments mounted there. Sunshield pieces shall be secured to the panel by bolts and shall have no less than 1 inch of clearance from the panel and from one another, to allow for air circulation over the sunshield surfaces and access to panel door(s).

F. Control Panel - Corrosion Control

a. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Instruments Model Zerust VC; Hoffman Engineering Model A-HCI; or equal. Corrosion inhibitors shall not be installed and activated until the panel is delivered to the site.

G. Control Panel - Internal Construction

1. Internal Electrical Wiring

a. Panel equipment shall be mounted and wired on or within the cabinet. Wiring shall comply with the National Electrical Code. Wiring within the panel shall be grouped together with harnesses or ducts and secured to the structure. Wiring shall be numbered in compliance with the numbering system used on the wiring/connection diagrams. Wiring and connection diagrams shall comply with ISA-5.4 and shall be submitted by the manufacturer as part of the Shop Drawings for review by the Engineer.

b. Power and low voltage DC signal wiring shall be routed in separate wire ways. Crossing of the two system wires shall be at right angles.

c. Power wire shall be 12 AWG Type THHN/THWN stranded and shall be insulated for not less than 600 volts unless specified otherwise. Conductors shall be of tinned copper construction. All interconnecting wiring, except for electronic circuits, shall be rated for not less than 90°C.

d. Control and signal wire shall be 1 pair 16 AWG stranded. Analog signal wire shall be shielded. Conductors shall be of tinned copper construction.

e. Electronic Communications cable (such as RS-232) shall be low-capacitance, double-shield cables consisting of twisted pairs with 22 AWG stranded conductors and PVC jacketing.

f. Wire colors shall be:

Line Power	Black
Neutral	White
AC Control	Red
DC Control	Blue
DC common	Gray
Equipment/Chassis Ground	Green
Externally-Powered Interlocks	Yellow

g. Wiring shall terminate at a master terminal board, rigid type and numbered.

h. Terminal blocks shall be arranged in vertical rows and separated into groups (Power, AC control, DC signal, and alarm). Terminal strips shall be provided for the purpose of connecting all control and signal wiring. Terminal blocks shall be Phoenix style, IEC rated, Allen-Bradley or similar, with the appropriate voltage rating (600 volts minimum).

i. Each 4-20 mA analog signal loop shall be individually fused. Each group of discrete loops for a common piece of equipment shall be fused.

j. Wiring trough for supporting internal wiring shall be plastic type with snap on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by using stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.

k. Wire connectors shall be the hook fork type with insulated barrel for crimp type compression connection to the wire.

l. Each wire shall be provided with a numbered heat shrink tubing identification marker, with the same number at both ends. Numbering shall be in accordance with the Control Panel Drawings and shall include the instrument Loop Number. Identification markers shall be pretyped. Handwritten markers or paper markers will not be permitted.

m. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6-in of the side panel or adjacent terminal.

n. Wiring troughs shall not be filled to more than 60 percent visible fill. Wiring trough covers shall be match marked to identify placement. If component identification is shown on covers for visibility, the ID shall also appear on the mounting sub-panel.

o. Each panel shall have a single tube, fluorescent light fixture, 20 Watt in size, mounted internally to the ceiling of the panel. Light fixture shall be switched and shall be complete with the lamp.

p. Each panel shall have a magnetic reed switch pair mounted to the frame of each door that will indicate a common panel intrusion condition in the PLC within that panel, when any door is opened. Magnetic reed switches shall be heavy-duty, GE Magnetic Contacts model 2505A or acceptable equal.

q. Each panel shall have a specification grade duplex convenience receptacle mounted internally within a stamped steel device box with appropriate cover.

r. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.

s. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.

t. Each panel, where applicable, shall be provided with analog signal isolation (I/I) where analog signals are sent from one panel or console to another.

u. Each panel shall be provided with surge suppression protection (electrical transients) for connections between AC power systems and electrical and electronic equipment. Surge suppressor grounding shall be accordance with the manufacturer's recommendations. Refer to Section 13300.

v. Each panel shall be provided with a fused power disconnect switch.

w. All wiring to hand switches and the like which are live circuits independent of the panel's normal circuit breaker protection shall be clearly identified as such.

x. Panels shall have an initial installed capacity of I/O (terminal blocks, fuses, surge suppressors, interposing relays as required) plus a minimum of twenty-five percent (25%) active spare I/O points of each type, and twenty-five percent (25%) room for future I/O points. All new, existing, and future I/O points shown on the Drawings or discovered in field investigation shall be included in the total count for the purpose of determining spares.

2. Pneumatic Tubing

a. Refer to Section 13300.

3. Print Storage Pockets

a. Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required to service the equipment.

H. Direct Current (DC) Power Supply

1. Provide a 24 VDC power supply in the control panel to power instrument loops, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.

2. Control panels that are principally designed to house Profibus DP fiber optic modules shall include battery backup capability.

3. Components shall meet the following requirements:

a. Input power: 115 VAC, plus or minus 10 percent, 60 Hz.

b. Output voltage: 24 VDC.

c. Output voltage adjustment: 5 percent.

d. Line regulation: 0.05 percent for 10 volt line change.

e. Load regulation: 0.15 percent no load to full load.

f. Ripple: 3 mV RMS.

g. Operating temperature: 32 to 140 degrees Fahrenheit.

h. Batteries: sealed high-temperature type with charger.

4. Size the 24 VDC power supply to accommodate the design load plus a minimum 25 percent spare capacity. Battery shall be sized to support full load operation for 30 minutes upon loss of power.

5. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.

6. Mount the 24 VDC power supply such that dissipated heat does not adversely affect other panel components.

7. Power supply shall be manufactured by Adtec, Sola, Power One, or acceptable equal.

I. Panel Components

1. Pilot Type Indicating Lights

a. Type: Heavy duty oil-tight type which utilizes a low voltage lamp.

b. Functional/Performance:
   i Units shall be provided with low voltage lamps suitable for the voltage supplied. Lights supplied with 120VAC power shall have integral reduced voltage transformers.
   ii Lamps shall be replaceable from the front of the unit.
   iii Units shall be push-to-test.

c. Physical:
   i Lens color shall be as indicated on the instrument device schedule. Lens shall be approximately 1-1/4-in diameter.

ii Provide legend faceplates engraved to indicate the required function of each device.
iii Units shall be rated NEMA 13 for indoor panels. Units located outdoors or indicated to be weatherproof shall be rated NEMA 4X.

d. Manufacturers:
i Microswitch
ii Allen Bradley
iii General Electric
iv Square D

2. Rotary Hand Switches and Push Buttons

a. Type: Control devices shall be heavy duty, oil-tight type with stackable contact blocks.

b. Functional/Performance: Provide contact arrangement and switching action as required for the control system specified.

c. Physical:
i For 120VAC service provide contacts rated 10 amps at 120VAC, for 24VDC service provide silver sliding contacts rated 5 amps at 125VDC, for electronic (millivolt/ milliamp) switching provide contacts rated 1 amp at 28VDC.
ii Push buttons shall have flush type operators. Selector switches shall have knob or wing lever operators.
iii Units shall be rated NEMA Type 13 for indoor service. Units located outdoors or indicated to be weatherproof shall be rated NEMA 4X.
iv Provide legend plates denoting switch/push button position/function.

d. Options/Accessories Required:
i Provide lock-out-push buttons, key-operators, etc., as indicated on the instrument device schedule.
ii Provide make-before-break bridging contacts where required.

e. Manufacturers:
i Microswitch
ii Allen Bradley
iii General Electric
iv Square D

3. Industrial Relays and Time Delays

a. Type: Industrial heavy duty relays.

b. Functional/Performance:
   i Contact arrangement/function shall be as required to meet the specified control function specified.
   ii Contacts shall be rated 10 amps continuous at 600 volts.
   iii Relays shall be provided with convertible contact blocks.
   iv Pneumatic time delay relays shall be used on time delays less than 180 seconds and shall be adjustable.
   v Solid state time delay relays shall be used on time delays between 180 seconds and one hour.

c. Options/Accessories Required:
   i Provide all mounting rails, etc. that are required.

d. Manufacturers:
   i Microswitch
   ii Allen Bradley
   iii General Electric
   iv Square D

4. General Purpose Relays and Time Delays

a. Type: Units shall be of the general purpose plug-in type.

b. Functional/Performance:
   i Coil voltage shall match supply voltage.
   ii Contact arrangement/function shall be as required to meet the specified control function.
   iii Mechanical life expectancy shall be in excess of 10,000,000 operations.
   iv Duty cycle shall be rated for continuous operation.
   v Units shall be provided with integral indicating light to indicate if relay is energized.
   vi Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
   vii Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.

c. Physical:
   i For 120VAC service provide contacts rated 10 amps at 120VAC, for 24VDC service provide contacts rated 5 amps at 28VDC, for electronic (milliamp/

millivolt) switching applicator provide gold plated contacts rated for electronic service.
ii Relays shall be provided with dust and moisture resistant covers.

d. Options/Accessories Required:
i Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
ii Provide mounting rails/holders as required.

e. Manufacturers:
i Eagle Signal Controls
ii Allen Bradley
iii Potter & Brumfield

5. Electronic Indicator

a. Type: Electronic; 3-in by 6-in NEMA 4X case.

b. Operation: To accept a standard analog input signal, and display the manually set flow on a vertical indicating scale.

c. Functional:
i Input - 4-20 mADC.
ii Accuracy plus or minus 0.5 percent of span for input/output.

d. Physical:
i Case Size - Nominal 3-in by 6-in face.
ii NEMA 4X enclosure, with slide tray.
iii Mounting - Flush panel, suitable for high density mounting arrangements.
iv Scales – Digital, 0 to 100 percent output.

e. Manufacturers:
i ABB Instrumentation
ii Moore Industries

6. Signal Relay Switches (Current Trips)

a. Type: Solid state electronic, dual setpoint.

b. Functional/Performance:
i Input - 4-20 mA
ii Output - Isolated contact output, double pole double throw, rated 5 Amps at 120 VAC.
iii Accuracy - 0.1 percent.
iv Protection - Provide RFI protection.

v Deadband - Adjustable between 0.1 and 5.0 percent of span.
vi Setpoint Adjustment - Provide graduated dial for each alarm set point from 0 to full scale. Alarms shall be adjustable to trip on rising or falling input signal.
vii Repeatability - Trip point repeatability shall be at least 0.1 percent of span.

c. Physical:
i Mounting - Suitable for mounting in an enclosure or high density instrument rack.

d. Options/Accessories Required:
i Mounting rack or general-purpose enclosure as required.

e. Manufacturers:
i Acromag
ii Moore Industries
iii Rochester Instrument Systems

PART 3 - EXECUTION

A. Installation

1. The panels shall be installed at locations as shown on the Drawings.

2. Panels shall be factory tested prior to shipment. Field installation shall consist only of setting the panel in place and making necessary electrical and conduit connections.

3. Refer to Section 13300.

B. Tests (General)

1. Refer to Section 13300.

END OF SECTION

SECTION 13448 AUTOMATIC LIQUID COMPOSITE SAMPLERS

PART 1 - GENERAL

A. Description

This section includes materials and installation of refrigerated automatic liquid composite samplers.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit manufacturer's catalog data and descriptive literature. Submit dimensional drawings. Show interface wiring for receiving the 4- to 20-mA flow proportional signal.

C. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. One labor day to check the installation and advise during start-up, testing, and adjustments of the equipment.

2. One labor day to instruct the Owner's personnel in the operation and maintenance of the equipment.

PART 2 - MATERIALS

A. Manufacturers

Samplers shall be ISCO Model 5800, SIGMA Model SD900A WRS or equal.

B. Automatic Samplers

1. Sampler shall be of the enclosed, refrigerated type containing a pump, controller, polyethylene container, and associated tubing and wiring. A corrosion-resistant fiberglass body and temperature control system shall allow the refrigerated sampler to be used outdoors without an enclosure in ambient temperatures from -20°F to 120°F. Provide calibrated control to select a storage

temperature of 32°F to 46°F. Provide forced air condensing coil and front ventilation.

2. The refrigerated sampler shall be equally suited for sequential and composite sampling applications. In sequential applications, the sampler shall be capable of collecting discrete samples in 24-, 8-, or 2-sample bottles. The 8- or 24-bottle versions shall hold the bottles in a nylon-coated slide-in rack. For composite applications, the sampler shall be capable of being converted to use a single 2-1/2-gallon glass or polyethylene container. Glass sample bottles shall have Teflon-lined screw caps. Plastic sample bottles shall have polyethylene-lined screw caps.

3. The refrigerator shall include electronic sensing devices for measuring ambient air temperature, evaporator plate temperature, and interior air temperature. Built-in temperature control circuitry shall utilize these sensors to control the operation of the compressor and built-in heaters. The built-in heaters shall prevent the sample from freezing if the ambient air temperature drops below freezing. The unit shall be self-defrosting and shall use a forced-air condensing coil with filtered frontal ventilation. Provide a compressor with a minimum rating of 1/6 hp. The refrigerator shall have a five-minute (maximum) recovery time to return to 39°F after the door has been opened for one minute with the unit operating at 39°F (4°C).

4. Construct the exterior and base of the refrigerator of FRP with a UV-resistant gel coat. The interior of the refrigerator shall be food grade ABS plastic. Provide copper refrigeration lines protected with polyester tubing and phenolic resin. Coat the condenser coil with UV-resistant polyurethane. The refrigerator evaporator plate shall be aluminum and coated with a food grade epoxy. The refrigerator shall include 1 1/2 inches of rigid foamed-in-place insulation on the sides. The top insulation shall consist of 3 inches of rigid insulation. Insulation shall not sustain bacterial growth or retain odors. The refrigerator shall have a hinged reinforced fiberglass controller cover, which is capable of being locked.

5. Locate the temperature control knob under the controller cover. The refrigerator's door shall also have hasps capable of accepting a padlock. Provide a magnetic

gasket to seal the refrigerator door. The refrigerator power supply and solid-state thermostat shall be contained in a sealed, NEMA 4, aluminum or stainless steel enclosure inside the refrigerator base. All other exposed metal components shall be anodized aluminum, stainless steel, or galvanized steel.

6. For multiple bottle sampling, the sample distribution system shall use a mechanism to lock the distributor arm above each bottle position. The distributor arm shall be made of polypropylene. The distribution drive assembly shall be included in a sealed NEMA 4X controller to prevent exposure of the electromechanical components.

7. Samples shall be collected using a peristaltic pump. The body of the peristaltic pump shall be made of plastic. The pump shall be capable of producing 26 feet of lift. A resettable indicator shall count and indicate the pump revolutions. Before and after each sample is collected, the pump shall air purge the suction line. Prepurges and postpurges shall be automatically controlled, and no precalibration adjustments shall be required. The sample stream shall not pass through any valves or metering chambers or through any distribution tubing unless under pumped flow.

8. The sampler shall utilize a nonwetted, nonconductive detector to sense the presence of the liquid at the inlet to the pump. The sensor shall not be dependent on or affected by any compositional, chemical, or physical property of the liquid, including high or low conductivity of the sample. The liquid detector shall require no routine maintenance or cleaning to allow the detector or sampler to operate. The liquid detector shall eliminate entering the head height in programming and shall minimize the effects of changing head, intermittent flow in the suction line, or variable battery conditions on sample volume. Once the liquid has been detected at the pump inlet, the sampler shall deliver repeatable and accurate sample volumes regardless of battery condition by counting the revolutions of the peristaltic pump. The sampler shall deliver repeatable sample volumes typically within ±10 mL to prevent any single sample from biasing the collected sample.

C. Programmable Sampling System

1. The sampling program shall be established using a sealed keypad and a liquid crystal display. The display shall continuously communicate the sampler's status. The sampler shall have software capable of storing up to three sampling routines identified by number. The sampler shall contain an internal battery, which provides the sampler with continuous memory. The battery shall have a minimum life of five years and shall maintain the sampler's program settings and any stored programs when the sampler is turned off or in the event of a power interruption.

2. The system shall allow the user to program the sampler to collect either sequential or composite samples at user-definable time intervals (time pacing) or at equal flow volume intervals based on flow pulse inputs from an external flowmeter (flow pacing). The flow intervals shall be selectable from 1 to 9,999 flow pulses. The sampler shall use an internal real-time clock to provide both time and date information. It shall also offer two types of time pacing: uniform and nonuniform. Uniform time paced samples shall be collected at regular time intervals from 1 minute to 99 hours and 59 minutes. Nonuniform time intervals from 1 to 999 minutes between samples or, based on real-time settings, shall be capable of being programmed. Nonuniform time shall be common to both sequential and composite sampling routines. A delay to first sample shall be programmable in minutes from 0 to 9,999 or by the real-time clock. The sampler shall have the ability to be programmed for up to 24 real-time sampling stop/resume times to allow unattended sampling of shift related discharges. A software program lock shall be provided to prevent unauthorized tampering or accidental changing of the sampler control settings.

3. The sampler program shall allow the user to select from three types of multiplexing: samples per bottle, bottles per sample, and multiple bottle compositing (a combination of samples per bottle and bottles per sample). Multiple bottle compositing shall allow the user to place many samples in a single bottle while simultaneously creating a duplicate bottle or set of bottles. The sampler shall switch bottles after a period of time has elapsed or a predetermined number of samples have been collected. The controller shall be programmable for up to three sample collection retries

if liquid is not detected due to suction line plugging or absence of liquid. Up to three suction line rinse cycles shall be programmable to precondition the suction line before each sample to prevent contamination from the previous sample.

D. Flow Signal

Samplers shall collect samples proportional to flow. Flow signal shall be a 4- to 20-mA d-c current signal from an external source. Provide interface device, if necessary, for each sampler to convert this signal to the signal used by the sampler. Interface enclosure shall be NEMA 4. Power source for the interface device shall be the associated sampler.

E. Alarms

Samplers shall provide alarm contact outputs for Bottle Full condition and for General Fault condition. Furnish and install the alarm module for each sampler.

F. Power Supply

Sixty hertz, 120-volt ac.

G. Sample Containers

Provide the sampler with two (2) 2.5-gallon glass bottles.

H. Suction Lines and Strainers

1. The materials in contact with the flow steam shall be medical grade silicone rubber, vinyl or Teflon, and stainless steel. The suction line shall be made of 3/8-inch inside diameter Teflon. Provide an all stainless steel low flow strainer.

2. Provide 3/8-inch tube inside diameter by 1/2-inch NPT (male), Type 316 stainless steel hose connector to male pipe adapter: Swagelok SS-6-HC-1-8 or equal. Provide one adapter for each sampler.

PART 3 - EXECUTION

A. Service Conditions

1. Composite sampler service conditions shall be as shown below.

2. Tag numbers: 500-CS-1 and 500-CS-2

Location	Preliminary Treatment Structure (Process 500)
Environment:	Indoors environmental temperature range up to 90°F
Elevation:	120 feet above mean sea level
Relative humidity	Up to 100%
Liquid Sampled	Raw Sewage

3. Tag number: 390-CS-1

Location	Phase III Effluent Pump Station
Environment:	Outdoors environmental temperature range up to 100°F
Elevation:	90 feet above mean sea level
Relative humidity	Up to 100%
Liquid Sampled	Reuse Water

B. Installation

Install in accordance with the manufacturer's instructions.

C. Field Testing

Operate each sampler for 30 consecutive days, during which time no repairs or adjustments shall be required. Assure that each sampler responds to its 4- to 20-mA flow proportional signal.

D. Warranty:

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and

materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

END OF SECTION

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DIVISION 15 – MECHANICAL

DIVISION 15 – MECHANICAL (Continued)

SECTION 15050 PIPING SCHEDULE AND GENERAL PIPING REQUIREMENTS

PART 1 - GENERAL

A. Description

This section describes the application of the Piping Schedule shown in the drawings and the general requirements for selecting piping materials; selecting the associated bolts, nuts, and gaskets for flanges for the various piping services in the project; and miscellaneous piping items.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit affidavit of compliance with referenced standards (e.g., AWWA, ANSI, ASTM, etc.).

3. Submit certified copies of mill test reports for bolts and nuts, including coatings if specified. Provide recertification by an independent domestic testing laboratory for materials originating outside of the United States.

4. Submit manufacturer's data sheet for gaskets supplied showing dimensions and bolting recommendations.

C. Definitions of Buried and Exposed Piping

1. Buried piping is piping buried in the soil, commencing at the wall or beneath the slab of a structure. Where a coating is specified, provide the coating up to the structure wall. Piping encased in concrete is considered to be buried. Do not coat encased pipe.

2. Exposed piping is piping in any of the following conditions or locations:

   a. Above ground.

   b. Inside buildings, vaults, or other structures.

   c. In underground concrete trenches or galleries.

D. Piping Service

Piping service is determined by the fluid conveyed, regardless of the pipe designation. For example, pipes designated "Air Low Pressure," "Air High Pressure," and "Air" is all considered to be in air service.

E. Default Piping Materials

If no material is shown in the drawings or in the Piping Schedule, use the following piping materials:

Service	Size Range (inches)	Material	Specification Section
Buried	3 and smaller	PVC	15290
	4 and larger	DIP	15240
Exposed	3 and smaller	PVC	15290
	4 and larger Air Service	SST	15276
	4 and larger	DIP	15240

PART 2 - MATERIALS

A. Materials Selection and Alternative Materials

1. The Piping Schedule in the drawings lists the material and specification for each piping service in the project. In locations where the piping material referenced on the Piping Schedule is not appropriate, the piping material is indicated in the drawings. Materials called out in the drawings shall govern over materials stated in the Piping Schedule.

2. The Piping Schedule in the drawings may show alternative piping materials for certain services. In such cases, the same pipe material shall be used for all pipe sizes in all locations for the given piping service. Do not intermix piping materials.

B. Thread Forming for Stainless Steel Bolts

Form threads by means of rolling, not cutting or grinding.

C. Bolts and Nuts for Flanges for Ductile-Iron Piping (Specification Section 15240)

1. Bolts and nuts for Class 150 flanges (including AWWA C207, Class D) located indoors, outdoors and above ground, shall be Type 304 stainless steel conforming to ASTM A193 (Grade B8) for bolts and ASTM A194 (Grade 8) for nuts.

2. Bolts and nuts for buried or submerged Class 150 flanges and Class 150 flanges located outdoors above ground or in vaults and structures shall be Type 304 stainless steel conforming to ASTM A193 (Grade B8) for bolts and ASTM A194 (Grade 8) for nuts.

3. Hex head machine bolts for use with lugged valves shall comply with ASTM A 193, Grade B7.

4. Fit shall be Classes 2A and 2B per ASME B1.1 when connecting to cast-iron valves having body bolt holes.

5. Bolts used in flange insulation kits shall conform to ASTM A193 (Grade B7). Nuts shall conform to ASTM A194 (Grade 2H).

6. Provide washers for each nut. Washers shall be of the same material as the nuts.

D. Bolts and Nuts for Flanges for Stainless Steel (Specification Section 15276)

1. Bolts and nuts for flanges shall be Type 304 stainless steel conforming to ASTM A 193, Grade B8 for bolts and ASTM A 194, Grade 8 for nuts.

2. Hex head machine bolts for use with lugged valves shall comply with ASTM A 193, Grade B8, Class 2.

3. Bolts for flange insulation kits shall conform to ASTM A 193, Grade B7. Nuts shall conform to ASTM A 194, Grade 2H.

4. Provide washer for each nut. Washers shall be of the same material as the nuts.

E. Bolts and Nuts for Flanges for PVC and CPVC (Specification Sections 15290, 15291, and 15294)

1. Bolts and nuts for flanges located indoors shall be carbon steel, ASTM A307, Grade B.

2. Bolts and nuts for buried and submerged flanges and flanges located outdoors above ground or in vaults and structures shall be Type 316 stainless steel conforming to ASTM A 193, Grade B8M for bolts and ASTM A194, Grade 8M for nuts.

3. Bolts for piping in sodium hypochlorite service shall be made of titanium, per ASTM F467, Grade Ti1 or Ti7. Nuts shall conform to ASTM F467, same material as the bolts.

4. Provide a washer under each nut and under each bolt head. Washers shall be of the same material as the nuts.

F. Lubricant for Stainless Steel Bolts and Nuts

Lubricant shall be chloride free and shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.

G. Gaskets for Flanges for Ductile-Iron Piping and Fittings in Water Service (Specification Section 15240)

Gaskets shall be full face, 1/8-inch thick, cloth-inserted rubber, with a Shore "A" hardness of 75 to 85. Gaskets shall be suitable for a water pressure of 200 psi at a temperature of 180°F. Gaskets shall have "nominal" pipe size inside diameters not the inside diameters per ASME B16.21. Products: Garlock Style 19 or equal.

H. Gaskets for Flanges for Ductile-Iron Piping and Fittings in Raw Sewage, Sludge, and Scum Service (Specification Section 15240)

Gaskets shall be full face, 1/8-inch thick, Buna-N having a hardness of 55 to 65 durometer. Gaskets shall be suitable for a water pressure of 200 psi at a temperature of 250°F. Gaskets shall have "nominal" pipe size inside diameters not the inside diameters per ASME B16.21. Provide Garlock Style 9122 or equal.

I. Gaskets for Flanges for PVC and CPVC Piping (Specification Sections 15290, 15291, and 15294)

Gaskets for flanged joints shall be full faced, 1/8-inch thick, having a hardness of 50 to 70 durometer A. Gasket material shall be EPR. Gasket material for sodium hypochlorite service shall be Viton ETP.

J. Gaskets for Flanges for Stainless Steel Piping in Air Service (Specification Section 15276)

Gaskets shall be EPDM, full face, 1/8-inch thick. Gaskets shall be suitable for an air pressure of 50 psi at a temperature of 250°F

K. Gaskets for Flanges for Ductile-Iron Piping and Fittings in Air Service (Specification Section 15240)

Gaskets shall be EPDM, full face, 1/8-inch thick. Gaskets shall be suitable for an air pressure of 50 psi at a temperature of 250°F. Gaskets shall have "nominal" pipe size inside diameters not the inside diameters per ANSI B16.21.

L. Threaded Caps for Protection of Nuts and Bolt Threads

Caps shall be high-density polyethylene, color orange. The caps shall be filled with an anticorrosive lubricant to prevent nuts and bolts from rusting and corroding. Lubricant shall be suitable for use in potable water. Caps shall withstand temperatures from -40°F to 200°F. Caps shall be suitable to use in exposed, buried, and submerged service conditions. Products: Sap-Seal Products, Inc.; Advance Products and Systems, Inc., "Radolid"; or equal.

M. Insulating Unions

Insulating unions shall consist of a molded nylon sealing sleeve mounted in a three-piece malleable-iron (ASTM A 47 or A 197) body. Ends shall be threaded (ANSI B1.20.1) when connecting to steel piping, and copper solder joint when connecting to copper piping. Minimum working pressure shall be 150 psi. Unions shall be as manufactured by Central Plastics Company, Capital Insulation, or equal.

N. Dielectric Sealant

Unbacked elastomeric tape 0.125-inch thick, "Moldable Sealant" by Tapecoat Co., "Tac-Tape" by Royston Laboratories, with manufacturer's primer.

O. Joint Bonding Wires

Joint bonding wires shall be No. 2 AWG single-conductor, stranded copper, with 600-volt TW insulation.

P. Flexible Pipe Coupling Bonds

Flexible pipe coupling bonds shall be copper straps 1/16 inch thick by 1-1/4 inches wide and shall have an electrical resistance equivalent to a 1/0 stranded copper wire. Each strap shall have five holes punched in it at the locations for thermite welding the strap to the pipe, coupling follower rings, and coupling middle ring or sleeve. The bonding strap shall allow a total of 1-inch expansion or contraction of the pipe joint. Connect the bonding strap to the pipe and coupling by thermite welds (five places) using a 15-gram cartridge as manufactured by Cadweld, Thermoweld, or equal.

Q. Flange Insulation Kits and Polyurethane Sealant

1. Flange insulation kits shall consist of insulating gasket, an insulating stud sleeve for each bolt, insulating washers for each bolt, and a steel washer between each insulating washer and the nut. The sleeves shall be one piece, integral with the insulating washer. Gaskets shall be full face. Provide double sleeve and washer sets for each bolt.

2. Gasket material shall be phenolic, 1/8 inch thick. The flange insulating gasket shall be full diameter of the flange with a nitrile O-ring on each side of the gasket. Dielectric strength shall be not less than 500 volts per mil and a compressive strength of not less than 24,000 psi.

3. Insulating flange bolt sleeves shall be high-density polyethylene or spiral-wrapped mylar. Dielectric strength shall be not less than 1,200 volts per mil.

4. Insulating flange bolt washers shall be high-strength phenolic a minimum thickness of 1/8- inch. Dielectric strength shall be not less than 500 volts per mil and a compressive strength of not less than 25,000 psi.

5. Steel flange bolt washers for placement over the insulating washers shall be a minimum thickness of 1/8 inch and be cadmium plated.

6. Flange insulation kits shall be as manufactured by Central Plastics Company, Advance Product Systems, or equal.

7. Polyurethane sealant shall be PRC 270 or equal.

PART 3 - EXECUTION

A. Installing Pipe Spools in Concrete

Install pipes in walls and slabs before placing concrete.

B. Raised Face and Flat Face Flanges

Where a raised face flange connects to a flat-faced flange, remove the raised face of the flange.

C. Installing Aboveground or Exposed Piping

1. Provide pipe hangers and supports as detailed in the drawings and as specified in Section 15064.

2. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

D. Installing Flanged Piping

1. Set pipe with the flange bolt holes straddling the pipe horizontal and vertical centerline. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment. Before bolting up, align flange faces to the design plane within 1/16 inch per foot measured across any diameter. Align flange bolt holes within 1/8-inch maximum offset.

2. Inspect each gasket to verify that it is the correct size, material, and type for the specified service and that it is clean and undamaged. Examine bolts or studs, nuts, and washers for defects such as burrs or cracks and rust and replace as needed.

3. Clean flanges by wire brushing before installing flanged fittings. Clean flange bolts and nuts by wire brushing, lubricate carbon steel bolts with oil and graphite, and tighten nuts uniformly and progressively.

4. Bolt lengths shall extend completely through their nuts. Any that fail to do so shall be considered acceptably engaged if the lack of complete engagement is not more than one thread.

5. Do not use more than one gasket between contact faces in assembling a flanged joint.

6. Tighten the bolts to the manufacturer’s specifications, using the recommended cross bolt pattern in multiple

steps of increasing torque, until the final torque requirements are achieved. Do not over torque.

7. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reset or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

8. Install threaded nut and bolt thread protection caps after completing the bolt, nut, and gasket installation. Install on exposed and buried piping.

9. Prior to paint, trim back gasket and caulk joints.

E. Installing Blind Flanges

1. At outlets not indicated to be connected to valves or to other pipes and to complete the installed pipeline hydrostatic test, provide blind flanges with bolts, nuts, and gaskets.

2. Coat the inside face of blind flanges per Section 09900, System No. 7.

F. Installation of Stainless Steel Bolts and Nuts

Prior to assembly, coat threaded portions of stainless steel bolts and nuts with lubricant.

G. Installing Polyurethane Sealant for Flange Insulation Kits in Piping 24 Inches and Larger

Apply sealant into the gap between the two flanges inside the pipe. Apply sufficient sealant to fill the gap to the thickness of the pipe lining; trowel to provide a smooth and even layer between the two pieces of pipe.

H. Installing Insulating Flange Kits

Install insulating flange kits per NACE RP0286. Prevent moisture, soil, or other foreign matter from contacting any portion of the insulating joint prior to its being sealed. If moisture, soil, or other foreign matter contacts any portion of the insulating joint, disassemble the entire joint, clean with a solvent, and dry prior to reassembly. Follow the manufacturer’s recommendations regarding the torquing pattern of the bolts and the amount of torque to be used when installing the flange insulating kit.

I. Coating Flexible Pipe Coupling Bonds

Prime coat with vinyl butyral acid wash. Then coat the copper straps used to bond the flexible pipe couplings in accordance with Section 09900, System No. 21.

J. Lining and Coating Insulating Flanges

1. After testing, wrap buried insulating flanges, including bolts, nuts, and washers, and adjacent surfaces of the pipe or valve with polyethylene wrap per Section 09954.

2. Line the interior of the piping per Section 09900, System No. 7 for a distance of two pipe diameters in each direction away from the insulating flange. At an insulated valve flange, line interior of the piping for a distance of two pipe diameters away from the valve.

END OF SECTION

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SECTION 15055 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

A. SUMMARY

1. This Section includes the following:

   a. Piping materials and installation instructions common to most piping systems.
   b. Dielectric fittings
   c. Mechanical sleeve seals
   d. Sleeves

B. DEFINITIONS

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

2. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

3. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

4. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

5. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. SUBMITTALS

Welding certificates

D. QUALITY ASSURANCE

1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

2. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

3. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

A. PIPE, TUBE, AND FITTINGS

1. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.

2. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. JOINING MATERIALS

1. Refer to individual Division 15 piping Sections for special joining materials not listed below.

2. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum

thickness unless thickness or specific material is indicated.

3. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

5. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

6. Welding Filler Metals: Comply with AWS D10.12.

7. Solvent Cements for Joining Plastic Piping:
   a. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

C. DIELECTRIC FITTINGS

1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

2. Insulating Material: Suitable for system fluid, pressure, and temperature.

3. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

4. Dielectric Flanges: Factory-fabricated, companion flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

5. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

6. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain,

threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

D. MECHANICAL SLEEVE SEALS

1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

E. SLEEVES

1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

1. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

1. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with set screws.

1. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

2. PVC Pipe: ASTM D 1785, Schedule 40.

3. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

PART 3 - EXECUTION

A. PIPING SYSTEMS - COMMON REQUIREMENTS

1. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

3. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

6. Install piping to permit valve servicing.

7. Install piping at indicated slopes.

8. Install piping free of sags and bends.

9. Install fittings for changes in direction and branch connections.

10. Install piping to allow application of insulation.

11. Select system components with pressure rating equal to or greater than system operating pressure.

12. Install escutcheons for penetrations of walls, ceilings, and floors.

13. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

14. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

    a. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
    b. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
    c. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

15. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

    a. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

16. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop

materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

17. Verify final equipment locations for roughing-in.

18. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

B. PIPING JOINT CONSTRUCTION

1. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

6. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

7. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding

operators according to Part 1 "Quality Assurance" Article.

8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

9. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

    a. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
    b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
    c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    d. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    e. PVC Nonpressure Piping: Join according to ASTM D 2855.
    f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

10. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

11. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

12. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

    a. Plain-End Pipe and Fittings: Use butt fusion.
    b. Plain-End Pipe and Socket Fittings: Use socket fusion.

13. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

C. PIPING CONNECTIONS

1. Make connections according to the following, unless otherwise indicated:

    a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
    a. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
    b. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

D. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

1. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

2. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

3. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

4. Install equipment to allow right of way for piping installed at required slope.

E. CONCRETE BASES

1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

    a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
e. Install anchor bolts to elevations required for proper attachment to supported equipment.
f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement

E. ERECTION OF METAL SUPPORTS AND ANCHORAGES

1. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

2. Field Welding: Comply with AWS D1.1.

F. ERECTION OF WOOD SUPPORTS AND ANCHORAGES

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

3. Attach to substrates as required to support applied loads.

END OF SECTION

SECTION 15062 WALL PIPES, SEEP RINGS, AND PENETRATIONS

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of steel, cast-iron, and ductile-iron wall pipes and sleeves (including wall collars and seepage rings) and penetrations.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit detail drawings for fabricated steel or cast-iron wall and floor pipes and sleeves, wall flanges, seep rings, and sealing materials. Show dimensions and wall thicknesses.

3. Show flange sizes and the appropriate ANSI or AWWA flange dimensional standard where flanged end wall pipes or penetrations are used.

4. Show grooved-end dimensions and AWWA grooved-end dimensional standard where grooved-end wall pipes or penetrations are used.

5. List coating systems to be applied, manufacturer, and dry thickness of coatings. Call out coatings where coatings are to be applied.

6. List materials of construction, with ASTM material reference and grade.

7. Submit manufacturer's instructions for installing rubber annular hydrostatic sealing devices.

8. Submit six copies of the results of the leakage test for cast-iron sleeves having shrink-fit steel collars or collar halves bottomed in a groove and steel sleeves having welded steel collars.

PART 2 - MATERIALS

A. General

1. Use cast-iron, ductile-iron, or fabricated steel wall sleeves when containing rubber annular hydrostatic sealing devices through which piping passes.

2. Use only cast-iron or ductile-iron wall pipes when connecting to cast-iron and ductile-iron pipe. Use only fabricated steel or stainless steel wall pipes when connecting to steel or stainless steel pipe, respectively.

3. Cast-iron flanges shall conform to ASME B16.1, Class 125 or 250, to match the flange on the connecting pipe.

4. Class 150 steel flanges shall conform to AWWA C207, Class D. Flanges shall be flat face. Flanges shall match the flange on the connecting pipe.

5. See Section 15050 for flange bolts and gaskets.

B. Cast-Iron or Ductile-Iron Wall Pipes and Sleeves

1. Provide cast- or ductile-iron wall pipes with ends as shown in the drawings for connection to adjacent cast-iron and ductile-iron pipe or for containing pipes where they pass through concrete walls, ceilings, and floor slabs. Provide seepage ring on wall pipes and sleeves passing through concrete walls and slabs that are to be watertight. Locate collars such that the collar is at the center of the wall or floor slab, unless otherwise shown in the drawings.

2. Wall pipes and sleeves shall be of the following types:

   a. Pipe or sleeve with integrally cast seep ring.

   b. Pipe or sleeve with shrink-fit steel collar attached.

   c. Pipe or sleeve with steel collar halves bottomed in a groove provided in the pipe or sleeve.

3. Minimum wall thickness for pipes and sleeves having integrally cast seep rings shall be as shown in the following table:

Pipe or Sleeve Size (inches)	Minimum Wall Thickness (inches)
3	0.48
4	0.52
6	0.55
8	0.60
10	0.68
12	0.75
14	0.66
16	0.70
18	0.75
20	0.80
24	0.89
30	1.03
36	1.15
42	1.28
48	1.42

4. Minimum wall thickness of pipes or sleeves having shrink-fit collars shall be special Class 52. Cut shrink-fit collars from a 1/4-inch-thick steel ring. Attach the collar to a cast-iron or ductile-iron pipe or sleeve by heating the steel collar and allowing it to shrink over the pipe at the necessary location. Provide an epoxy bond (Keysite 740 or 742 or Scotchkote 302) between the pipe and collar. Sandblast the area of the pipe to be epoxy coated per SSPC SP-10.

5. Wall pipes or sleeves having steel collar halves bottomed in a groove shall be ductile iron Special Class 54 minimum unless otherwise shown. Wall flanges shall consist of 1/4-inch-thick steel seep ring halves for pipes through 24-inch and 3/8-inch-thick halves for pipe 30-inches and larger, bottomed in a groove provided on the pipe. The pipe groove shall be machine cut to a depth of 1/16-inch to 5/64-inch to provide a press fit for the seep ring. Seep ring halves shall be welded together after fit into groove but shall not be welded to pipe. Seep rings shall be sealed completely around the pipe with silicon sealant manufactured by Dow-Corning No. 790, General Electric Silpruf, or equal.

6. The material used in cast- or ductile-iron wall flanges, wall sleeves, and wall penetrations shall conform to ASTM A395, A436, A536, A48 (Class 35), or A126 (Class B).

7. Pressure test at least one of each size of cast-iron pipes or sleeves having shrink-fit steel collars or collar halves installed in a groove in the pipe at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for four hours duration and shall show zero leakage.

C. Fabricated Steel Wall Pipes and Sleeves

1. Provide fabricated steel wall pipes and sleeves with ends as shown in the drawings for connection to adjacent steel pipes, or for containing pipes, where they pass through concrete walls. Provide seepage ring or wall flange on wall pipes and sleeves passing through concrete walls and slabs that are to be watertight. Wall thickness shall be the same as the pipe wall thickness when connecting to steel pipe. Minimum wall thickness for sleeves containing pipes shall be standard weight per ASME B36.10 for sleeves 72-inches and smaller and 1/2-inch for sleeves greater than 72-inches through 96-inches.

2. Wall flanges shall be in the form of a steel wall collar welded to the steel sleeve or penetration. Cut welded wall collars from a 1/4-inch steel ring. Attach the collar to a steel wall pipe or sleeve with full circle, 3/16-inch fillet welds. Welding procedures shall be in accordance with ASME B31.3, Chapter V.

3. Steel pipe used in fabricating wall sleeves containing pipes shall comply with ASTM 53 (Type E or S), Grade B; ASTM A135, Grade B; ASTM A139, Grade B; or API 5L or 5LX. Wall pipes connecting to steel pipe shall be of the same material as the connecting pipe. Wall collar material shall comply with ASTM A36, A105, A181, or A182.

4. Stainless steel pipe used in fabricating wall pipes shall be of the same material as the connecting pipe. Wall collar material shall comply with ASTM A240.

5. Pressure test at least one of each size of fabricated steel wall sleeve or penetration and collar assemblies at the place of fabrication to demonstrate watertightness of the seal between the collar and the sleeve. The test shall be at a pressure of 20 psig for four hours duration and shall show zero leakage.

D. Rubber Annular Hydrostatic Sealing Devices

1. Rubber annular hydrostatic sealing devices shall be of the modular mechanical type, utilizing interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe sleeve and the passing pipe. Assemble links to form a continuous rubber belt around the pipe, with a pressure plate under each bolthead and nut.

2. Materials of construction shall be as follows:

Compound	Material
Pressure plate	Type 316 stainless steel
Bolts and nuts for links	Type 316 stainless steel
Sealing element	Nitrile rubber

3. The size of the wall sleeve needed to accommodate the passing pipe shall be as recommended by the rubber annular seal manufacturer.

4. Provide centering blocks in 25% of the sealing elements on pipelines larger than 12-inches in diameter.

5. The rubber annular hydrostatic sealing devices shall be Link Seal as manufactured by Thunderline Corporation; Innerlynx as manufactured by Advance Products & Systems, Inc.; or equal.

E. Bolts, Nuts, and Gaskets for Flanged-End Wall Pipes

See Section 15050.

F. Polyethylene Foam Filler for Pipe Penetrations

Packing foam shall be an extruded closed-cell polyethylene foam rod, such as Minicel backer rod, manufactured by Industrial Systems Department, Plastic Products Group of Hercules, Inc., Middletown, Delaware; Ethafoam, as manufactured by Dow Chemical Company, Midland, Michigan; or

equal. The rod shall be 1/2-inch larger in diameter than the annular space.

G. Polyurethane Sealant for Pipe Penetrations

Sealant shall be multipart, polyurethane sealant, to cure at ambient temperature, for continuous immersion in water. Install as recommended by the manufacturer. Products: SIKA Sikaflex 2C or equal.

H. Painting and Coating

1. Coat penetrations and sleeves exposed, above ground, or in vaults and structures in accordance with Section 09900, System No. 10 unless fusion-bonded epoxy coatings are shown in the drawings or specified elsewhere.

2. Coat submerged sleeves and penetrations per Section 09900, System No. 7 unless fusion-bonded epoxy coatings are shown in the drawings or specified elsewhere.

3. Coat buried sleeves and penetrations per Section 09900, System No. 21.

4. Do not coat stainless steel sleeves and penetrations.

PART 3 - EXECUTION

A. Location of Pipes and Sleeves

1. Provide a wall or floor pipe where shown in the drawings and wherever piping passes through walls or floors of tanks or channels in which the water surface is above the pipe penetration.

2. Provide a floor sleeve where shown in the drawings and wherever plastic pipe, steel, or stainless steel pipe 3-inches and smaller or stainless steel or copper tubing passes through a floor or slab. Provide a rubber annular sealing device in the annular space between the sleeve and the passing pipe or tubing.

3. Provide wall sleeves where shown in the drawings and wherever plastic, steel or stainless steel pipe 3-inches and smaller, or stainless steel or copper tubing passes through a wall. Provide a single rubber annular seal when the wall is 8-inches thick or less. Provide two rubber annular seals (one at each end of the sleeve) when the wall is more than 8-inches thick. Pack the

annular space with polyethylene foam filler and fill the ends of the penetration with 2-inches of elastomeric sealant on both sides of the structure.

4. Where wall sleeves are installed in which water or soil is on one or both sides of the channel or wall, provide two rubber annular seals (one at each end of the sleeve).

5. Where pipes pass through walls or slabs and no sleeves or wall or floor pipe with seep ring is provided, pack the annular space with polyethylene foam filler and fill the ends of the penetration with 2-inches of elastomeric sealant on both sides of the structure.

B. Installation in Existing Concrete Walls and Slabs

Core drill holes 1 to 2 inches larger in diameter than the outside diameter of the wall flange or collar. Install wall pipe and collar assembly axially aligned with the piping to which it will be connected or will contain. Pack the void space between the sleeve and concrete with grout. See Section 03600 for grouting specification.

C. Installation in New Concrete Walls and Slabs

Install wall pipes and sleeves in walls before placing concrete. Do not allow any portion of the pipe or sleeve to touch any of the reinforcing steel. Install wall pipe or sleeve and collar assembly axially aligned with the piping to which it will be attached or will contain. Provide supports to prevent the pipe or sleeve from displacing or deforming while the concrete is being poured and is curing.

D. Installation in Dry Floors and Slabs

Install pipe sleeves and spools in concrete floors and slabs which do not have water over them such that the sleeve or pipe extends from the bottom of the floor or slab to 2-inches above the floor or slab unless shown otherwise in the drawings.

E. Installation of Wall Pipes Having Flanged End Connections

1. Check alignment before grouting in place or pouring concrete. Realign if the sleeve is not properly aligned.

2. Install flanged end wall sleeves or penetrations with bolt holes of the end flanges straddling the horizontal and vertical centerlines of the sleeve.

3. Lubricate flange bolts with oil and graphite prior to installation.

F. Qualifications of Welders

Welder qualifications shall be in accordance with AWS D1.1.

G. Installation of Rubber Annular Hydrostatic Sealing Devices

Install in accordance with the manufacturer's instructions.

H. Field Testing

Check each wall penetration for leakage at the time the hydraulic structure is tested for leakage; see Section 03800. Penetrations shall show zero leakage.

END OF SECTION

SECTION 15064 PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

A. Description

This section includes materials and installation of pipe hangers and supports including accessory items, such as anchor bolts and screws, neoprene isolation pads.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Provide line drawings of each piping system to the scale shown in the drawings, locating each support or hanger. Identify each type of hanger or support by the manufacturer's catalog number or figure.

3. Provide installation drawings and manufacturer's catalog information on each type of hanger and support used. Clearly indicate the actual pipe outside diameter (not just nominal pipe size) that is used for the hangers and supports.

PART 2 - MATERIALS

A. Design Criteria

1. Not all pipe supports or hangers required are shown in the drawings. Provide pipe supports for every piping system installed. Support piping by pipe support where it connects to pumps or other mechanical equipment.

2. Pipe support and hanger components shall withstand the dead loads imposed by the weight of the pipes, fittings, and valves (all filled with water), plus valve actuators and any insulation, and shall have a minimum safety factor of five based on material ultimate strength.

B. Hanger and Support Systems

1. Pipe hangers and supports shall be as manufactured by Anvil, Unistrut, B-Line, Superstrut, or equal.

2. Pipe hangers and supports shall comply with MSS SP-58 for the standard types referenced in the drawings. Construct special hangers and supports if detailed in the drawings. Type numbers for standard hangers and supports shall be in accordance with MSS SP-58 as listed below:

Type Number	Description	Manufacturer and Model (or Equal)
1	Adjustable steel clevis	Anvil Fig. 590 or 260, B-Line B3100 or B3102
3	Steel double-bolt pipe clamp	Anvil Fig. 295A or 295H, B-Line B3144 or B3144A
4	Steel pipe clamp (pipes smaller than 3 inches)	Anvil Fig. 212, B-Line B3140
4	Steel pipe clamp (pipes 3 inches and larger)	Anvil Fig. 216, B-Line 3142
5	Pipe hanger	B-Line B6690
6	Adjustable swivel pipe ring	Anvil Superstrut 714, Anvil Fig. 104
7	Adjustable steel band hanger	B-Line B3172
8	Extension pipe or riser clamp	Anvil Fig. 261, B-Line B5573
9	Adjustable band hanger	Anvil Fig. 97
10	Adjustable swivel ring band hanger	Anvil Fig. 70, B-Line B3170 NF
11	Split pipe ring with adjustable turnbuckle	Anvil Fig. 108, B-Line B3173
13	Steel turnbuckle	Anvil Fig. 230, B-Line B3202
14	Steel clevis	Anvil Fig. 299, B-Line B3201
15	Swivel turnbuckle	Anvil Fig. 114, B-Line B3224
16	Malleable iron socket	Anvil Fig. 110R, B-Line B3222
17	Steel weldless eye nut	B-Line B3200
18	Steel or malleable iron concrete insert	Anvil Fig. 281, Superstrut 452

Type Number	Description	Manufacturer and Model (or Equal)
19	Top beam C-clamp	Anvil Fig. 92, B-Line B3033
20	Side I-beam or channel clamp	Anvil Fig. 14 or 217
21	Center I-beam clamp	Anvil Figure 134
22	Welded attachment type	Anvil Fig. 66 B-Line B3083
23	C-clamp	Anvil Fig. 86, B-Line B3036L
24	U-bolt	Anvil Fig. 137, B-Line B3188
26	Clip	Anvil Fig. 262, B-Line B3180
28	Steel I-beam clamp with eye nut	Anvil Fig. 228
29	Steel wide flange	Anvil Fig. 228 clamp with eye nut
30	Malleable iron beam clamp with extension piece	Superstrut CM-754, B-Line B3054
31	Light welded steel bracket	Anvil Fig. 194, B-Line B3063
32	Medium welded steel bracket	Anvil Fig. 195, B-Line B3066
33	Heavy welded steel bracket	Anvil Fig. 199, B-Line B3067
34	Side beam bracket	Anvil Fig. 202, B-Line B3062
36	Pipe saddle support	Anvil Fig. 258, B-Line B3095
37	Pipe stanchion saddle	Anvil Fig. 259, B-Line B3090
38	Adjustable pipe saddle support	Anvil Fig. 264, B-Line B3093/B3089
39	Steel pipe covering	Anvil Fig. 160, 161, 162, 163, 164, or 165; Superstrut A 789; B-Line B3160/B3165
40	Insulation protection shield	Anvil Fig. 167, B-Line B3151

Type Number	Description	Manufacturer and Model (or Equal)
41	Single pipe roll	Anvil Fig. 171, B-Line B3114
43	Adjustable roller hanger with swivel	Anvil Fig. 181, B-Line B3110
44	Pipe roll, complete	Anvil Fig. 271, B-Line B3117SL

3. Pipe hangers and supports shall be hot-dipped galvanized per ASTM A 153 carbon steel (ASTM A36, A575, or A576). Bases, rollers, and anchors shall be steel as described above or may be cast iron (ASTM A48). Pipe clamps shall be steel as described above or may be malleable iron (ASTM A47).

4. Pipe hangers and supports in submerged service shall be type 316 stainless steel.

C. Miscellaneous Pipe Supports and Hangers

1. Pipe Anchor Chair: Anvil Figure 198 or equal.

2. One Hole Clamp: Anvil Figure 126 or equal.

3. Roller Chair: Anvil Figure 175 or equal.

D. Pipe Spiders

Superstrut S-794 or equal.

E. Waffle Isolation Pads

Mason Type "W"; Machinery Installation Systems "Unisorb" Type S, SB, F, or FB; or equal. Provide minimum 1/4-inch thickness.

F. Neoprene Isolating Sleeves for Metal Pipe

Unistrut P2600, B-Line "Vibrocushion," or equal.

G. Anchor Bolts and Screws

Anchor bolts and screws for attaching pipe supports and hangers to walls, floors, ceilings, and roof beams shall be Type 316 stainless steel, ASTM A276 or F593. Nuts shall be Type 316 stainless steel, ASTM A194, Grade 8M or ASTM F594, Type 316 stainless steel.

PART 3 - EXECUTION

A. Pipe Hanger and Wall Support Spacing

Install pipe hangers and wall supports on horizontal and vertical runs at the spacing shown or detailed in the drawings. Provide hanger rods (for horizontal runs) and wall supports of the sizes shown or detailed in the drawings. If no spacing or rod sizes are given in the drawings or in the specifications for a particular piping system, use the following:

1. Pipe Hanger and Wall Support Spacing for Stainless Steel and Ductile-Iron Pipe (Sections 15240 and 15276):

Pipe Size (inches)	**Maximum Support or Hanger Spacing (feet)**	**Minimum Rod Size (inches)**
3/8 and smaller	4	3/8
1/2 through 1	6	3/8
1-1/4 through 2	8	3/8
2-1/2 and 3	10	1/2
3-1/2 and 4	10	5/8
6	12	3/4
8	12	7/8
10 and 12	14	7/8
14 and 16	16	1
18	15	1
20 through 24	9	1
30	6	1

2. Pipe Hanger or Wall Support Spacing for PVC Pipe (Sections 15290, 15291 and 15294):

Pipe Size (inches)	**Maximum Support or Hanger Spacing (feet)**	**Minimum Rod Size (inches)**
3/4	4	3/8
1	4	3/8
1-1/2	5	3/8
2	5	3/8
2-1/2	5	1/2
3	6	1/2

Pipe Size (inches)	Maximum Support or Hanger Spacing (feet)	Minimum Rod Size (inches)
4	6	5/8
6	7	3/4
8	7	7/8

3. Pipe Hanger or Wall Support Spacing for FRP Pipe (Section 15299):

Pipe Size (inches)	Maximum Hanger or Support Spacing (feet)	Minimum Rod Size (inches)
1	3	3/8
1 1/2	4	3/8
2	5	3/8
3	6	1/2
4	6	5/8
6	7	3/4
8	8	7/8
10	9	7/8
12	10	7/8
14 to 16	10	1
18	10	1
20 to 24	9	1
30	6	1

4. Pipe Hanger or Wall Support Spacing for Stainless Steel Tubing (Section 15278):

Tube Outside Diameter (inches)	Maximum Hanger or Support Spacing (feet)	Minimum Rod Size (inches)
1/8 to 1/4	2	3/8
5/16 to 1/2	3	3/8
5/8 to 7/8	4	3/8
1 to 2	6	3/8

B. Pipe Support Spacing for Supports on Top of Slabs or Grade

Install pipe supports on horizontal runs at the spacing shown or detailed in the drawings. Provide supports of the type shown or detailed in the drawings. If no spacings are given in the drawings or in the specifications for a particular piping system, use the following:

1. Pipe Support Spacing for Steel and Ductile-Iron Pipe (Sections 15240 and 15276):

Pipe Size (inches)	**Maximum Support Spacing (feet)**
3/8 and smaller	4
1/2 through 1	6
1-1/4 through 2	8
2-1/2 and 3	10
3-1/2 and 4	10
6	12
8	12
10 and 12	14
14 and 16	16
18	16
20 through 24	18
30 through 36	18

2. Pipe support spacing for other pipe materials shall be the same as described above in paragraph entitled “Pipe Hanger and Wall Support Spacing.”

C. Installing Pipe Hangers and Supports

1. Provide separate hangers or supports at each valve. Provide one hanger or support around each end of the valve body or on the adjacent connecting pipe within one pipe diameter of the valve end. Provide additional hangers or supports to relieve eccentric loadings imposed by offset valve actuators.

2. Provide separate hangers or supports at each pipe elbow, tee, or fitting. Provide separate hangers or supports on both sides of each nonrigid joint or flexible pipe coupling.

3. Adjust pipe hangers per MSS SP-89, paragraph 10.6.

4. Install leveling bolts beneath support baseplates. Provide 1-inch thick grout pad beneath each base.

5. Install piping without springing, forcing, or stressing the pipe or any connecting valves, pumps, and other equipment to which the pipe is connected.

D. Installing Stainless Steel Channel Frames

Use 1-5/8-inch high channel frames unless 3-1/4-inch is needed to provide clearance from walls. Use multiple back-to-back channels if additional clearance is needed.

E. Installing Neoprene Isolating Sleeves

Install a sleeve around each metal pipe 6-inches and smaller at the point of bearing or contact with the pipe hanger or support.

F. Painting and Coating

1. Grind welds of fabricated steel pipe supports smooth, prepare surface by sandblasting, and apply coating system.

2. Paint exposed pipe hangers and supports to match the color of the adjacent wall using System No. 10 per Section 09900. If the adjacent wall is not painted, paint the hangers and supports to match color code of the largest pipe on the support.

3. Do not coat stainless steel pipe supports.

4. Remove heat tint completely from the heat affected zones HAZ of the finished weld on stainless steel pipe supports by grinding or blasting. The maximum depth of grinding or abrasive blasting to remove defects shall not exceed 10% of the support thickness. Do not perform abrasive blasting with steel shot, grit, or sand. Perform a final cleaning then pickle, and passivate the heat affected zones (HAZ) on stainless steel pipe supports.

END OF SECTION

SECTION 15075 PROCESS EQUIPMENT, PIPING, DUCT, AND VALVE IDENTIFICATION

PART 1 - GENERAL

A. Description

This section includes materials and installation of markers, labels, and signs for pipes, ducts, and valves; for mechanical equipment; for hazardous materials warnings; and for miscellaneous plant services.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's catalog data and descriptive literature describing materials, colors, letter size, and size of labels.

PART 2 - MATERIALS

A. Labels for Exposed Piping

1. Labels for piping shall bear the full piping system name as shown in the Piping Schedule in the drawings. Provide separate flow directional arrows next to each label. Color, size, and labeling shall conform to ANSI A13.1 and Z535.1. Labels for piping inside buildings shall be vinyl cloth: W. H. Brady Co. B-500 vinyl cloth, Seton Name Plate Corporation Pipe Markers, or equal. Labels for piping located outdoors shall be weather and UV-resistant acrylic plastic and shall be W. H. Brady Co. B-946, Seton Name Plate Corporation Pipe Markers, or equal.

2. Alternatively, provide preprinted, semirigid, snap-on, color coded pipe markers. Color, size, and labeling shall conform to ANSI A13.1 and Z535.1. Label shall cover 360 degrees (minimum). Labels shall be fabricated of weather and UV-resistant acrylic plastic. Labels shall be Seton Nameplate Corporation SetMark pipe marks or equal.

3. Provide 1-inch thick molded fiberglass insulation with jacket for each plastic pipe label or marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F or greater. Cut length to extend 2 inches beyond each end of plastic pipe marker.

B. Labels for Valves

Provide each valve of size 3 inches and larger with an identification tag. Tag shall be 2-inch square or circular aluminum or 1/16-inch thick fiberglass: W. H. Brady B-60, Seton Name Plate Corp. Series SVT, or equal. Aluminum tags shall have black-filled letters. Tag shall show the valve tag number and/or name or designation as given in the drawings.

C. Hose Bibb Signs--Unsafe Water

Provide a rigid sign labeled "DANGER--UNSAFE WATER—NO BEBER" for each hose bibb as denoted for a reclaimed water source. The size and lettering shall conform to OSHA requirements. Signs shall be Seton Nameplate Company 20-gauge baked enamel, minimum size 7 inches by 3 inches; Brady B-120 Fiber-Shield fiberglass, minimum size 7 inches by 3 inches, 1/8-inch thick; or equal.

D. Labels for Mechanical Equipment

Provide a label for each pump, blower, compressor, tank, feeder, flocculator, flash mixer, clarifier mechanism, or other piece of mechanical equipment. Label shall show the equipment name. Labels shall be 1-1/2 inches (minimum) by 4 inches (minimum) brass, aluminum, or 1/8-inch thick fiberglass tags: Brady B-120 Fiber-Shield, Seton Style 2065, or equal.

E. Labels for Tanks

Signs shall be weather- and UV-resistant. Labels shall be Brady B-946, Seton Name Plate Corporation PSPL, or equal. Minimum size shall be 7 inches by 10 inches. Provide a sign on each tank bearing the tank tag number and the name of the liquid stored.

F. Wall Signs

Wall signs shall be 1-1/2 inches by 4 inches (minimum dimensions), 1/16-inch thick satin-surfaced material conforming to ASTM D709 (Grades ES-1, ES-2, or ES-3).

Lettering shall be 1/2-inch high white letters on black background. Do not provide mounting holes.

G. Labels for Automatic Start/Stop Equipment

Provide a sign reading "CAUTION--EQUIPMENT STARTS AND STOPS AUTOMATICALLY" on each piece of equipment listed below. Signs shall be pressure-sensitive vinyl with adhesive for application to equipment. Signs mounted on adjacent walls are also acceptable. Table does not include all equipment within the Project to receive signage. Reference the Drawings and provide signage for all equipment within the Project that stops and starts automatically. Size shall be 10 inches by 7 inches minimum. Products: Seton, Brady, or equal.

Equipment Type	Location	Tag Number
Vertical Turbine Pumps	Effluent Pump Station	390-P-4 through 390-P-8. 395-P-1 through 395-P-4
Electric Actuated Fabricated Stainless Steel Slide Gates	See Drawings	See Specification Section 15119
Electric Actuated High Density Polymer Slide Gates	See Drawings	See Specification Section 15119
Submersible Raw Sewage Pumps	Phase IV-C Plant LS	110-P-1 and 110-P-2
Nonclog Centrifugal Pumps (RAS)	Clarifiers 1-4 and Clarifiers 10&11	250-P-1, 250-P-2, 250-P-3, 250-P-X, 250-P-X and 250-P-X, and 450-P-X
Nonclog Centrifugal Pumps (WAS)	Clarifiers 1-4, Clarifiers 7&8, and Clarifier 9	250-P-X, 250-P-X, 250-P-X, 250-P-X, 250-P-X and 250-P-X and 350-P-X
Recessed Impeller Grit Pumps	Headworks / Preliminary Treatment Structure	500-P-1, 500-P-2, 500-P-3, 500-P-4, and 500-P-5
Submersible Scum Pumps	Clarifiers 1-4	250-P-X, 250-P-X, 250-P-X and 250-P-X

Equipment Type	Location	Tag Number
Grit Collecting Equipment – Grit Snail	Headworks / Preliminary Treatment Structure	500-GS-1 and 500-GS-2
Mechanically Cleaned Fine Screens and Appurtenances (Band Type)	Headworks / Preliminary Treatment Structure	500-BS-1, 500-BS-2 and 500-BS-3 and 500-SC-1, 500-SC-2 and 500-SC-3
Secondary Clarifier Equipment	Clarifier No. 11	500-C-1
Submersible Mixers	See Drawings	See Specification Section 11338
Packaged Chemical Feed System	Supplemental Carbon Building	520-P-1, 520-V-2, 520-P-3 and 520-P-4
Cast-Iron Multistage Centrifugal Blowers	Phase I/II supplemental aeration @ Phase III basin and electrical/ blower building	220-B-1 and 220-B-2, 320-B-1, 320-B-2, and 420-B-4
FRP Centrifugal Fan	Odor Control System @ Headworks	500-EF-1 & 500-EF-2

H. Labels for Ventilation Ducts

Identify air supply, return exhaust, intake, and relief ductwork with duct markers, showing ductwork service and direction of flow. Signs shall be pressure-sensitive vinyl with adhesive for application to ducts and duct insulation. Size shall be 10 inches by 7 inches minimum. Products: Seton, Brady, or equal.

I. Underground Plastic Warning Tape for Metallic Pipe

Provide permanent, bright-colored, continuous-printed plastic tape, intended for direct burial service, not less than 6 inches wide by 3.5 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe. Provide the following colored tape for the various piping services:

Service	Color
Cable TV	Orange
Chemical	Yellow
Electric	Red
Fuel Oil, Gasoline	Yellow
Gas	Yellow
Reclaimed Water	Violet
Sewer	Green
Telephone	Orange
Water	Blue

J. Underground Detectable Metallic Pipe Warning Tape for Nonmetallic Pipe

Provide permanent, bright-colored, continuous-printed tape consisting of an aluminum or steel foil sheathed in a plastic laminate, not less than 2 inches wide by 3 mils thick. Provide tape with printing which most accurately indicates type of buried service. Provide the following colored tape for the various piping services:

Service	Color
Cable TV	Orange
Chemical	Yellow
Electric	Red
Fuel Oil, Gasoline	Yellow
Gas	Yellow
Reclaimed Water	Violet
Sewer	Green
Telephone	Orange
Water	Blue

K. No Smoking Signs

Provide a sign reading "NO SMOKING" at each location listed below. Signs shall be weather and UV resistant, minimum size 10 inches by 7 inches, 1/8-inch thick fiberglass. Products: Brady, Seton, or equal.

Room & Process Number	Location
Electrical Switchgear/MCC Room	New West Electrical Building

PART 3 - EXECUTION

A. Installing Pipe Labels

1. Provide label and flow arrow at each connection to pumps or other mechanical equipment, at wall boundaries, at tees and crosses, and at 20-foot centers on straight runs of piping.

2. On piping having external diameters less than 6 inches (including insulation, if any), provide full-band pipe markers, extending 360 degrees around pipe at each location.

3. On piping having external diameters of 6 inches and larger (including insulation, if any), provide either full-band or strip-type pipe markers but not narrower than three times letter height (and of required length), fastened by one of the following methods:

   a. Laminated or bonded application of pipe marker to pipe or insulation.

   b. Strapped-to-pipe or insulation application of semirigid type with Type 304 or 305 stainless steel bands.

4. Label destination on pipes entering and leaving buildings.

B. Installing Valve and Equipment Labels

1. Attach labels to the valve or piece of equipment with Type 304 or 316 stainless steel chains or wires.

2. Attach valve labels to the valve handwheels. If the valve has no handwheel, attach the label to the valve by tying the tag wire or chain around the operating shaft or nut.

C. Installing Miscellaneous Signs

Attach per sign manufacturer's recommendations and per OSHA requirements.

D. Installing Wall and Door Signs

Attach to walls and doors using epoxy adhesive.

E. Installing Labels for Automatic Start/Stop Equipment and Hazardous Materials Warning Signs for Equipment

1. Attach signs for exposed equipment directly to the equipment.

2. Attach signs for sump pumps on the adjacent wall.

F. Installing Ventilation Ductwork Labels

1. In each space where ductwork is exposed or concealed only by a removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground, or similar concealment) and at 20-foot spacings along exposed runs.

2. Provide markers on each access door in ductwork and housings, indicating purpose of access.

3. Assure that all identification labels are clearly visible.

G. Installing Underground Plastic Warning Tape for Metal Pipe

During backfilling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6 to 8 inches above the top of the pipe. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inches, install single line marker.

H. Installing Underground Detectable Metallic Pipe Warning Tape

Install tape 12 to 18 inches below finished ground surface, located directly over buried pipelines. Where multiple small pipelines are buried in a common trench and do not exceed an overall width of 16 inches, install a single marker tape.

END OF SECTION

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SECTION 15076 - HVAC IDENTIFICATION

PART 1 - GENERAL

A. SUMMARY

This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.

2. Equipment markers.

3. Access panel and door markers.

B. SUBMITTALS

Product Data: For each type of product indicated.

C. QUALITY ASSURANCE

ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

A. EQUIPMENT IDENTIFICATION DEVICES

1. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

    a. Data:

        1) Manufacturer, product name, model number, and serial number.

        2) Capacity, operating and power characteristics, and essential data.

        3) Labels of tested compliances.

    b. Location: Accessible and visible.

    c. Fasteners: As required to mount on equipment.

2. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

   a. Terminology: Match schedules as closely as possible.

   b. Data:

      1) Name.

   c. Size: 2-1/2 by 4 inches for equipment.

PART 3 - EXECUTION

A. APPLICATIONS, GENERAL

Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

A. EQUIPMENT IDENTIFICATION

Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fan coil and Condensing Units.

B. ADJUSTING AND CLEANING

1. Relocate mechanical identification materials and devices that have become visually blocked by other work.

2. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION

SECTION 15080 - HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes mechanical insulation for boiler breeching, duct, equipment, and pipe, including the following:

1. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.

2. Insulating cements.

3. Adhesives.

4. Mastics.

5. Sealants.

6. Factory-applied jackets.

7. Field-applied fabric-reinforcing mesh.

8. Field-applied jackets.

9. Tapes.

10. Securements.

11. Corner angles.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show details for the following:

1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Attachment and covering of heat tracing inside insulation.

3. Insulation application at pipe expansion joints for each type of insulation.

4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Removable insulation at piping specialties, equipment connections, and access panels.

6. Application of field-applied jackets.

7. Application at linkages of control devices.

8. Field application for each equipment type.

C. Field quality-control inspection reports.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2. Products: Subject to compliance with requirements, provide one of the products specified.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products:

a. Aeroflex USA Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

    a. CertainTeed Corp.; Duct Wrap.

    b. Johns Manville; Microlite.

    c. Knauf Insulation; Duct Wrap.

    d. Manson Insulation Inc.; Alley Wrap.

    e. Owens Corning; All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

    a. CertainTeed Corp.; Commercial Board.

    b. Fibrex Insulations Inc.; FBX.

    c. Johns Manville; 800 Series Spin-Glas.

    d. Knauf Insulation; Insulation Board.

    e. Manson Insulation Inc.; AK Board.

    f. Owens Corning; Fiberglas 700 Series.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products:

    a. Aeroflex USA Inc.; Aeroseal.

    b. Armacell LCC; 520 Adhesive.

    c. Foster Products Corporation, H. B. Fuller Company; 85-75.

    d. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products:

    a. Childers Products, Division of ITW; CP-82.

    b. Foster Products Corporation, H. B. Fuller Company; 85-20.

    c. ITW TACC, Division of Illinois Tool Works; S-90/80.

    d. Marathon Industries, Inc.; 225.

    e. Mon-Eco Industries, Inc.; 22-25.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products:

    a. Childers Products, Division of ITW; CP-82.

    b. Foster Products Corporation, H. B. Fuller Company; 85-20.

    c. ITW TACC, Division of Illinois Tool Works; S-90/80.

    d. Marathon Industries, Inc.; 225.

    e. Mon-Eco Industries, Inc.; 22-25.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates: Comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products:

a. Childers Products, Division of ITW; CP-35.

b. Foster Products Corporation, H. B. Fuller Company; 30-90.

c. ITW TACC, Division of Illinois Tool Works; CB-50.

d. Marathon Industries, Inc.; 590.

e. Mon-Eco Industries, Inc.; 55-40.

f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

B. FSK and Metal Jacket Flashing Sealants:

1. Products:

a. Childers Products, Division of ITW; CP-76-8.

b. Foster Products Corporation, H. B. Fuller Company; 95-44.

c. Marathon Industries, Inc.; 405.

d. Mon-Eco Industries, Inc.; 44-05.

e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

5. Color: Aluminum.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. For exterior ducts, provide a field applied jacket to ensure a weather tight, liquid tight seal for all ductwork insulation in addition to aluminum jackets.

C. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.

1. Products:

a. Childers Products, Division of ITW; Metal Jacketing Systems.

b. PABCO Metals Corporation; Surefit.

c. RPR Products, Inc.; Insul-Mate.

2. Sheet and roll stock ready for shop or field sizing.

3. Finish and thickness are indicated in field-applied jacket schedules.

4. Moisture Barrier for Indoor Applications: 1-mil-(0.025-mm-) thick, heat-bonded polyethylene and kraft paper.

5. Moisture Barrier for Outdoor Applications: 3-mil-(0.075-mm-) thick, heat-bonded polyethylene and kraft paper.

6. Factory-Fabricated Fitting Covers:

   a. Same material, finish, and thickness as jacket.

   b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

   c. Tee covers.

   d. Flange and union covers.

   e. End caps.

   f. Beveled collars.

   g. Valve covers.

   h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.

1. Width: 3 inches (75 mm).

2. Thickness: 6.5 mils (0.16 mm).

3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.

6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Width: 2 inches (50 mm).

2. Thickness: 3.7 mils (0.093 mm).

3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.

4. Elongation: 5 percent.

5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal.

B. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

1. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
2. Spindle: Aluminum, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
3. Adhesive: Recommended by hanger manufacturer. = Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

D. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

E. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

F. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

2.10 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation with tightly butted joints free of voids and gaps. Vapor barriers shall be continuous. Before installing jacket material, install vapor-barrier system.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item

of equipment, duct system, and pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Hangers and Anchors: Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [2 inches (50 mm)] [4 inches (100 mm)] o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

Q. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Handholes.

5. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).

4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).

1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Through-Penetration Firestop Systems."

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).

2. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire-rated assemblies according to Division 7 Section "Through-Penetration Firestop Systems."

3.4 DUCT AND PLENUM INSULATION INSTALLATION

A. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.

   b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

   d. Do not overcompress insulation during installation.

   e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and

surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

3.5 PIPE INSULATION INSTALLATION

A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Secure single-layer insulation with bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.

C. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with bands at 12-inch (300-mm) intervals.

D. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

E. Cover segmented insulated surfaces with a layer of insulating cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

F. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin,

install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

G. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

H. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed insulation to pipe with wire or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

4. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.

5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

I. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of same insulation material and thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

5. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

J. Insulation Installation on Pipe Fittings and Elbows:

1. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

2. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

K. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

5. Install insulation to flanges as specified for flange insulation application.

L. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

M. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

N. Special Installation Requirements for Flexible Elastomeric Insulation:

1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

2. Insulation Installation on Pipe Flanges:

a. Install pipe insulation to outer diameter of pipe flange.

b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

d. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3. Insulation Installation on Pipe Fittings and Elbows:

a. Install mitered sections of pipe insulation.

b. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.7 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating for interior concealed insulation.

B. Color: white.

C. Do not field paint aluminum jackets.

3.8 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.

C. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.

2. Indoor, exposed supply and outdoor air.

3. Indoor, concealed return located in nonconditioned space.

4. Indoor, exposed return located in nonconditioned space.

5. Outdoor, concealed supply and return.

6. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.

2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

3. Factory-insulated flexible ducts.

4. Factory-insulated plenums and casings.

5. Flexible connectors.

6. Vibration-control devices.

7. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed Supply-Air and Outside Air Duct and Plenum Insulation: Mineral-fiber board, 1 inches (75 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density to achieve a min R value installed of R=4.3.

B. Concealed Supply-Air and Outside Air Duct and Plenum Insulation: Mineral-fiber board, 2.2 inches (75 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density to achieve a min R value installed of R=6.

3.11 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed, Supply-Air and Return Duct and Plenum Insulation: Mineral-fiber board, 4 inches (75 mm) thick and 1.5-lb/cu. ft. (24-kg/cu. m) nominal density to obtain an R Value of R=8.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Fire-suppression piping.

2. Drainage piping located in crawl spaces.

3. Below-grade piping.

4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping: Flexible elastomeric 1 inch (25 mm) thick.

B. Condensate Piping: Flexible elastomeric - 1 inch (25 mm) thick.

3.14 OUTDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping: Insulation shall be the following:

1. Flexible elastomeric, 2 inches (50 mm) thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. Painted aluminum, stucco embossed, 0.032 inch (0.81 mm) thick.

D. Ducts and Plenums, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

1. Painted Aluminum, stucco embossed with 1-1/4-inch- (32-mm-) deep corrugations, 0.040 inch (1.0 mm) thick.

E. Piping, Exposed:

1. aluminum, stucco embossed, 0.024 inch (0.61 mm)

END OF SECTION

SECTION 15081 PROCESS PIPING INSULATION

PART 1 - GENERAL

A. Description

This section includes materials and installation for insulating piping, valves, and equipment.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's catalog data and descriptive literature for the insulating and jacketing material. Show thickness of insulation and type of jacketing for each insulated pipe service in the project.

3. Submit manufacturer's installation instructions for insulation, facing, jacketing, adhesives, sealants, and paints.

PART 2 - MATERIALS

A. Fire and Smoke Hazard Ratings

Insulation, cover, and jacketing shall have composite fire and smoke hazard ratings as tested by procedure ASTM E84, NFPA 255, and UL 723 not exceeding:

1. Flame Spread: 25.

2. Smoke Developed: 50.

B. Type 3 Piping Insulation (Fiberglass) for Stainless Steel Piping

Piping insulation materials shall be Johns Manville, MICRO-LOK, Owens-Corning fiberglass ASJ/SSL-II, or equal. Insulation materials around pipefittings shall be Johns Manville Microlite, Owens-Corning unfaced fiberglass duct wrap, or equal. The insulation shall comply with NFPA 90A and 90B, Type I, Grade A and ASTM C795. Label clearly on the exterior of the insulation that it is intended for use with stainless steel. Insulation thickness (unless otherwise indicated) shall be:

Pipe Size (inches)	Insulation Thickness (inches)
2 and smaller	1
2 ½ through 3	1.5

C. Jacketing and Facing for Type 3 Insulation (Fiberglass)

1. Facing shall be foil-reinforced Kraft (FSK) or bonded white Kraft foil laminate (AP) complying with ASTM D1136.

2. Jacketing material for exposed service shall be aluminum conforming to ASTM B209, Alloys 1100 or 3003, Temper H-14, minimum 0.016 inch thick for piping and 0.032 inch thick for mechanical equipment and vessels, smooth pattern. Provide built-in isolation felt. Products: Childers "LOCK-ON" or equal.

3. Jacketing around exposed pipefittings shall be aluminum, conforming to ASTM B209, Alloys 1100 or 3003, minimum 0.024 inch thick, manufactured to conform to ASTM C450.

4. Do not use asbestos materials.

D. Insulating Cement

Insulating Cement: Ryder SC-10, Forty-Eight Insulations Super 48, or equal.

E. Insulation Protection Shields for Pipe Hangers

Provide Type 316 stainless steel protection shields (Type 40 per MSS SP-69). Shields shall extend over the bottom 180 degrees of the pipe insulation. Length shall be at least three times the pipe outside diameter. The thickness of the shield shall be sufficient such that the insulation and jacketing are not crushed or distorted when the insulated pipe is resting on the hanger.

F. Accessories

Accessories, such as adhesives, mastics, cements, and tapes, shall have the same component ratings. Use accessory products as recommended by the insulation manufacturer. All products or their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed those listed above. Any treatment of jackets or facings to impact flame and smoke safety shall be permanent. Do not use water-soluble treatments.

PART 3 - EXECUTION

A. Storage

1. Store insulation in a manner that will prevent contamination from external sources.

2. Store insulation and accessory materials in weathertight buildings. Storage buildings shall be situated and constructed so that they will not be subject to flooding. The floor shall be paved and well drained.

3. Place insulation on pallets or shoring to prevent direct contact with the ground or floor.

4. Store insulation to be used with stainless steel separate from other insulation.

B. Piping Surfaces To Be Insulated

1. Provide insulation on piping as shown in the drawings.

C. Painting and Coating

Coat insulated steel piping per Section 099000, System No. 9 before applying insulation.

D. Installation--General

1. Insulation shall be continuous through wall and ceiling openings and sleeves except where required by the FBC. Provide vapor barriers. Point cracks with insulating cement. Build up fittings to the thickness of the adjacent piping with insulating cement and finish with canvas.

2. Apply insulation only after pipes have been cleaned, flushed, hydrostatically tested, and there is no evidence of leakage.

3. Insulation and jacketing shall be continuous through pipe hangers and supports. Support horizontal and vertical pipes on hangers, supports, or riser clamps with the addition of a protection shield.

4. Provide rigid insulation inserts (calcium silicate or cellular glass) between the pipe outside diameter and the protection shield to prevent the weight of the pipe from crushing the insulation. Inserts shall be the same thickness as the pipe insulation, shall cover the bottom

180-degree arc of the pipe, and shall extend at least 2 inches beyond the protection shield. The pipe insulation jacket shall be continuous over the insulation insert or cork insert.

5. Support vertical pipes by means of riser clamps per MSS SP-69 and two protection shields covering the entire 360-degree arc of the insulation.

6. Where vertical piping is supported with riser clamps or anchors attached directly to the pipe outside diameter, insulate the riser clamps or anchors with the same material used to insulate the pipe and seal the jacket.

7. Install insulation over clean, dry surfaces with adjoining sections firmly butted together and covering all surfaces. Fill voids and holes. Seal raw edges.

8. Install insulation in a manner such that the insulation may be split, removed, and reinstalled with vapor barrier tape on strainers, caps, and unions.

9. Spread tarpaulins over equipment and uncovered pipes as protection from dirt and rubbish caused by the installation of the insulation.

10. Install insulation products in accordance with the manufacturer's recommendations.

11. Handle, transport, ship, store, and apply insulation for stainless steel piping per ASTM C929. Remove contaminants, such as ink from marking pens, tape adhesive, dirt, dust, and any other contaminants that may contain chlorides, from the stainless steel surfaces. Prevent the entrance of such contaminants onto the surface of the stainless steel during and after application of the insulation material. When insulating cements are used that will be in contact with the stainless steel surfaces, mix the cements with distilled or demineralized water. Thoroughly clean and dry the cement mixing containers. Do not use containers such as mortar boxes or empty paint or mastic pails that have previously been used with other materials.

E. Installation of Type 3 (Fiberglass) Insulation

1. Install with ends butted together. Lap seal insulation with waterproof adhesive. Do not use staples or other methods of attachment that would penetrate the vapor

barrier. Apply fitting covers with seated tacks and vapor barrier tape.

2. When multiple layers of split insulation are used, butt horizontal joints together and stagger joints. Secure with rubber insulation adhesive.

F. Installing Insulation at Flanges

Install per ASTM F683, Figure 16 or 17.

G. Labeling and Marking

Provide labels and arrows on piping and identification tags on valves per Section 15075. Attach labels and arrows to the jacketing.

END OF SECTION

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SECTION 15097 PIPE, ESCUTCHEONS AND GUARDS

PART 1 - GENERAL

A. Related Documents

The other Contract Documents complement the requirements of this Section. The General Requirements apply to the work of this Section.

B. Scope

1. Contractor shall be responsible for reviewing and complying with all local code and installation procedures.

2. Provide materials, equipment, labor and supervision necessary to install Pipe Sleeves, Escutcheons and Guards as required by the Drawings and this Section.

C. Submittals

Provide submittal data on pipe sleeves, escutcheons and guards and all specified optional equipment indicating weight, dimensions, and required clearances. Refer to Section 15050 for submittal procedures and be governed accordingly.

PART 2 - PRODUCTS

A. Sleeves

1. Sleeves passing through non-load bearing and non-fire rated walls and partitions shall be galvanized sheet steel with lock seam joints of minimum gauges as follows:

   a. For pipes 2-1/2-inches size and smaller - 24 gauge;

   b. 3-inch to 6-inch - 22 gauge;

   c. Over 6-inch - 20 gauge.

2. Sleeves passing through non-fire rated load bearing walls, concrete beams, foundations, footings and waterproof walls and floors shall be Schedule 40 galvanized steel pipe or cast iron pipe.

3. For penetrations through fire-rated floor and walls see subsection titled 'Fire Proofing' in Part 2 of this section.

4. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and to allow for free movement of pipe. Waterproof sleeves shall be of sufficient internal diameter to take pipe and waterproofing material.

5. In finished areas, where pipes are exposed, sleeves shall be terminated flush with wall, partitions and ceilings, and shall extend 1/2-inch above finished floors. Extend sleeves 1-inch above finished floors in areas likely to entrap water. Fill space between sleeves and pipe with graphite packing and caulking compound.

6. Sleeves passing through membrane waterproofing or lead safing shall be provided with 4 pound sheet lead flashing extending 12-inch beyond sleeve in all directions, flashing shall be secured and sealed to membrane or lead safe and turned down into space between pipe and sleeve, fill space between pipe and sleeve with oakum, pour lead and caulk watertight. Sleeves passing through roof shall be installed in same manner except sleeves shall extend to 8-inch above roof.

B. Escutcheons

Provide chrome plated escutcheons at each sleeved opening into finished spaces. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension. Secure escutcheons or plates to sleeve but not to insulation with set screws or other approved devices.

C. Guards

Where exposed insulated piping extends to floor, provide sheet metal guard around insulation to extend up from floor 24-inch. Guard to be galvanized sheet steel not less than 26 gauge.

D. Fire Proofing

1. All combustible pipe and fixtures not in fire-rated chases that penetrate through fire-rated floors and walls shall be sleeved and firestopped using through-penetration firestop devices and methods meeting or exceeding ASTM E814 requirements and accepted by local jurisdiction. The fire-rating of the firestop device/method to be equivalent or greater than fire-rating of the floor or wall penetrated. Cavity between pipe and sleeve to be filled with an alumina/silica bulk ceramic fiber (or equal fire safing material) and both ends to be plugged with the same fire-rating as floor/wall.

2. All non-combustible pipe and fixtures not in fire-rated chases that penetrate through fire-rated floors and walls shall be sleeved with manufactured fire-sleeve coupling or schedule 40 galvanized steel or cast iron pipe. Cavity between pipe and sleeve to be filled with alumina/silica bulk ceramic fiber (or equal fire safing material). Both ends to be sealed with plugs or 3M fire caulking 612 or approved equal to maintain rating of the walls/ceiling/ floor.

3. Other sections of this specification complement the requirements of this section.

PART 3 - EXECUTION

A. Sleeves

Install sleeves for piping passing through floors, roof, walls, concrete beams and foundations.

B. Escutcheons

1. Install escutcheons for pipes entering finished spaces.

2. Seal all penetrations through walls, ceilings and floors to prevent water from entering walls, ceilings or floors.

END OF SECTION

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SECTION 15100 MANUAL, CHECK, AND PROCESS VALVES

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of manually operated valves, check valves, and process valves including gate, knife gate, butterfly, ball, hose bibbs, fire hydrant, angle, eccentric plug, check, solenoid, pet cocks, and mud valves.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit manufacturer's catalog data and detail construction sheets showing all valve parts. Describe each part by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Identify each valve by tag number to which the catalog data and detail sheets pertain.

3. Show valve dimensions including laying lengths. Show port sizes. Show dimensions and orientation of valve actuators, as installed on the valves. Show location of internal stops for gear actuators. State differential pressure and fluid velocity used to size actuators. For worm-gear actuators, state the radius of the gear sector in contact with the worm and state the handwheel diameter.

4. Show valve linings and coatings. Submit manufacturer's catalog data and descriptive literature.

5. Submit six copies of a report verifying that the valve interior linings and exterior coatings have been tested for holidays and lining thickness. Describe test results and repair procedures for each valve. Do not ship valves to project site until the reports have been returned by the Owner's Representative and marked "Resubmittal not required."

6. For butterfly and eccentric plug valves, show the clear diameter or size of the port. Show the actual area of the port as a percentage of the area as calculated for the nominal valve size.

C. Proof of Design Test for Eccentric Plug Valves (Types 500, 510, 520)

1. The Contractor shall require the valve manufacturer to furnish six certified copies of reports covering the design tests for the eccentric plug valves as described in AWWA C517 and the following. One prototype valve of each size and class of a manufacturer's design shall be tested for leakage at the specified design pressure and hydrostatically tested with twice the specified design pressure. The hydrostatic test shall be performed with the plug in the open position. The leakage test shall be performed with the plug in the closed position. The duration of each test shall be 10 minutes minimum. During the leakage test, there shall be no indication of leakage past the valve plug. Valves specified to have bi-directional seats shall be leak tight in both directions. In the case of flanged valves, the valve body shall be bolted to a flanged test head.

2. No part of the valve or plug shall be permanently deformed by the hydrostatic test. During the hydrostatic test, there shall be no leakage through the metal, the end joints, or the shaft seal.

3. It is the intent that the valve manufacturer provide evidence of the adequacy of each type offered to perform under design pressures within the applicable rating for a sufficient number of test cycles simulating a full service life. The adequacy is to be proven by tests, made on one or more valves selected to represent each basic type of seat design of a size within each applicable group, in a pressure class or classes equal to or greater than that specified. The required number of test cycles appears in the following table:

TEST CYCLES REQUIRED		
Size Group (inches)	**No. of Cycles**	**Minimum Differential Pressure (psig)**
3 to 20	10,000	150
24 to 42	5,000	150

Every test cycle shall consist of applying the specified differential pressure to the plug in the closed position, then opening the plug (which will relieve the pressure) to the wide-open position and then closing the plug.

4. The valve shall be leak tight under the specified pressure differential upon completion of the cycle test without having to stop during the test to repair the valve, modify or reinforce the seat, or install shims or wedges around the seat.

5. The plug shall not be rotated past the center position to jam the plug onto the seat during the hydrostatic test, the leakage test, or the cycle test.

PART 2 - MATERIALS

A. General

1. Valves are identified in the drawings by size and type number. For example, a callout in the drawings of 2V310 refers to 2-inch Type 310 valve in these specifications, which is a 2-inch double union PVC ball valve.

2. In addition, valves are further described by a suffix letter on the type number:

Suffix Letter	Description
L	Limit switches at the fully open and/or fully closed positions
M	Motorized actuator per Section 15119

3. Install valves complete with operating handwheels or levers, chainwheels, extension stems, floor stands, gear actuators, operating nuts, chains, and wrenches required for operation.

4. Valves shall have the name of the manufacturer and the size of the valve cast or molded onto the valve body or bonnet or shown on a permanently attached plate.

5. For buried locations, valves with mechanical joint ends may be substituted for the flanged ends specified provided the mechanical joint ends are compatible with the pipe ends.

B. Valve Actuators

1. Provide lever or wrench actuators for exposed valves 6 inches and smaller. For larger valves, provide handwheels.

2. Where manually operated valves (size 4 inches and larger) are installed with their centerlines more than 6 feet 9 inches above the floor, provide chainwheel and guide actuators.

3. Provide 2-inch AWWA operating nuts for buried and submerged valves. Provide 2-inch AWWA operating nuts with the handwheels for manually actuated valves 12 inches and larger for use with a portable electric valve actuator.

4. Provide enclosed gear actuators on butterfly, ball, and plug valves 6 inches and larger, unless electric valve actuators are shown in the drawings. Gear actuators for valves 12 inches and larger shall be of the worm and gear types. Gear actuators for motorized valves shall be of the worm and gear type, regardless of size.

5. Design gear actuators assuming that the differential pressure across the plug or disc is equal to the test pressure of the connecting piping unless otherwise required in the detailed valve specifications.

6. Gear actuators shall be enclosed, oil lubricated, with seals provided on shafts to prevent entry of dirt and water into the actuator. Gear actuators for valves located above ground or in vaults and structures shall have handwheels. The actuators for valves in exposed service shall contain a dial indicating the position of the valve disc or plug. Gear actuators for buried or submerged valves shall have 2-inch-square AWWA operating nuts.

7. For buried or submerged service, provide watertight shaft seals and watertight valve and actuator cover gaskets. Provide totally enclosed actuators designed for buried or submerged service.

8. Traveling nut and worm and gear actuators shall be of the totally enclosed design so proportioned as to permit operation of the valve under full differential pressure rating of the valve with a maximum pull of 80 pounds on the handwheel or crank. Provide stop limiting devices in the actuators in the open and closed positions. Actuators shall be of the self-locking type to prevent the disc or plug from creeping. Design actuator components between the input and the stop-limiting devices to withstand without damage a pull of 200 pounds for handwheel or chainwheel actuators and an input

torque of 300 foot-pounds for operating nuts when operating against the stops.

9. Handwheel diameters for traveling nut actuators shall not exceed 8 inches for valves 12 inches and smaller and shall not exceed 12 inches for valves 20 inches and smaller.

10. Self-locking worm gear shall be a one-piece design of gear bronze material (ASTM B427; or ASTM B84, Alloy C86200), accurately machine cut. Actuators for eccentric and lubricated plug valves may use ductile-iron gears provided the gearing is totally enclosed with spring-loaded rubber lip seals on the shafts. The worm shall be hardened alloy steel (ASTM A322, Grade G41500 or G41400; or ASTM A148, Grade 105-85), with thread ground and polished. Support worm-gear shaft at each end by ball or tapered roller bearings. The reduction gearing shall run in a proper lubricant. The handwheel diameter shall be no more than twice the radius of the gear sector in contact with the worm. Worm-gear actuators shall be Limitorque Model HBC, EIM Series W, or equal.

11. Design actuators on buried valves to produce the required torque on the operating nut with a maximum input of 150 foot-pounds.

12. Valve actuators, handwheels, or levers shall open by turning counterclockwise.

C. Portable Valve Actuator

1. Provide two portable actuators for the project. The actuator shall be suitable for manual operation of valves 24 inches and larger. Actuator shall be electrically powered, 120 volts a-c. Provide 2-inch AWWA socket. Peak torque shall be at least 800 foot-pounds. Provide the following controls:

   a. Two-speed gearbox: low speed/high torque, high speed/low torque.

   b. Overload reset button.

   c. On/off, forward/reverse, and neutral.

   d. Ground fault interrupter with test and reset.

2. Products: E. H. Wachs Company "Pow-R-Drive II" or equal.

a. The two portable actuators included within the project shall be the following two models or approved equals; the E. H. Wachs Company Handheld Valve Exerciser (WAVE) and E. H. Wachs Company RS-2.

D. Cast-Iron Valve Boxes With Debris Caps for Buried Valves

1. Valve boxes shall be two-piece sliding type, cast iron, with extension shafts. Units shall be as manufactured by Bingham/Taylor Foundry, Russco/Sigma, Star Pipe Products, or equal. Extension pipes shall be cast iron.

2. Debris cap shall be comprised of a hollow member having a cylindrical outer surface, a closure for one end, and three resilient contact pads projecting from the outer surface. Stainless steel springs under each contact pad shall hold the debris cap in position against the interior of the extension pipe or valve box. Provide handle to allow the contact pads to be extended and retracted. The cap shall have a flexible skirt providing an outward seal preventing debris from passing the cap. The cap shall withstand, without slipping, a minimum vertical force of 50 pounds when the contact pads are extended against the wall of the extension pipe or valve box. The cap shall be made of molded ABS plastic material. Color of handle shall be indicated by the Owner. The cap shall have retaining prongs to retain a copper locating wire coil. Provide locking mechanism to accept a lock furnished by the Owner. Manufacturer: Bingham/Taylor Foundry, Russco/Sigma, Star Pipe Products, or equal.

3. Coat buried cast-iron pieces per Section 09900, System No. 21 or with fusion-bonded epoxy per Section 09961.

E. Indicator Posts

Indicator posts for buried gate valves in fire protection service shall be UL listed, FM approved for use on valves of sizes 4 through 12 inches. Provide a target or sign visible through a window on both sides of the post that indicates the open or shut position of the gate valve. Working parts shall be fully enclosed for weather protection. Body shall be cast or ductile iron. Provide post extension if trench is deeper than can be served by manufacturer's standard post. Coat buried portion of indicator posts per Section 09900, System No. 21. Products: Nibco NIP-1, Stockham Fig. G-951, or equal.

F. Extension Stems for Buried and Submerged Valve Actuators

1. Where the depth of the valve is such that its centerline is more than 4 feet below grade, provide operating extension stems to bring the operating nut to a point 6 inches below the surface of the ground and/or box cover. Where the valve is submerged, provide operating extension stems to bring the operating nut to 6 inches above the high water level surface. Extension stems shall be steel, solid core, and shall be complete with 2-inch-square operating nut. The connections of the extension stems to the operating nuts and to the valves shall withstand without damage a pull of 300 foot-pounds.

2. Extension stem diameters shall be as tabulated below:

Valve Size (inches)	**Minimum Extension Stem Diameter (inches)**
2	3/4
3, 4	7/8
6	1
8	1-1/8
10, 12	1-1/4
14	1-3/8
16, 18	1-1/2
20, 24, 30, 36	1-3/4
42, 48, 54	2

G. Floor Stands, Extension Stems, and Extension Stem Support Brackets

1. When required by the installations, provide floor stands and extension stems for operation of valves. Floor stands shall be of the nonrising stem, indicating type, complete with steel extension stems, couplings, handwheels, stem guide brackets, and special yoke attachments as required by the valves and recommended and supplied by the stand manufacturer. Floor stands shall be cast-iron base type: Clow, Figure F-5515; Bingham and Taylor; Stockham; or equal. Handwheels shall turn counterclockwise to open the valves.

2. Provide Type 316 stainless steel anchor bolts.

3. Provide Type 316 stainless steel extension stems for valves in exposed service. Provide Type 316 stainless steel stems for valves in submerged service.

4. Provide adjustable stem guide brackets for extension stems. The bracket shall allow valve stems to be set over a range of 2 to 36 inches from walls. Provide bushings drilled to accept up to 2-inch-diameter stems. Base, arm, and clamp shall be Type 316 stainless steel. Coat ductile iron components with fusion-bonded epoxy per Section 09961. Bushing shall be bronze (ASTM B584, Alloy C86400 or C83600). Bolts, nuts, screws, and washers (including wall anchor bolts) shall be Type 316 stainless steel. Provide slots in the bracket to accept 3/4-inch bolts for mounting the bracket to the wall. Products: Trumbull Industries, Inc., Adjustable Stem Guide or equal.

H. Chainwheels and Guides

Chainwheels and guides shall be Clow Figure F-5680, DeZurik Series W or LWG, Stockham, or equal. Chainwheels and guides shall be galvanized iron or steel. Chains shall extend to within 4 feet of the operating floor. Chains shall be Type 316 stainless steel.

I. Valve Tagging and Identification

Provide identifying valve tags per Section 15075.

J. Bolts and Nuts for Flanged Valves

Bolts and nuts for flanged valves shall be as described in Section 15050.

K. Gaskets for Flanges

Gaskets for flanged end valves shall be as described in Section 15050.

L. Limit Switches for Check Valves

Provide oiltight position limit switches for indication of open position of check valves. Provide single-pole double-throw contacts rated for 3 amperes break, minimum, at 120-volt a-c, 35% power factor. Provide an adjustable mounting bracket to permit the actuation point to be field adjustable at any point of the valve’s travel. Switch to be Square D, Allen-Bradley, or equal.

M. Painting and Coating

1. Coat metal valves located above ground or in vaults and structures the same as the adjacent piping. If the adjacent piping is not coated, then coat valves per Section 09900, System No. 10. Apply the specified prime and intermediate coat at the place of manufacture. Finish coat shall match the color of the adjacent piping. Coat handwheels the same as the valves.

2. Coat buried metal valves at the place of manufacture per Section 09900, System No. 21.

3. Coat submerged metal valves, stem guides, extension stems, and bonnets at the place of manufacture per Section 09900, System No. 7.

4. Line the interior metal parts of metal valves 4 inches and larger, excluding seating areas and bronze and stainless steel pieces, per Section 09900, System No. 7. Apply lining at the place of manufacture.

5. Coat floor stands per Section 09900, System No. 19.

6. Test the valve interior linings and exterior coatings at the factory with a low-voltage (22.5 to 80 volts, with approximately 80,000-ohm resistance) holiday detector, using a sponge saturated with a 0.5% sodium chloride solution. The lining shall be holiday free.

7. Measure the thickness of the valve interior linings per Section 09900. Repair areas having insufficient film thickness per Section 09900.

N. Packing, O-Rings, and Gaskets

Unless otherwise stated in the detailed valve specifications, packing, O-rings, and gaskets shall be one of the following nonasbestos materials:

1. Teflon.

2. Kevlar aramid fiber.

3. Acrylic or aramid fiber bound by nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal.

4. Buna-N (nitrile).

O. Rubber Seats

Rubber seats shall be made of a rubber compound that is resistant to free chlorine and monochloramine concentrations up to 10 mg/l in the fluid conveyed.

P. Valves

1. Gate Valves:

a. Type 100--Aboveground Bronze Gate Valves 3 Inches and Smaller:

Aboveground threaded end gate valves, 1/4 inch through 3 inches, for water and air service shall be rising stem, screwed bonnet, solid wedge disc type, Class 125, having a minimum working pressure of 200 WOG psi at a temperature of 150°F. Ends shall be female threaded, ASME B1.20.1. Materials of construction shall be as follows:

Component	Material	Specification
Body and bonnet	Bronze	ASTM B61 or B62
Disc	Bronze	ASTM B61, B62, or B584 (Alloy C97600)
Stem	Bronze or copper silicon	B99 (Alloy 651), B584 (Alloy C87600), B371 (Alloy C69400)
Seat rings (Classes 200 and 300 only)	Stainless steel	AISI Type 410

Handwheels shall be aluminum, brass, or malleable iron. Packing shall be Teflon or Kevlar aramid fiber. Valves shall be American Flow Control Series 2500, Clow Series F-6100, Mueller Series A2360 or equal.

b. Type 120--2- and 3-Inch Cast-Iron Buried Gate Valves:

Buried gate valves of sizes 2 inches through 3 inches for water service shall be iron body, bronze mounted, nonrising stem type, double disc, parallel seat, and shall have a working pressure of at least

200 psi. Valves shall have flanged, PVC, or threaded ends to match the pipe ends. Valves shall have a 2-inch AWWA operating nut. Materials of construction shall be as follows:

Component	Material	Specification
Body, bonnet, operating nut, and stuffing box	Cast iron	ASTM A126, Class B or C
Bonnet bolts and stuffing box bolts	Stainless steel	ASTM A193, Grade B8M
Discs and seat ring	Bronze or cast iron	ASTM B62 or ASTM A126, Class B or C
Disc nut and disc ring	Bronze or copper alloy	ASTM B62 or ASTM B584
O-ring	Synthetic rubber	
Stem	Copper silicon	ASTM B584, Alloy C87600,

Valves shall be Clow Series F-5070, Mueller Model 71 or equal.

c. Type 130--Cast-Iron Gate Valves 4 Inches and Larger:

Valves shall conform to AWWA C500 and the following. Valves shall be iron bodied, bolted bonnet, nonrising stem, solid bronze internal working parts, parallel faced, bottom wedging double-discs, and O-ring seals. Discs shall be solid bronze. Bronze for internal working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 (85-5-5-5) or ASTM B584 (Alloy C83600), except that stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10% elongation in 2 inches (ASTM B584, Alloy C87600). Body bolts shall be Type 316 stainless steel, ASTM A276. End connections for exposed valves shall be flanged. End connections for buried valves shall be push-on type to match the connecting pipe material. Valves shall be Mueller Series A-2361, American Flow Control Series 2500, Clow Series F-6100, or equal.

d. Type 135--Cast-Iron Tapping Gate Valves 3 Through 12 Inches:

Valves shall conform to AWWA C500 and the following. Valves shall be iron bodied, bolted bonnet, nonrising stem, solid bronze internal working parts, parallel faced, bottom wedging double-discs, and O-ring seals. Discs shall be solid bronze. Bronze for internal working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 or ASTM B584 (Alloy C83600), except that stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10% elongation in 2 inches (ASTM B584, Alloy C87600). Body bolts shall be Type 316 stainless steel, ASTM A276. Ends shall be flanged, Class 125, ASME B16.1. One end shall have slotted bolt holes to fit tapping machines. Seat rings shall be oversized to permit the use of full size cutter. Valves shall be Mueller Series A-2360, Kennedy Model 8950SS, AVK Series 25, or equal.

e. Type 137--Ductile-Iron Resilient Wedge Tapping Gate Valves 4 Inches Through 48 Inches (AWWA C515):

Valves shall comply with AWWA C515 and the following. Valves shall be of the bolted bonnet type with nonrising stems. Valve stems shall be Type 304 or 316 stainless steel or cast, forged, or rolled bronze. Stem nuts shall be made of solid bronze. Bronze for internal working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 or ASTM B584 (Alloy C83600), except the stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10% elongation in 2 inches (ASTM B584 or B763, Alloy C87600 or C99500). Body bolts shall be Type 316 stainless steel. Ends shall be flanged, Class 125, ASME B16.1. One end shall have slotted bolt holes per AWWA C515, paragraph 4.4.1.3.4 to fit tapping machines.

Provide reduction thrust bearings above the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in stem above thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets.

Valves shall be lined and coated at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Minimum epoxy thickness shall be 8 mils.

Manufacturers: Clow, AVK, American Flow Control, Mueller, Kennedy, or equal.

f. Type 175--Buried Cast-Iron Gate Valves 4 Inches and Larger for Fire Protection Service:

Gate valves of sizes 4 inches through 12 inches for fire protection service shall be UL listed, FM approved, nonrising stem for use with indicator posts, solid wedge disc, bolted bonnet, with indicator post flange. Valves shall be rated for at least 175 psi, nonshock cold water. Ends shall be mechanical joint. Materials of construction shall be as follows:

Component	Material	Specification
Body, bonnet, disc, and indicator post flange	Cast iron	ASTM A126, Class B
Disc bushing, disc ring, backseat bushing, and seat ring	Bronze	ASTM B62 or ASTM B584 (Alloy C83600)
Stem	Copper silicon or brass	ASTM B21 or ASTM B584 or ASTM B763 (Alloys C87600, C99500)

Valves shall be Stockham G-632 or G-634, Nibco F-609, Clow F-6100 or F-6102, or equal.

g. Type 180—Cast-Iron Resilient Wedge Gate Valves 3 Inches Through 20 Inches (AWWA C509):

Valves shall comply with AWWA C509 and the following. Valves shall be of the bolted-bonnet type with nonrising stems. Valve stems shall be Type 304 or 316 stainless steel or cast, forged, or rolled bronze. Provide operating nut for buried valves. Provide handwheel for exposed valves. Stem nuts shall be made of solid bronze. Bronze for internal

working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 or ASTM B584 (Alloy C83600), except the stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10% elongation in 2 inches (ASTM B584 or B763, Alloy C87600 or C99500). Body bolts shall be Type 316 stainless steel. End connections for exposed valves shall be flanged. End connections for buried valves shall be mechanical joint or push-on type.

Provide reduction thrust bearings above the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in stem above thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets.

Valves shall be lined and coated at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Minimum epoxy thickness shall be 8 mils.

Manufacturers: Mueller Series A-2361, American Flow Control Series 2500, Clow Series F-6100, or equal.

Type 185 valves may be substituted for Type 180 valves.

h. Type 185—Ductile-Iron Resilient Wedge Gate Valves 2 Inches Through 36 Inches (AWWA C515):

Valves shall comply with AWWA C515 and the following. Valves shall be of the bolted-bonnet type with nonrising stems. Valve stems shall be Type 304 or 316 stainless steel or cast, forged, or rolled bronze. Provide operating nut for buried valves. Provide handwheel for exposed valves. Stem nuts shall be made of solid bronze. Bronze for internal working parts, including stems, shall not contain more than 2% aluminum nor more than 7% zinc. Bronze shall conform to ASTM B62 or ASTM B584 (Alloy C83600), except the stem bronze shall have a minimum tensile strength of 60,000 psi, a minimum yield strength of 30,000 psi, and a minimum of 10% elongation in 2 inches (ASTM B584 or B763, Alloy C87600 or C99500). Body bolts shall be Type 316 stainless steel. End connections for exposed valves

shall be flanged. End connections for buried valves shall be mechanical joint or push-on type.

Provide reduction thrust bearings above the stem collar. Stuffing boxes shall be O-ring seal type with two rings located in stem above thrust collar. Each valve shall have a smooth unobstructed waterway free from any sediment pockets.

Valves shall be lined and coated at the place of manufacture with either fusion-bonded epoxy or heat-cured liquid epoxy. Minimum epoxy thickness shall be 8 mils.

Manufacturers: Clow, AVK, American Flow Control, Mueller, Kennedy, or equal.

2. Knife Gate Valves:

a. Type 195--Stainless Steel Knife Gate Valves 2 Inches Through 24 Inches:

Knife gate valves shall be of the solid one-piece cast body design. Minimum working pressure shall be 150 psi. Provide bevel gear actuators for valves 14 inches and larger. Materials of construction shall be as follows:

Component	Material	Specification
Body	Stainless steel	ASTM A743, Grade CF8M
Yoke, superstructure, fasteners, and packing gland	Stainless steel	AISI Type 304 or 316 stainless steel
Gate	Stainless steel	ASTM A240, Type 316
Stem	Stainless steel	ASTM A582, Grade S20300
Handwheel	Cast iron	ASTM A126, Class B
Packing	Flax or acrylic PTFE	--

Valves shall be bonnetless, wafer type with through bolting flange, for installation between two adjacent flanges. Flange holes in the body shall be Class 125, ASME B16.1. Valve leakage shall be in

accordance with MSS SP-81. Valves shall have a resilient seat (neoprene or nitrile) for drip-tight shutoff. Valves shall be DeZurik Series KGS, ITT Fabri-Valve Model C67S, or equal.

3. Butterfly Valves:

a. Thrust Bearings for Butterfly Valves (Types 200 and 210):

Provide thrust bearings to hold the valve disc in the center of the valve seat. No bearings shall be mounted inside the valve body within the waterway. Do not use thrust bearings in which a metal bearing surface on the disc rubs in contact with an opposing metal surface on the inside of the body.

b. Bronze Components in Butterfly Valves (Types 200 and 210):

Bronze components in contact with water shall comply with the following requirements:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

c. Actuator Sizing for Butterfly Valves (Types 200 and 210):

Actuators shall be sized to produce valve shaft output torques equivalent to at least 75% of the torsional shear stress of the minimum required shaft diameters.

d. Port Sizes for Butterfly Valves (Types 200 and 210):

For valves 24 inches and smaller, the actual port diameter shall be at least 93% of the nominal valve size. For valves larger than 24 inches, the port diameter shall not be more than 1.25 inches smaller than the nominal valve size. The dimension of the port diameter shall be the clear waterway diameter plus the thickness of the rubber seat.

e. Corrosion-Resistant Materials in Butterfly Valves (Types 200 and 210):

Where AWWA C504 requires “corrosion resistant” material, such material shall be one of the following:

(1) Bronze as described above.

(2) Type 304 or 316 stainless steel.

(3) Monel (UNS N04400).

(4) Synthetic nonmetallic material.

f. Seating Surfaces in Butterfly Valves (Types 200 and 210):

Seating surfaces in valves having motorized actuators shall be stainless steel or nickel-copper per AWWA C504 or nickel-chromium alloy containing a minimum of 72% nickel and a minimum of 14% chromium.

g. Factory Leakage Testing (Types 200 and 210):

Perform factory leakage tests per AWWA C504 on both sides of the seat.

h. Type 200--Flanged, Rubber-Seated Butterfly Valves 4 Through 72 Inches, Class 150B:

Butterfly valves shall be short body, flanged type for exposed valves and valves in vaults or structures, and either flanged or mechanical joint for buried valves. Valve shall conform to AWWA C504, Class 150B. Minimum working differential pressure across the valve disc shall be 150 psi. Flanged ends shall be Class 125, ASME B16.1. Valve shafts shall be stub shaft or one-piece units extending completely through the valve disc. Materials of construction shall be as follows:

Component	Material	Specification
Body	Cast iron or ductile iron	AWWA C504
Exposed body capscrews and bolts and nuts	Stainless steel	ASTM A276, Type 304 or 316
Discs	Cast iron, ductile iron, or Ni-Resist	AWWA C504
Shafts, disc fasteners, seat retention segments, and seat fastening devices	Stainless steel	ASTM A276, Type 304 or 316
Seat material	Viton rated to 250°F	--

Where the rubber seat is applied to the disc, it shall be bonded to a stainless steel seat retaining ring which is clamped to the disc by Type 304 or 316 stainless steel screw fasteners or secured to a stainless steel seat by a combination of cap screws, a serrated disc retaining ring, and molded shoulders in the seat mating with machined registers in the disc. The rubber valve seat shall be secured to or retained in the valve body. Valves shall be Clow Series 4500, DeZurik Series BAW, M&H Series 4500, or equal.

i. Type 210--Flanged, Rubber-Seated Butterfly Valves 4 Through 72 Inches, Class 75A:

Butterfly valves shall be short body, flanged type, conforming to AWWA C504, Class 75A or 75B. Minimum working differential pressure across the valve disc shall be 75 psi. Flanged ends shall be Class 125, ASME B16.1. Valve shafts shall be stub shaft or one-piece units extending completely through the valve disc. Materials of construction shall be as follows:

Component	Material	Specification
Body	Cast iron or ductile iron	AWWA C504
Exposed body capscrews and bolts and nuts	Stainless steel	ASTM A276, Type 304 or 316
Discs	Cast iron, ductile iron, or Ni-Resist	AWWA C504
Shafts, disc fasteners, seat retention segments, and seat fastening devices	Stainless steel	ASTM A276, Type 304 or 316
Seat material	Viton rated to 250°F	--

The rubber valve seat shall be secured to or retained in the valve body. Valves shall be Clow Series 4500, DeZurik Series BAW, M&H Series 4500, or equal.

4. Ball Valves:

   a. Type 300--Threaded Bronze Ball Valves 3 Inches and Smaller:

      Ball valves, 2 inches and smaller, for air or water service shall have bronze (ASTM B62 or ASTM B584, Alloy C83600 or C84400) body and plug ball retainer. Ball and stem shall be bronze (as specified for the body) or Type 316 stainless steel. Provide chrome-plated ball, if ball is bronze. Valves shall have screwed ends (ASME B1.20.1), nonblowout stems, reinforced Teflon seats, and have plastic-coated lever operators. Valves shall have a pressure rating of at least 600 psi WOG at a temperature of 150°F. Valves shall be Stockham S-206, Apollo 77-100 Series, or equal.

   b. Type 305--Flanged Bronze Ball Valves, Class 150, 4 Inches and Smaller:

      Ball valves 4 inches and smaller shall have a minimum pressure rating of 200 psi at a temperature of 150°F. Valve body shall be aluminum bronze (ASTM

B148, Alloy C95400) or bronze (ASTM B62 or ASTM B584, Alloy C83600). Ball and stem shall be Type 316 stainless steel or bronze (ASTM B21, Alloy C48500). Seat and seals shall be Teflon. Ends shall be flanged, flat faced ASME B16.5, Class 150. Valves shall be Neles-Jamesbury Style 5150, McCanna Series S151-BR, or equal.

c. Type 310--Double Union PVC Ball Valves 3 Inches and Smaller:

Thermoplastic ball valves, 3 inches and smaller, for water and chemical service shall be rated at a pressure of 150 psi at a temperature of 105°F. Body, ball, and stem shall be PVC conforming to ASTM D1784, Type 1, Grade 1. Seats shall be Teflon. O-ring seals shall be Viton. Valve ends shall be of the double-union design. Ends shall be socket welded except where threaded or flanged-end valves are specifically shown in the drawings. Valves shall have handle for manual operation. Valves shall be as manufactured by Chemtrol, Hayward, R & G Sloan, Spears Manufacturing Company, Plast-O-Matic, or equal.

d. Type 316--Double Union CPVC Ball Valves 3 Inches and Smaller with Vented Ball:

Vented CPVC ball valves, 3 inches and smaller, for chemical service shall be rated at a pressure of 150 psi at a temperature of 105°F and rated at a pressure of 85 psi at a temperature of 140°F. Provide machined vent hole, deburred, in the ball to allow gases to vent. Body, ball, and stem shall be CPVC conforming to ASTM D1784, Type 4, Grade 1. Seats shall be Teflon. O-ring seals shall be Viton. Valve ends shall be of the double-union design. Ends shall be socket welded except where threaded or flanged-end valves are specifically shown in the drawings. Valves shall have handle for manual operation. Valves shall be Plast-O-Matic “Z-MBV-Vent,” Asahi/America Type 21, or equal.

e. Type 320--Regular Port Threaded Stainless Steel Ball Valves 2 Inches and Smaller:

Stainless steel ball valves, 2 inches and smaller, for water service shall be rated at a minimum pressure of 1,500 psi WOG at a temperature of 100°F.

Valve body, ball, and stem shall be Type 316 stainless steel, ASTM A276 or A351. Seat and seals shall be reinforced Teflon. Valves shall have lever actuators, plastic coated. Valves shall have screwed ends (ASME B1.20.1) and nonblowout stems. Valves shall be McCanna Figure M402, Worcester Series 48, Stockham Figure SD 2120-SSMO-R-T, Apollo 76-100 Series, or equal.

f. Type 322--Nut-and-Ferrule Stainless Steel Ball Valves (Straight Pattern), 3/4 Inch and Smaller:

Stainless steel ball valves, 3/4 inch and smaller, for water and chemical service shall be straight pattern and rated at a minimum pressure of 2,500 psi at a temperature of 150°F. Adjust valves for an operating pressure of 200 psi at a temperature of 70°F. Valve body, ball, stem, side rings, disc rings, and packing bolt shall be Type 316 stainless steel (ASTM A276, A351, or A479). Upper and lower packing shall be Teflon. Provide lever actuators with plastic handle. Provide end connections of the nut-and-ferrule type for connection to tubing. Products: Whitey Series 40 or equal.

g. Type 330--Regular Port Threaded Carbon Steel Ball Valves 2 Inches and Smaller:

Carbon steel ball valves, 2 inches and smaller, shall be rated at a minimum pressure of 1,500 psi WOG at a temperature of 100°F. Valve body shall be carbon steel, ASTM A216, Grade WCB. Ball shall be Type 316 stainless steel or carbon steel, chrome or nickel-plated. Seat and seals shall be reinforced Teflon. Valves shall have lever handle, plastic coated. Valves shall have screwed ends (ASME B1.20.1) and nonblowout stems. Valves shall be McCanna M402, Worcester Series 48, Stockham SD 2120-CS, Apollo 73-100 Series, or equal.

h. Type 340--Flanged Ductile-Iron Ball Valves 4 Inches and Smaller, Class 125:

Ball valves 4 inches and smaller shall be rated at a pressure of 200 psi at a temperature of 300°F. Valve body shall be ductile iron (ASTM A395 or A536). Ball, stem, and compression ring shall be Type 316 stainless steel. Seat and seals shall be Teflon. Provide seats both upstream and downstream of the

ball. Ends shall be flanged, ASME B16.1, Class 125. Valves shall be Neles-Jamesbury Style 5150, McCanna Series S151, Worcester Series 51, or equal.

5. Globe Valves, Angle Hose Valves, Hose Bibbs, and Fire Hydrants:

   a. Type 400—Bronze Globe Valves 2 Inches and Smaller:

      Globe valves, 2 inches and smaller, shall be all bronze (ASTM B62 or ASTM B584, Alloy C83600) with screwed ends, union bonnet, inside screw, rising stem, and composition or PTFE disc. Valves shall have a pressure rating of at least 300 psi at a temperature of 150°F. Stem shall be bronze: ASTM B371 (Alloy C69400), ASTM B99 (Alloy C65100), or ASTM B584 (Alloy C87600). Valves shall be Crane No. 7TF, Walworth Figure 3095, Stockham B-22T, or equal.

   b. Type 410--Bronze Angle Hose Valves:

      Angle-type hose valves of sizes 1-1/2 inches and 2-1/2 inches shall be brass or bronze (ASTM B62 or ASTM B584, Alloy C83600) body with rising or nonrising stem, composition disc, and bronze or malleable iron handwheel. Stem shall be bronze, ASTM B62, ASTM B584 (Alloy C83600), or ASTM B198 (Alloy C87600). Valves shall have a cold-water service pressure rating of at least 150 psi. Provide cap and chain with valve. Threads on the valve outlet shall be American National Standard fire hose coupling screw thread. Valves shall be Nibco T-301-HC, Powell Figure 151 with Figure 527 nipple adapter, Crane 17TF with hose nipple adapter, or equal.

   c. Type 420--Bronze Hose Bibbs:

      Hose bibbs of size 1/2 inch, 3/4 inch, and 1 inch shall be all bronze (ASTM B62 or ASTM B584, Alloy C83600) with rising or nonrising stem, composition disc, bronze or malleable iron handwheel, and bronze stem (ASTM B99, Alloy C65100; ASTM B371, Alloy C69400; or ASTM B584, Alloy C87600). Packing shall be Teflon or graphite. Valves shall have a pressure rating of at least 125 psi for cold-water service. Threads on valve outlet shall be American National Standard fire hose coupling screw thread (ASME B1.20.7). Provide atmospheric vacuum breaker conforming to the state of Florida health department on each hose bibb. Valves shall be Jenkins Figure

112, 113, or 372, Nibco Figure T-113-HC, Powell Figure 503H, or equal.

1. Type 440—Stainless Steel Globe Valves 2 Inches and Smaller:

Globe valves 2 inches and smaller shall have bodies, stems, packing nuts, glands, bonnets, union bonnet rings, discs, and disc nuts made of Type 316 stainless steel (ASTM A351, Grade CF8M; or ASTM A276). Packing shall be Teflon. Provide screwed ends (ASME B1.20.1), rising stem, and malleable iron or aluminum handwheel. Valves shall have a pressure rating of at least 150 psig at a temperature of 200°F. Valves shall be Jenkins Figure 1308, Crane/Alloyco Figure 40, or equal.

d. Type 490--Wet Barrel Fire Hydrants (AWWA C503):

See Section 15109.

6. Plug Valves:

a. Plug and Seating Design for Eccentric Plug Valves (Types 500, 510, and 520):

Eccentric plug valves shall comply with AWWA C517 and the following. Provide a rectangular or circular plug design, with an associated rectangular or round seat. Provide bidirectional seating design. The valve shall seat with the rated pressure both upstream and downstream of the closed plug. Provide geared actuators sized for bidirectional operation.

b. For Types 500, 510 and 520 eccentric plug valves, the metallic portion of the plug shall be one-piece design and shall be without external reinforcing ribs which result in there being a space between the rib and the main body of the plug through which water can pass. Valves shall be repackable without any disassembly of valve or actuator. The valve shall be capable of being repacked while under the design pressure in the open position. Nowhere in the valve or actuators shall the valve shaft be exposed to iron on iron contact. Sleeve bearings shall be stainless steel in valve sizes 20 inches and smaller and bronze or stainless steel in valve sizes 24 inches and larger. Provide enclosed worm-gear actuators for valves 6 inches and larger.

c. Rubber compounds shall have less than 2% volume increase when tested in accordance with ASTM D471 after being immersed in distilled water at a temperature of 73.4°F ±2°F for 70 hours.

d. Type 500--Eccentric Plug Valves 3 Inches and Smaller:

Eccentric plug valves, 1/2 inch through 3 inches, shall be nonlubricated type. Minimum pressure rating shall be 175 psi. Bodies shall be made of cast iron per ASTM A126, Class B. Ends shall be threaded or flanged (ASME B16.1, Class 125). Plug shall be cast iron (ASTM A126, Class B) with neoprene facing. Design plugs to seat over a pressure range of 0 to 5 psi. Body capscrews and bolts and nuts shall be Type 316 stainless steel. Packing shall be nitrile butadiene-filled Teflon. Provide 100% port area. Valves shall be DeZurik Series –PEC, Val-Matic series 5600R or series 5800 RTL, or equal.

e. Type 510--Eccentric Plug Valves 4 Inches Through 12 Inches:

Eccentric plug valves, 4 inches through 12 inches, shall be nonlubricated type. Minimum pressure rating shall be 175 psi. Bodies shall be cast iron per ASTM A126, Class B. Ends shall be flanged, Class 125 per ASME B16.1 or mechanical joint per ANSI/AWWA C111/A21.11. Plugs shall be cast iron (ASTM A126, Class B), or ductile iron (ASTM A536, Grade 65-45-12) with neoprene facing. Design plugs to seat over a pressure range of 0 to 5 psi. Valve body seats shall be Type 304 or 316 stainless steel or have a raised welded-in overlay at least 1/8-inch thick of not less than 90% nickel. Body capscrews and bolts and nuts shall be Type 316 stainless steel. Packing shall be butadiene-filled Teflon. Alternatively, U-cup seals may be provided. Provide 100% port area. Valves shall be Valves shall be DeZurik Series –PEC, Val-Matic Series 5600R or Series 5700R, Milliken Series 601, or equal.

f. Type 520--Eccentric Plug Valves 14 Inches and larger:

Eccentric plug valves, 14 inches and larger, shall be nonlubricated type. Minimum pressure rating shall be 150 psi. Bodies shall be cast iron per ASTM A126,

Class B. Ends shall be flanged, Class 125 per ASME B16.1 or mechanical joint per ANSI/AWWA C111/A21.11. Plugs shall be cast iron (ASTM A126, Class B), or ductile iron (ASTM A536, Grade 65-45-12) with neoprene facing. Design plugs to seat over a pressure range of 0 to 5 psi. Valve body seats shall be Type 304 or 316 stainless steel or have a raised welded-in overlay at least 1/8-inch thick of not less than 90% nickel. Plug shall be of the one-piece design. Body capscrews and bolts and nuts shall be Type 316 stainless steel. Packing shall be butadiene-filled Teflon. Alternatively, U-cup seals may be provided. Provide 100% port area. Valves shall be Valves shall be DeZurik Series –PEF, Val-Matic Series 5600R or Series 5700R, Milliken Series 601 or equal.

7. Check Valves:

   a. Type 720--Cast-Iron Swing Check Valves 3 Inches and Larger, Class 125:

      Swing check valves, 3 inches and larger, shall be iron body, bronze mounted with the following materials of construction:

Description	Material	Specification
Disc or clapper seat ring and valve body seat ring	Bronze or brass	ASTM B62 or B584 (Alloy C84400 or C87600)
Body and cap (bonnet)	Cast iron	ASTM A126, Class B
Disc and hinge or arm (valves 4 inches and smaller)	Bronze	ASTM B62 or ASTM B584 (Alloy C84400)
Disc and hinge or arm (valves larger than 4 inches)	Cast iron or bronze	ASTM A126, Class B; ASTM B62.
Hinge pin	Stainless steel	Type 303, 304, or 410 stainless

Description	Material	Specification
Cover bolts and nuts	Stainless steel	ASTM A193, Grade B8M; ASTM A194, Grade 8M
Internal fasteners and accessories	Bronze or Type 304 or 316 stainless steel	

Bronze or brass components in contact with water shall comply with the following requirements:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

Ends shall be flanged, Class 125, ASME B16.1. Minimum valve working pressure shall be 150 psi. Provide check valves with outside lever and spring.

The shop drawing submittal shall include a detail showing how the hinge pin extends through the valve body. Show packing gland, hinge pin gland, cap, and other pieces utilized.

Valves shall be Milliken 800, Kennedy 106, M&H Style 159, Mueller Series 2600, Clow 106, Empire 220, American Flow Control Series 600, Val-Matic Series 9800, ARI NR-040, DeZurik, or acceptable equal.

b. Type 725--Cast-Iron Swing Check Valves 2-1/2 Inches and Larger for Fire Protection Service:

Swing check valves of sizes 2-1/2 through 12 inches for fire protection service shall be UL listed, FM approved, rated for at least 175 psi nonshock, cold water. Ends shall be flanged, Class 125, ASME B16.1. Materials of construction shall be as follows:

Description	Material	Specification
Body and cap	Cast iron	ASTM A126, Class B
Disc	Bronze or cast iron	ASTM B62; ASTM B584, Alloy C83600; or ASTM A126, Class B
Disc bushing, disc ring, and seat ring	Bronze	ASTM B62, or ASTM B584 (Alloy C83600)
Hinge pin	Brass	ASTM B16 or ASTM B21

Valves shall be Stockham G-939, Walworth Fig. 8883 F, Nibco F-908, or equal.

c. Type 728—Swing Check Valves 10 Through 66 Inches With Controlled Closing Using Bottom-Mounted Hydraulic Buffer:

Controlled closing swing check valves shall be iron body with the following materials of construction:

Description	Material	Specification
Disc or clapper seat ring	Buna-N	
Valve body seat ring	Aluminum bronze	ASTM B148
Body and cap (bonnet)	Cast iron	ASTM A126, Class B
Disc and hinge or arm	Ductile iron	ASTM A536
Shaft and hinge pin	Stainless steel	Type 303, 304, or 410
Cover bolts and nuts	Stainless steel	ASTM A193, Grade B8M; ASTM A194, Grade 8M
Buffer rod	Stainless steel	ASTM A582: Type 303, 304, or 410

Ends shall be flanged, Class 125, ASME B16.1. Minimum valve working pressure shall be 150 psi. Provide check valves with outside lever and weight.

The cushion swing check valve shall conform to AWWA C508. Provide integral flanges (not wafer). The body shall have a flush and drain hole. The seat shall be locked in place with stainless steel lock screws and be field replaced without the use of special tools. The shaft shall be one piece, extending through both sides of the body with a lever and weight mounted on each side. The disc shall utilize a double clevis hinge to prevent disc tipping and be connected to a disc arm. The disc arm assembly shall be suspended from the shaft. The valve shall have a bottom hydraulic buffer to permit free open but positive nonslam control closure of the disc. The hydraulic buffer shall make contact with the disc during the last 10% of closure to instantly control the valve disc until shutoff. The last 10% of closure shall be externally adjustable and variable. The line media to the buffer must be separated by a combination pressure sensing, oil/water separator device to protect the buffer cylinder against corrosion from the main line media. The hydraulic buffer assembly shall be removable from valve without need to remove the entire valve from the pipeline.

Cylinders shall be of tie-rod or bolted-flange construction and shall have a pressure rating of 150 psi minimum, as determined by National Fluid Power Association Specification T3.6.8. Cylinder mounting dimensions shall comply with National Fluid Power Association Specification T3.6.8 regarding mounting and physical dimensions with slight modifications where required to adapt to the valve cylinder mounting. Construction materials shall incorporate a design factor of safety of 4:1 based on tensile strength.

Cylinder barrels, heads, and caps shall be AISI Type 304 or 316 stainless steel, or bronze. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

The shop drawing submittal shall include a detail showing how the hinge pin extends through the valve body. Show packing gland, hinge pin gland, cap, and other pieces utilized.

Valve shall be APCO Series 6000B or equal.

d. Type 730—PVC Ball Check Valves, 3 Inches and Smaller:

PVC check valves, 3 inches and smaller, shall be constructed of PVC per ASTM D1784, Type I, Grade 1. Ends shall be double union, socket welded. Seats and seals shall be Viton. Valve shall have a pressure rating of 150 psi at a temperature of 73°F.

e. Type 742—Slanting Disc Check Valves With Controlled Opening and Closing, Class 250:

Slanting disc check valves of sizes 16 through 20 inches shall have materials of construction as described below:

Component	Material	Specification
Body	Ductile iron	ASTM A536, Grade 65-45-12
Seat ring and disc ring	Bronze	See paragraph below
Pivot pins	Stainless steel	ASTM A582, Type 303 or 304
Bushings	Stainless steel	ASTM A269, Type 304 or 316
Oil reservoirs	Stainless steel	AISI Type 316

Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

Ends shall be flanged, ASME B16.1, Class 250. The body shall be of two-piece construction, bolted at

the center to hold the seat at angle of 55 degrees. The area throughout the valve body shall equal the full pipe area. Provide top-mounted hydraulic dashpot to control valve opening and closing. Dashpot shall have a control valve to adjust the speed of the opening and closing cycles. Time spreads shall be adjustable 5 to 30 seconds. Provide oil-fitted dashpots to operate the opening and closing arrangement. The reservoir for the opening cycle shall contain pressurized air and shall have a 3-inch pressure gauge and pneumatic fill valve. Valve shall be APCO Series 800, Val-Matic Series 9700, or equal.

f. Type 756--Duckbill-Shaped Check Valves, 1 Through 54 Inches, Class 125:

Valve shall consist of a contoured rubber body with a duckbill sleeve-type exit. The body entrance shall be round, with a connecting Class 125 ASME B16.1 rubber flange to match the connecting pipe. Material of construction of body, sleeve, and flange shall be polyurethane. Provide synthetic fabric reinforcement. Provide Type 316 stainless steel backing rings on the rubber body flanges. The valve shall open at a differential pressure of 2 inches of water column and shall close under a no-flow condition. Minimum body pressure rating shall be 50 psi. Maximum backpressure: 10 psi. Products: Red Valve Company “Tideflex” Series TF-1 or equal.

g. Type 760--Double-Door Check Valves 36 Inches, Class 125:

Double-door check valves shall conform to API 594. Valves shall be equipped with a Type 316 stainless steel spring mechanism to provide for nonslam closure of the valve without backflow, in any position, and shall not be dependent on gravity or backflow for closure. Sealing members shall be Viton suitable for a maximum pressure of 35 psi and a maximum temperature of 250°F. Bodies shall be cast iron, ASTM A 48 or A 126. Internal assemblies shall be aluminum. Ends shall be flanged, Class 125, ANSI B16.1. Valves shall be APCO Series 9000 or equal.

8. Solenoid Valves:

a. Design and construct solenoid valves such that they can be used in both horizontal and vertical piping.

b. Type 900—-Pilot-Operated, Slow Closing, Solenoid Valves 2-1/2 Inches and Smaller:

Solenoid valves of sizes 3/8 inch through 2-1/2 inches for water and air service shall have forged brass (Alloy C23000) bodies with Teflon main seats. Solenoid enclosures shall be NEMA 7. Valve actuators shall be 120-volt a-c. Valves shall have a maximum operating pressure and a maximum differential pressure of 150 psi. Solenoid valves shall be energized to open. Valves shall be provided with snubber to slow disc closing speed to protect system against water hammer damage. Valves shall be ASCO "Redhat" Model 8221, Parker Model A66, A67, A68, or equal.

Solenoid valves shall be brass (Alloy C23000) body with the following materials of construction:

Description	Material
Seals	NBR
Body	Brass (Alloy C23000)
Disc	Buna-N
Core Tube	Type 304 or 305 Stainless Steel
Core and Plugnut	Type 430F or 430FR Stainless Steel
Springs	Type 301 or 302 Stainless Steel
Piston	Stainless Steel or Brass
Shading Coil	Copper

9. Pet Cocks and Drain Cocks:

a. Type 1000--Pet Cocks 1/2 Inch and Smaller:

Pet cocks shall be all bronze (ASTM B62) or brass (ASTM B16), rated at 125 psi. Provide lever or tee handle operator. Pet cocks shall be Crane Figure 724, Lunkenheimer Figure 478 or 479, or equal.

b. Type 1010--Drain Cocks 1/2 Inch and Smaller:

Drain cocks shall be all bronze (ASTM B62) or brass (ASTM B16), rated at 125 psi. Provide lever or tee handle operator. Drain cocks shall be Crane Figure 702, Lunkenheimer Figure 476 or 980, or equal.

10. Mud Valves:

Type 1020--Mud Valves 4 Inches Through 24 Inches:

Mud valves shall be rising stem with flanged end, unless otherwise shown in the drawings. Materials of construction shall be as follows:

Component	Material	Specification
Body	Cast iron	ASTM A48 or A126
Stem, nut, disc ring, and seat ring	Bronze	ASTM B62 or B584, Alloy C83600
Extension stem	Stainless steel	AISI Type 316

Provide extension stem, stem guides, and AWWA operating nut. Mud valves shall be Clow Figure F-3088, Waterman Industries, or equal.

11. Spare Parts:

1. Provide five (5) T-handle wrenches for 2-inch nuts, as follows:

a. Two (2) 4-foot T-handle wrenches

b. Two (2) 5-foot T-handle wrenches

c. One (1) 6-foot T-handle wrench

2. Provide two (2) adjustable 4-foot to 10-foot valve wrenches for 2-inch nuts.

PART 3 - EXECUTION

A. Joints

1. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with

oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

2. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

3. Install lug-type valves with separate hex head machine bolts at each bolt hole and each flange (two bolts per valve bolt hole).

4. Install grooved-end couplings for valves in accordance with Section 15050.

B. Installing Exposed Valves

1. Unless otherwise indicated in the drawings, install valves in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the floor with their operating stems vertical. Install valves in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the floor with their operating stems horizontal.

2. Install valves on vertical runs of pipe that are next to walls with their stems horizontal, away from the wall. Valves on vertical runs of pipe that are not located next to walls shall be installed with their stems horizontal, oriented to facilitate valve operation.

C. Installing Buried Valves

1. Connect the valve, coat the flanges, apply tape wrapping or polyethylene encasement, and place and compact the backfill to the height of the valve stem.

2. Place block pads under the extension pipe to maintain the valve box vertical during backfilling and repaving and to prevent the extension pipe from contacting the valve bonnet.

3. Mount the upper slip pipe of the extension in midposition and secure with backfill around the extension pipe. Pour the concrete ring allowing a depression so the valve box cap will be flush with the pavement surface.

4. In streets without concrete curbs and in open areas, install the valve box as for a paved area with concrete curb except include a marker post. Cut the marker post from 4-inch by 4-inch dense structural grade Douglas fir No. 2 surfaced on four sides to a length of 5 feet. Chamfer the top. Set the post in concrete, 2 feet into the ground, away from traffic, and to the side of the pipeline. Coat with a seal and finish coat of white alkyd exterior paint. On the side facing the valve, letter in black the word "VALVE" and the distance in feet from the marker post to the valve box cap.

5. Install debris cap as close as possible under the cast-iron cover without interfering with the cover operation. Trim flexible skirt to provide a smooth contact with the interior or the extension pipe. Install Owner-furnished locks.

D. Field Coating Buried Valves

1. Coat flanges of buried valves and the flanges of the adjacent piping, and the bolts and nuts of flanges and mechanical joints, per Section 09900, System No. 24.

E. Installing Eccentric Plug Valves

1. Install such that the rotation of the plug is about a horizontal axis.

2. Install such that the plug stores in the top when the valve is open.

3. Orient the valve such that the seat is opposite the high-pressure side.

F. Installing Extension Stem Guide Brackets

Install at 6- to 8-foot centers. Provide at least two support brackets for stems longer than 10 feet, with one support near the bottom of the stem and one near the top.

G. Mounting Gear Actuators

The valve manufacturer shall select and mount the gear actuator and accessories on each valve and stroke the valve from fully open to fully closed prior to shipment.

H. Field Installation of Gear Actuator

Provide the actuator manufacturer's recommended lubricating oil in each actuator before commencing the field testing.

I. Valve Leakage Testing

Test both sides of valves for leakage at the same time that the connecting pipelines are tested. See Section 15144 for pressure testing requirements. Protect or isolate any parts of valves, actuators, or control and instrumentation systems whose pressure rating is less than the pressure test. Valves shall show zero leakage. Repair or replace any leaking valves and retest.

J. Valve Field Testing

1. Operate manual valves through three full cycles of opening and closing. Valves shall operate from full open to full close without sticking or binding. Do not backfill buried valves until after verifying that valves operate from full open to full closed. If valves stick or bind, or do not operate from full open to full closed, repair or replace the valve and repeat the tests.

2. Gear actuators shall operate valves from full open to full close through three cycles without binding or sticking. The pull required to operate handwheel- or chainwheel-operated valves shall not exceed 80 pounds. The torque required to operate valves having 2-inch AWWA nuts shall not exceed 150 ft-lbs. If actuators stick or bind or if pulling forces and torques exceed the values stated previously, repair or replace the actuators and repeat the tests. Operators shall be fully lubricated in accordance with the manufacturer's recommendations prior to operating.

END OF SECTION

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SECTION 15108 AIR-RELEASE AND VACUUM-RELIEF VALVES

PART 1 - GENERAL

A. Description

This section includes materials and installation of air and vacuum valves, air-release valves, combination air-release valves, water service and sewage service. These valves are designated in the drawings as Types 1200 through 1240. Two types of valves are allowed:

1. Type A: A body containing a stainless steel float with associated stainless steel lever or linkage mechanism.

2. Type B: A cylindrical body containing a series of HDPE floats having air release orifices within them.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit manufacturer's catalog data and detail drawings showing all valve parts and described by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show linings and coatings. Identify each valve by tag number to which the catalog data and detail sheets pertain.

PART 2 - MATERIALS

A. Valve Identification

Valves are identified in the drawings by size and type number. For example, a callout in the drawings of a 1-V1201 refers to a 1-inch Type 1201 valve in these specifications, which is a 1-inch 150-psi air-release valve.

B. Valve Tagging and Identification

Provide identifying valve tags per Section 15075.

C. Bolts, Nuts, and Gaskets for Flanged Valves

See Section 15050 and specification for the pipe to which the valve is attached.

D. Type A: Valve Design and Operation

1. Valve design shall comply with AWWA C512, except as modified herein. Class 150 valves shall have a maximum working pressure of at least 150 psi. Class 300 valves shall have a maximum working pressure of at least 300 psi. Class 500 valves shall have a maximum working pressure of at least 500 psi.

2. Air-Release Valves for Water Service:

   a. Air-release valves for water service 3/4 inch and smaller shall be of the direct-acting type or lever type. Valves larger than 3/4 inch shall have a float-actuated compound lever with linkage mechanism to release air.

   b. Air-release valves of sizes 1 and 2 inches shall incorporate a body with flanged top cover and replaceable orifice and a synthetic rubber needle or disc actuated by the float and linkage mechanism. Top cover shall include a 1/2-inch threaded port with bronze plug. Body shall include a 1/2-inch threaded drain port near the bottom with a bronze plug.

3. Air and Vacuum Valves for Water Service:

   a. Air and vacuum valves for water service shall have a body with a flanged top containing the air-release orifice. The float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seat.

   b. Air and vacuum valves 3 inches and smaller shall have 1/2-inch threaded ports with bronze plugs in the top cover and near the bottom of the valve body. Air and vacuum valves larger than 3 inches shall have a 1-inch threaded drain outlet with bronze plug near the bottom of the valve body and a 1-inch threaded port with bronze plug on the side of the valve body above the minimum water level in the valve which forces the float against the valve seat.

4. Combination air valves 3 inches and smaller shall have a float with lever arm to actuate a poppet valve. A needle shall be attached to the float arm. The poppet valve shall serve to admit large quantities of air when the pipeline drains. The needle shall serve to release small

quantities of air as the pipeline fills or as air accumulates in the pipeline.

5. Air and vacuum valves for vertical turbine pump service (3 inches and smaller) shall have a float assembly. The discharge orifice shall have a double-acting throttling device to restrict air venting; it shall fully open to allow unrestricted air entry when the pump is shut down. Valve shall have a body with flanged top containing the air-release orifice. The float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seat.

   a. Valves 3 inches and smaller shall include the following features:

      (1) Water diffuser around the float to break up the incoming water column before contacting the float.

      (2) Double-acting throttling device that restricts airflow when the pump is started and opens fully when the pump is stopped.

E. Type B: Valve Design and Operation

1. The air-release and vacuum-relief valve shall be of a single chamber design with solid cylindrical HDPE control floats housed in a tubular stainless steel body with epoxy powder-coated cast iron, steel, or stainless steel ends secured by means of stainless steel tie rods or by a flanged connection. The valve shall have an integral orifice mechanism that shall operate automatically to limit transient pressure rise or shock induced by closure to twice valve rated working pressure. Provide a double (small and large) orifice design.

2. The intake orifice area shall be equal to the nominal size of the valve. The large orifice sealing shall be affected by the flat face of the control float seating against a nitrile rubber O-ring housed in dovetail groove circumferentially surrounding the orifice. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal affixed into the control float. The nozzle shall have a flat seating land surrounding the orifice.

3. Provide a 1/4-inch NPT test/bleed cock.

4. Prior to the ingress of liquid into the valve chamber, as when the pipeline is being filled, valves shall vent through the large orifice. At higher water approach velocities, the valve shall automatically discharge air through the orifice mechanism and reduce water approach velocity.

5. Valve shall not exhibit leaks or weeping of liquid past the large orifice seal at operating pressures of 7 psi to twice rated working pressure.

6. Valves shall respond to the presence of air by discharging it through the small orifice at any pressures within the specified design range and shall remain leak tight in the absence of air.

7. Valves shall react immediately to pipeline drainage or water column separation by the full opening of the large orifice so as to allow unobstructed air intake at the lowest possible negative internal pipeline pressure.

F. Type A: Materials of Construction

1. Materials of construction for air-release, air and vacuum, and combination air valves for water service shall be as follows:

Item	Material	Specification
Body and cover	Cast iron	ASTM A48, Class 35; or ASTM A126, Class B
Float, lever or linkage, air-release mechanism, poppet, guide rod, guide bushings, fasteners, other internal metal parts	Stainless steel	AISI Type 316
Plugs	Bronze	-
Seat, plunger, needle	Buna-N	–

2. Rubber seats shall be made of a rubber compound that is resistant to free chlorine concentrations up to 10 mg/L in the fluid conveyed.

3. Body and cover bolts, nuts, and cap screws shall be Type 316 stainless steel.

G. Type B: Materials of Construction

1. Materials of construction for air-release valves/air and vacuum-relief valves for sewage service shall be as follows:

Item	Material	Specification
Top flange, lower flange, screen mesh, bolts, nuts, connecting screws, float screw, and assembly screws	Stainless steel	AISI Type 304
Top cover	ABS plastic	–
Barrel	Stainless steel	AISI Type 304L
Floats	HDPE	–
Air-release nozzle or orifice mechanism	Stainless steel	AISI Type 304
Nozzle seal and seat	Natural rubber	–
Nozzle seal retaining plate	Stainless steel	AISI Type 304
Tie rod assembly and support fasteners	Stainless steel	AISI Type 304
Float O-ring seals	Nitrile rubber	–

H. Seating

Valves shall seat drip tight at a pressure of 1 psi.

I. Valve End Connections

1. Valves 2 inches and smaller shall have threaded ends. Valves 3 inches and larger shall have flanged ends.

2. Flanges for Class 150 valves shall comply with ASME B16.1, Class 125. Flanges for Class 300 valves shall comply with ASME B16.1, Class 250.

3. Threaded ends shall comply with ASME B1.20.1.

J. Valves

1. Type 1201--Air-Release Valves, 1 and 2 Inches, Class 150: Valves shall have a maximum working pressure of 150

psi. Orifice size shall be 1/4 or 3/16 inch. Valves shall be APCO 200, Crispin PL10, Val-Matic VM-38/VM-45.

2. Type 1204--Air-Release Valves, 2 Inches, Class 500: Orifice size shall be 3/16 or 7/32 inch. Valves shall be APCO 205, Val-Matic Model 50, or equal.

3. Type 1207--Air and Vacuum Valves for Vertical Turbine Pump Service, 6 Inches and Smaller: Valves shall be APCO Series 140DAT or Series 1900, Val-Matic Series 100SS, Crispin Series DL-D/DBL, or equal. Valve shall incorporate an air-release valve, Type 1201. If necessary, modify valve size from that shown in the drawings for 200% of the vertical turbine pump design point flow shown in Section 11214.

4. Type 1225--Sewage Air-Release Valves, 2 Through 4 Inches, Class 150: After entraining air escapes through the orifice, the orifice shall be closed by a needle on a compound lever mechanism or by a float which buoys to close the orifice by seating against the top cover to prevent the escape of sewage. The orifice shall remain closed until more gas accumulates and the cycle automatically repeats. Valve shall seat to prevent sewage from leaking through the valve at any pressure. Valves shall have an operating pressure of at least 175 psi. Venting capacity shall be at least 100 scfm. Valves shall be Vent-O-Mat Series RGX, Model 050RGX1621.

5. Type 1230--Combination Air Valves, 1 Through 3 Inches, Class 300: Valves shall have a maximum working pressure of 300 psi. Combination Air Valves shall be APCO Series 140C, Val-Matic VM-201C-M or equal.

PART 3 - EXECUTION

A. Lining and Coating

1. Coat cast-iron valves the same as the adjacent piping. If the adjacent piping is not coated, then coat per Section 09900, System No. 10. Apply the specified prime and intermediate coats at the place of manufacture. Apply finish coats in field. Finish coat shall match the color of the adjacent piping.

2. Coat interior surfaces of cast-iron valves at the place of manufacture per Section 09900, System No. 7. Do not coat seating areas and plastic, bronze, stainless steel, or other high alloy parts.

B. Installation

1. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

2. Clean threaded joints by wire brushing or swabbing. Apply Teflon® joint compound or Teflon® tape to pipe threads before installing threaded valves. Joints shall be watertight.

3. Do not use duct tape and plastic for covering the ends of pipe flanges. Use a solid metal cover with rubber gasket to cover flange openings during installation. These metal covers shall remain in place until the piping is connected to the valves.

4. Do not spring flanges of connecting piping into position. Separately work connecting piping systems into position to bring the piping flanges into alignment with the matching valve flanges. Do not move valves to achieve piping alignment. Do not use electrical heating stress relieving to achieve piping alignment.

5. Line up pipe flange bolt holes with valve nozzle bolt holes within 1/16 inch maximum offset from the center of the bolt hole to permit insertion of bolts without applying any external force to the piping.

6. Flange face separation shall be within the gasket spacing ±1/16 inch. Use only one gasket per flanged connection.

C. Valve Pressure Testing

Test valves at the same time that the connecting pipelines are pressure tested. See Section 15144 for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure.

END OF SECTION

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SECTION 15109 FIRE HYDRANTS

PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation of wet barrel fire hydrants.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit certificate of compliance with AWWA C502.

3. Submit manufacturer's catalog data and descriptive literature. Show materials of construction. Submit dimensional drawings. Show coatings.

PART 2 - MATERIALS

A. Fire Hydrant Selection

Provide fire hydrants of the wet barrel design.

B. Wet Barrel Fire Hydrant Design

1. Fire hydrants shall comply with AWWA C503. Provide hydrant head, barrel and bury section. Barrel connecting flange shall be drilled to the dimensions of ASME B16.1, Class 125, 6-inch size, flat face.

2. Head and barrel shall be ductile iron per AWWA C503.

3. Provide two 2-1/2-inch and one 4-1/2-inch nozzles. Threads on nozzles shall conform to Orange County Fire Department Threads. Provide cap with chain on each nozzle.

4. Bury section shall be ductile iron per Section 15240.

5. Inlet Connection of Bury: mechanical joint or ductile iron push-on with rubber gaskets.

6. Provide a double-grooved break-off riser and check valve. The valve flapper shall be bronze and be housed in a recess out of the waterway.

C. Bolts and Nuts for Flanges (Wet Barrel Hydrants)

Bolts and nuts connecting the top section to the bury section shall be steel, ASTM A307, Grade B, per AWWA C503. Provide a washer for each nut. Washers shall be of the same material as the nuts.

D. Wrenches

Provide one wrench, per hydrant supplied, in order to operate the hydrants in the project.

PART 3 - EXECUTION

A. Painting and Coating

1. Coat hydrant top section and the exposed portion of the bury section per Section 09900, System No. 21. Apply prime coat at factory. Color of finish coat shall be as specified by the Owner. Apply finish coat in field.

2. Coat buried ductile iron per Section 15240.

3. If cement-mortar coated bury sections are used, hold back the mortar coating so it does not extend more than 2 inches above grade.

B. Factory Testing

Test per AWWA C502, Section 5.

C. Installation

1. Install with the face of the bottom flange of the barrel 4 to 6 inches above the adjacent ground or paving.

2. Install hydrants so that the distance from the curb face to a hydrant outlet is no less than 2 feet and no greater than 6 feet.

3. Install per details in the drawings.

END OF SECTION

SECTION 15110 GLOBE PATTERN CONTROL VALVES (AWWA C530)

PART 1 - GENERAL

A. Description

This section includes materials and installation of globe pattern (including Y-pattern globe) diaphragm-actuated control valves acting as pump control valves, pressure-reducing valves, pressure-relief valves, pressure-sustaining valves, flow control valves, and altitude control valves.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following:

2. Submit dimensional drawings for each size and type of valve provided.

3. Provide listing of materials of construction, with ASTM reference and grade. Show valve lining and paint primer coating with coating manufacturer and coating system number or designation.

4. Submit electrical drawings, showing wire and terminal connections, for valves that are electrically controlled.

5. Submit manufacturer's recommended maximum operating pressure and maximum recommended flow.

C. Manufacturers' Services

Provide equipment manufacturers' services at the jobsite for the minimum labor days listed below, travel time excluded:

One labor days to check the installation and advise during start-up, testing, and adjustment of the valves and instruct the Owner's personnel in the operation and maintenance of the valves.

PART 2 - MATERIALS

A. Valve Identification

Valves are identified in the drawings by size and type number. For example, a callout in the drawings of 8" V-1300 refers to a Type 1300 valve in these specifications, which is a Class 125 pressure-reducing valve.

B. Manufacturers

Diaphragm-actuated control valves shall be manufactured by Cla-Val Company, Newport Beach, California; Bermad, Anaheim, California; Watts Automatic Control Valve, Houston, Texas.

C. Valve Design--Diaphragm Actuated

1. Valves shall be hydraulically actuated diaphragm type complying with AWWA C530 except as modified herein. The body shall contain a removable seat insert. A resilient rubber disc shall form a drip-tight seal with the valve seat when pressure is applied above the diaphragm. The diaphragm assembly shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

2. All major components of the pilot control system shall be manufactured by the same company that manufactures the main valve. The main valve diaphragm shall either be vulcanized at the stem hole to ensure against wicking of the product within the diaphragm or the diaphragm shall utilize an FDA-approved nonwicking material and an elastomeric insert seal at the stem hole. The diaphragm shall not be used as a seating surface.

3. Provide guides at both ends of the stem or provide a center-guided stem. For design utilizing guides at both ends of the stem, provide a bearing in the valve cover and an integral bearing in the valve seat. Provide valve position indicator. Repairs and modifications other than the replacement of the main valve body shall be possible without removing the main valve from the line.

D. Materials of Construction--Diaphragm-Actuated Valves

1. Materials of construction for Class 125 and Class 250 valves larger than 1 inch in size shall be as follows:

Item	Material
Main valve body and cover	Ductile iron, ASTM A536, Grade 65-45-12
Main valve trim, seat, disc guide, and cover bearings	Type 316 stainless steel, ASTM A276, A 351, or A 743
Diaphragm washer and disc retainer	Type 303 stainless steel
Pilot control system	Bronze per paragraph 3 below with Type 303 stainless steel trim
Piping and tubing	Type 316 stainless steel per ASTM A269
Stem sleeves	Type 303 stainless steel
Elastomers	Buna-N
Cover screws, caps, and nuts and bolts	Type 316 stainless steel

2. Materials of construction for Class 150 and Class 300 valves larger than 1 inch in size shall be as follows:

Item	Material
Main valve body and cover	Cast steel, ASTM A216, Grade WCB
Main valve trim, seat, disc guide, and cover bearings	Type 316 stainless steel, ASTM A276, A351, or A743
Diaphragm washer and disc retainer	Bronze per paragraph 3 below
Pilot control system	Bronze per paragraph 3 below with Type 303 stainless steel trim
Piping and tubing	Type 316 stainless steel per ASTM A269
Stem sleeves	Type 303 stainless steel
Elastomers	Buna-N

3. Bronze shall have the following chemical characteristics:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

E. Valve End Connections

1. Valves 2 inches and smaller shall have threaded ends. Valves larger than 2 inches shall have flanged ends.

2. Flanges for ductile-iron valves shall be ductile iron, same grade as the valve. Class 150 flanges shall comply with ASME B16.42, Class 150. Class 300 flanges shall conform to ASME B16.42, Class 300. Flanges shall be flat face.

3. Flanges for cast steel valves shall be steel, ASTM A216, Grade WCB. Class 150 flanges shall comply with ASME B16.5, Class 150. Class 300 flanges shall comply with ASME B16.5, Class 300. Flanges shall be flat face.

4. Threaded ends shall comply with ASME B1.20.1.

5. Do not provide raised-face mating flanges on the connecting piping.

F. Limit Switches

Limit switches shall be single pole, double throw in a NEMA 7, Class I, Groups C and D and Class II, Groups E, F, and G enclosure. Voltage shall be 120 volts, 60 hertz, a-c.

G. Valves

1. Type 1300--Class 125 Pressure-Reducing Valves:

The valve shall automatically reduce a high inlet pressure to a steady lower downstream pressure regardless of changing flow rate or varying inlet pressure. The pressure-reducing pilot control shall be adjustable over a range of 15 to 75 psi. Provide strainer, three isolation valves, closing speed control, and opening speed control in the pilot control piping and tubing. Flanges shall be Class 125, ASME B16.1. The

valve shall be globe pattern. Valves shall be Cla-Val Series 6590-01, Bermad Model 720, Ross Model 40 WR, Watts 115, or equal.

H. Valve Tagging and Identification

Provide identifying valve tags per Section 15075.

I. Bolts and Nuts for Flanged Valves

1. Bolts and nuts for flanged valves shall be as specified for the piping to which the valves are connected.

2. Provide washers for each nut. Washers shall be of the same material as the nuts.

J. Gaskets for Flanges

Gaskets for flanged end valves shall be as specified for the piping to which the valve is connected.

K. Spare Parts

1. Provide the following spare parts for each valve:

Quantity	Description
1	Diaphragm, disc, and spacer washer set (for diaphragm-actuated valves).
1	Strainer.
2	Isolation valves for each valve pilot system.
1	Solenoid control valve for each solenoid-controlled valve.
1	Limit switch for each valve having a limit switch assembly.
1	Throttling valve for opening/closing speed control.

2. Pack spare parts in a wooden box and label with parts description and vendor name, address, and telephone number.

PART 3 - EXECUTION

A. Shipment and Storage

1. Ship and deliver valves in accordance with AWWA C530, Section 6 and as follows.

2. Provide flanged openings with metal closures at least 3/16-inch thick, with elastomer gaskets and at least four full-diameter bolts. Install closures at the place of valve manufacture prior to shipping. For studded openings, use all the nuts needed for the intended service to secure closures.

3. Provide threaded openings with steel caps or solid-shank steel plugs. Do not use nonmetallic (such as plastic) plugs or caps. Install caps or plugs at the place of valve manufacture prior to shipping.

4. Inspect valves on receipt for damage in shipment and conformance with quantity and description on the shipping notice and order. Unload valves carefully to the ground without dropping. Use forklifts or slings under skids. Do not lift valves with slings or chain around valve bonnet, pilot housing, or through waterway. Lift valves with eyebolts or rods through flange holes or chain hooks at ends of valve parts.

5. Protect the valve and pilot system from weather and the accumulation of dirt, rocks, and debris. Also, see the manufacturer’s specific storage instructions.

6. Make sure flange faces, joint sealing surfaces, body seats, and disc seats are clean. Check the bolting attaching the bonnet or pilot housing to the valve for loosening in transit and handling. If loose, tighten firmly.

7. If the valves and associated actuators are stored or installed outside or in areas subject to temperatures below 40°F or are exposed to the weather prior to permanent installation, provide the manufacturer’s recommended procedures for extended storage. Provide temporary covers over actuator electrical components. Provide temporary conduits, wiring, and electrical supply to space heaters. Exercise each valve from its fully open to fully closed position at least once every seven days. Inspect electrical contacts before start-up.

B. Lining and Coating

1. Coat exteriors of valves with 15 mils of fusion-bonded epoxy per Section 09961.

2. Line interiors of valves with 15 mils of fusion-bonded epoxy per Section 09961.

3. Do not coat seating areas and bronze or stainless steel pieces.

C. Valve Service Conditions

1. Valve service conditions shall be as shown below.

2. Valve Tag Number: 390-V-20

Valve location	In-plant Reuse Pump Station
Size	4″
Maximum flow	3600 gpm
Minimum flow	800 gpm
Maximum upstream pressure	105 psi
Minimum upstream pressure	15 psi Valve Wide Open
Maximum downstream pressure	14 psi
Minimum downstream pressure	4 psi
Flow/Pressure Setting	1200 gpm

3. Valve Tag Number: YP-V-5

Valve location	Backflow Preventer Modifications
Size	8″
Maximum flow	4000 gpm
Minimum flow	0 gpm
Maximum upstream pressure	105 psi
Minimum upstream pressure	15 psi Valve Wide Open
Maximum downstream pressure	14 psi
Minimum downstream pressure	4 psi
Flow/Pressure Setting	1200 gpm

D. Valve Installation

1. Remove covers over flanged openings and plugs from threaded openings, after valves have been lifted off the truck and placed at the point to which it will be connected to the adjacent piping.

2. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads as specified in the piping specifications, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

3. Clean threaded joints by wire brushing or swabbing. Apply Teflon® joint compound or Teflon® tape to pipe threads before installing threaded valves. Joints shall be watertight.

4. Handle valves carefully when positioning, avoiding contact or impact with other equipment or vault or building walls.

5. Clean valve interiors and adjacent piping of foreign material prior to making up valve to pipe joint connection. Prepare pipe ends and install valves in accordance with the pipe manufacturer’s instructions for the joint used. Do not deflect pipe-valve joint. Do not use a valve as a jack to pull pipe into alignment. The installation procedure shall not result in bending of the valve/pipe connection with pipe loading.

6. Prior to assembly, coat threaded portions of stainless steel bolts and nuts with lubricant.

E. Valve Pressure Testing

Test valves at the same time that the connecting pipelines are pressure tested. See Section 15144 for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure.

F. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of Beneficial Use as designated by the County Resident Project Representative.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

G. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

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SECTION 15111 SPRING-ACTUATED CONTROL VALVES

PART 1 - GENERAL

A. Description

This section includes requirements for materials and installation of spring-loaded, pressure-reducing valves.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit dimensional drawings for each size and type of valve provided.

3. Submit manufacturer’s catalog data and detail drawings showing all valve parts and describe by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show manufacturer's recommended maximum operating pressure and maximum recommended flow. Show linings and coatings. Identify each valve by tag number to which the catalog data and detail sheets pertain.

PART 2 - MATERIALS

A. Valve Identification

Valves are identified in the drawings by size and type number. For example, a callout in the drawings of 1V1402 refers to a Type 1402 valve in these specifications which is a spring-actuated pressure reducing valve.

B. Coating

Coat valves the same as the adjacent piping. If the adjacent piping is not coated, then coat valves per Section 09000, System No. 10. Apply the specified prime and intermediate coats at the place of manufacture. Apply finish coat in the field. Finish coat shall match the color of the connecting piping. Do not coat aluminum or stainless steel valves.

C. Bronze

Bronze in contact with water shall have the following chemical constituents:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

D. Valves

1. Type 1402 – Spring-Actuated Pressure-Reducing Valves:

   a. Valves shall be of the spring-loaded, direct-operated type for air and water service. The valves shall automatically convert high, varying inlet pressure to a lower, constant outlet pressure. Provide a valve design consisting of a spring in a chamber, acting on a diaphragm that transmits motion to the valve. Outlet pressure shall be adjustable by turning an adjusting handwheel to vary spring tension. Provide pressure gauge integral with the valve, indicating outlet pressure. Body shall be bronze or brass. Diaphragm shall be nitrile or rubber.

   b. Outlet pressure shall be field adjustable over a range of 5 to 95 psi. Valves shall be Leslie Class AWRG, Fisher Series 67, or equal.

2. Type 1405 – PVC Pressure-Relief or Backpressure Valves:

   Relief and backpressure valves shall be of the spring-actuated type, with an adjusting screw to change the relief or backpressure pressure setting. Pressure setting shall be field adjustable over a range of 5 to 100 psi. Bodies shall be PVC conforming to ASTM A 1784, Type I, Grade 1. Shafts shall be Teflon. Seals shall be Viton. Valves shall be Plastic-O-Matic Type RVT, Harrington, or equal.

E. Valve Tagging and Identification

Provide identifying valve tags per Section 15075.

PART 3 - EXECUTION

A. Valve Installation

Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be leak-tight.

B. Field Testing

1. Test valves at the same time that the connecting pipelines are pressure tested. See Section 15144 for pressure testing requirements. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure. Valve bodies and joints shall have zero leakage.

2. Run water through liquid service valves and air through air service valves and assure that valves regulate or sustain pressure to the specified setting. Duration of this test shall be at least 10 minutes.

C. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the Owner.

END OF SECTION

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SECTION 15112 BACKFLOW PREVENTERS

PART 1 - GENERAL

A. Description

This section includes materials and installation of reduced pressure backflow preventers.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit manufacturer's certificate of compliance with AWWA C511 for backflow preventers.

3. Provide manufacturer's certification that materials are lead free.

4. Submit dimensional drawings for each size and type of backflow preventer.

5. Submit manufacturer’s catalog data and detail drawings showing backflow preventer parts and describe by material of construction, specification (such as AISI, ASTM, SAE, or CDA), and grade or type. Show manufacturer’s recommended maximum operating pressure and maximum recommended flow. Show linings and coatings.

6. Submit certificate of approval of backflow preventer device by Orange County Utilities Water Division.

7. Submit certificate of backflow preventer installation by a certified installer. Installer shall be certified by the Orange County Utilities Water Division.

PART 2 - MATERIALS

A. Backflow Preventers

1. Backflow preventers shall be of the reduced pressure type, complying with AWWA C511. Provide two independently operating check valves, two shutoff valves, an automatic pressure differential relief valve, and test cocks so that a test of each check valve can be made.

2. Backflow preventers of sizes 2 inches and smaller shall have bronze (ASTM B61 or B62) check valves. Check valves shall be of the poppet type and have replaceable seats.

3. Backflow preventers 2 inches and larger shall have check valves of either the poppet or the toggle lever type. Check valves larger than 2 inches shall have cast-iron (ASTM A126, Class B) body and cover.

4. Differential relief valve shall be bronze (ASTM B61 or B62) with Type 304 or 316 stainless steel trim.

5. Isolation valves shall be Type 100 gate or Type 300 ball per Section 15100 for backflow preventers smaller than 3 inches.

6. Service conditions shall be as follows:

Unit Tag Number	Service Conditions
500-BFP-1	Cold Water

7. Backflow preventers shall be Clayton Model RP, Mueller Model FRP-II or 6CM, or equal.

B. Bronze Components

Bronze in contact with water shall have the following chemical constituents:

Constituent	Content
Zinc	7% maximum
Aluminum	2% maximum
Lead	8% maximum
Copper + Nickel + Silicon	83% minimum

PART 3 - EXECUTION

A. Painting and Coating

1. Coat backflow preventers including isolation valves the same as the adjacent piping. If the adjacent piping is not coated, then coat per Section 09900, System No. 15. Apply the specified prime at the place of manufacture. Apply intermediate and finish coats in field. Do not coat bronze or stainless steel items. Finish coat shall match the color of the adjacent piping.

B. Shipment and Storage

1. Identify the equipment with item and serial numbers. Material shipped separately shall be identified with securely affixed, corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. In addition, ship crated equipment with duplicate packing lists, one inside and one on the outside of the shipping container.

2. Pack and ship one copy of the manufacturer's standard installation instructions with the equipment. Provide the instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the jobsite and before start-up.

3. Provide flanged openings with metal closures at least 3/16-inch thick, with elastomer gaskets and at least four full-diameter bolts. Provide closures at the place of manufacture prior to shipping. For studded openings, use all the nuts needed for the intended service to secure closures.

4. Clearly identify lifting points and lifting lugs on the equipment or equipment package. Identify the recommended lifting arrangement on boxed equipment.

C. Installation of Backflow Preventers

1. Installation shall be done by an installer certified by the Orange County Utilities Division.

2. Do not use duct tape and plastic for covering the ends of pipe flanges. Use a solid metal cover with rubber gasket to cover flange openings during installation. These metal covers shall remain in place until the piping is connected to the equipment.

3. Do not spring flanges of connecting piping into position. Separately work inlet and outlet piping systems into position to bring the piping flanges into alignment with the matching equipment flanges. Do not move equipment to achieve piping alignment. Do not use electrical heating stress relieving to achieve piping alignment.

4. Line up pipe flange bolt holes with machinery nozzle bolt holes within 1/16 inch maximum offset from the center of the bolt hole to permit insertion of bolts without applying any external force to the piping.

5. Flange face separation shall be within the gasket spacing ±1/16 inch. Use only one gasket per flanged connection.

D. Field Testing

Pressure test the backflow preventers along with the connecting piping per Section 15144. There shall be no visible leaks in the backflow preventer assembly, valves, or joints of the interconnecting piping.

END OF SECTION

SECTION 15119 ELECTRIC MOTOR ACTUATORS FOR VALVES AND GATES

PART 1 - GENERAL

A. Description

This section includes materials and installation of electric motor actuators for valves and gates.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit manufacturer's catalog data showing motor actuator parts and materials of construction, referenced by AISI, ASTM, SAE, or CDA specification and grade. Show motor actuator dimensions and weights. Show coatings.

3. Show the maximum torque required to open and close each motor-actuated valve.

4. Submit certified factory performance test records.

5. Submit motor data including nameplate data, insulation type, duty rating, and torque output at duty rating.

6. Submit electrical schematic drawings and wiring diagrams showing physical locations of components.

7. The manufacturer’s inspection, field testing and evaluation of the existing valves where actuators are to be installed.

C. Manufacturer's Services

Provide equipment manufacturer's services at the jobsite for the minimum labor days listed below, travel time excluded:

1. One (1) labor day per six (6) electric motorized actuators installed to check the installation and advise during start-up, testing, and adjustment of the equipment.

2. Two (2) labor days (one (1) day for each shift) to instruct the County's personnel in the operation and maintenance of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's

design or fabrication, additional service shall be provided at no cost to the Owner.

PART 2 - MATERIALS

A. Manufacturers

1. Electric motor actuators with torque output requirements of 750 ft-lbs and less for butterfly valves and eccentric plug valves shall be quarter-turn type and shall be Limitorque “QX” Series or Rotork “IQT” Series.

2. Other electric motor actuators for open-close service shall be multi-turn type and shall be Limitorque “MX” Series or Rotork “IQ” Series.

3. Intelligent electric motor actuators for modulating service shall be Limitorque “MX” Series or Rotork “IQ” Series.

4. Electric motor actuators for explosion proof service shall be Limitorque “MX” Series or Rotork “IQ” Series.

5. All actuators on the project shall be of one manufacturer.

6. All actuators on the project shall be compatible with Profibus DP communications.

B. Actuator Identification

1. Motorized valves are identified in the drawings by size, type number, and suffix letter "M." For example, a callout in the drawings of 24" V-200M refers to Type 200 valve in Section 15100, which is a Class 150 butterfly valve with an electric motor actuator.

2. Motor actuators shall have the name of the manufacturer cast or molded onto the actuator body or shown on a permanently attached plate in raised letters.

C. Actuator Tagging

Provide identifying tags for electric motor-actuated valves per Section 15075. Show valve actuator tag number, name or designation as shown in the drawings, and valve size. Attach tags to actuators by means of stainless steel wire.

D. Motors for Electric Actuators

1. Motors shall be 480 volt, 3 phase and specifically designed for high torque, low inertia duty. Motors for on/off, open/close actuators shall be designed and rated for 15-minute duty or 60 starts per hour at 104°F. Motors and starters for modulating actuators shall be designed for 30-minute duty or 600 starts per hour at 104°F.

2. Output capacity shall be sufficient to open or close the valve against the maximum differential pressure when the voltage is 10% above or below normal at the specified service conditions. Motors shall have Class F insulation. Provide motor with torque output (at duty rating) that exceeds the requirements of paragraph E below including safety factor.

3. Provide an electrical and mechanical disconnection of the motor without draining the lubricant from the actuator gearcase.

E. Actuator Torque Requirements

1. Actuators being installed on existing valves shall include the manufacturer's inspection, field testing and evaluation of the existing valve in order to apply the applicable torque requirements in order to properly actuate the existing valves.

2. The rated output torque of the motor actuator shall be at least 1.5 times the maximum torque required to open or close the valve at any position including seating and unseating conditions when subjected to the most severe operating condition including any mechanical friction and/or other restrictive conditions that are inherent in the valve assembly. Do not include hammer-blow effect in sizing the actuator to comply with this torque requirement. Coordinate with the valve manufacturer to assure that the motor actuator stall torque output does not exceed the torque limits of the valve operating stem or shaft.

3. Maximum torque shall include seating or unseating torque, bearing torque, dynamic torque, and hydrostatic torque. Assume that the differential pressure across the valve is equal to the pressure or head rating of the valve.

4. Assume a maximum pipeline fluid velocity of 16 fps with the valve fully open, unless a higher velocity is specified in the detailed valve specification.

F. Design of Electric Motor Actuators

1. Actuators shall comply with AWWA C542, except as modified herein. Output capacity of motors shall be sufficient to open or close the valve against the maximum differential pressure when the voltage is 10% above or below normal at the specified service conditions. Provide motor with torque output (at duty rating) that exceeds the requirements of the following paragraphs including safety factor.

2. Provide a reversing starter, three overloads (one in each ungrounded leg) or two motor thermal cutouts, 120-volt control power transformer, local-off-remote selector switch, stop-open-close push buttons, and open and closed indicator lights. Provide magnetic starters in actuators for open/close operation and for modulating operation. Provide dry contact for remote indication of the actuator mode of operation. The contact shall be closed when the local-off-remote selector switch is in the remote position and the internal control power exists.

3. Provide a separate (remote) 316 Stainless Steel NEMA 4X (unless otherwise noted) enclosure with local/remote selector switch, stop-open-close push buttons, and open and closed indicator lights for motor actuators over 6 feet 6 inches above floor or deck in lieu of integral controls.

4. Do not use external conduit for wiring any components within the actuator.

5. Gear actuators shall be totally enclosed and factory-grease packed or oil-bath lubricated. The power gearing shall consist of helical gears of heat-treated steel. Worm gears shall be alloy bronze accurately cut with a hobbing machine. Worm shall be hardened steel alloy. Design gears for 24-hour continuous service with an AGMA rating of 1.50.

6. Position switches shall be adjustable and capable of actuation at any point between fully opened and fully closed positions. The position switches shall operate while the actuator is either in manual or in motor operation. Provide motor actuators with position

switches capable of being separately used to provide remote indication of end of travel in each direction and to stop motion at the end of travel in each direction.

7. Provide two individually adjustable torque switches to protect the valve and motor against overload in the opening and closing directions. To prevent hammering, the torque switch shall not reclose until the valve is made to travel in the opposite direction.

8. Provide a manually operated handwheel that shall not rotate during electrical operation. In the event electrical power is interrupted, handwheel operation shall be activated by a hand lever attached to the mechanism. While the valve is being operated manually, the motor shall not rotate. Upon restoration of electrical power, the handwheel shall automatically disengage. Design the handwheel diameter such that hand operation will not damage the valve.

9. The position switch and torque switch contacts shall be capable of interrupting at least 0.2-ampere inductive load at 125-volt dc or 6-ampere inductive load at 120-volt ac.

10. Provide a lost motion device for open/close operation to permit the motor to reach full speed before the load is applied. Provide lost motion action for manual operation also. Do not provide lost motion device for modulating applications.

11. "Latching" shall be provided to inhibit high torque during unseating or starting in mid-travel against high inertia loads. The actuator electrical diagram shall be identical, regardless of whether the valve is to operate on torque or position limit. Provide the actuator with means to non-intrusively calibrate torque or position and interrogate the status and performance of the actuator.

12. Motor shall de-energize in the event of a stall when attempting to unseat a jammed valve.

13. Provide a time delay to prevent instant reversal of the actuator motor.

14. Provide terminal connections for external remote controls fed from an internal 24-volt or 120-volt supply.

15. Provide two separate 3/4-inch conduit connections for control and power wiring.

G. Local Actuator Control

1. Integral to the actuator shall be local controls for Open, Close, and Stop, and a local/remote selector Switch:

   a. Local Control Only

   b. Off (No Electrical Operation)

   c. Remote Control plus Local Stop Only.

2. Provide a separate NEMA 4X enclosure with local/remote selector switch, stop-open-close push buttons, and open and closed indicator lights for motor actuators over 6'-6" above or below the floor or deck in lieu of integral controls. Mount in an accessible location closest to the valve.

3. All the necessary wiring, indication relays and terminals shall be provided in the actuator to accommodate the remote mounted push button control functions. Provide terminal connections for external remote controls fed from an internal 120-volt AC supply.

4. The following Control, Status and Alarm indication shall be available locally at the actuator:

Controls:	**Status:**	**Alarms:**
1. Open/Stop/Close	1. Motor Running Open Direction	1. Communications Failure
2. Desired Valve Position Control	2. Motor Running Closed Direction	2. Actuator Alarm
	3. Fully Open	3. Valve Alarm
	4. Fully Closed	4. Battery Low Alarm, if required
	5. Percentage Open	

5. The actuator must provide a local display of the position of the valve, even when the power supply is not present. The display shall be able to be rotated in 90 degree increments so as to provide easy viewing regardless of mounting position.

6. The actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments with +/- ½% accuracy. Red, green, and yellow lights corresponding to Open, Closed, and Intermediate positions shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.

7. The local display should be large enough to be viewed from a distance of six feet (6') when the actuator is powered up.

8. Provide a diagnostic module, which will store and enable download of historical actuator data to permit analysis of changes in actuator or valve performance. A software tool for a PDA or laptop shall be provided to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured.

9. Diagnostic status screens must be provided to show multiple functions. Emergency Shut Down shall be selectable; Last-position, Full Open, Full Closed.

H. Actuator Communication Board

1. General: Communication board shall support Profibus DP communication or hardwired analog and discrete signals, as required between the electric-motor valve actuator and the protocol gateway.

2. Profibus DP:

   a. The communication board shall support Profibus DP data transmission with the plant SCADA system.

   b. The communication boards shall support assigning individual addresses, unique to the Profibus DP network.

   c. The communication board shall be powered by the actuator assembly. No external power source shall be required.

   d. The communication board shall supply the following for transmission to the host system(s)

      (1) Status: Open, Closed, Moving, Stopped mid travel, valve position.

(2) Alarms: Local Control, High Temperature, Valve Obstructed, and Valve Jammed.

e. The communication board shall accept and act upon the following commands transmitted by the host system(s) via the protocol gateway: Open, Close, Stop mid travel, Emergency Shut Down.

f. Features:

(1) Communication boards shall be plug-in type, easily installed in the electric-motor valve actuator housing. Externally-mounted communication devices will not be accepted.

3. Hardwired

a. Capabilities shall be provided to position the valve (or gate) locally via the Local/Off/Remote selector switch and Open/Stop/Close push buttons.

b. For on/off service, when in remote, the actuator shall accept one remote signal to open the valve or gate and a second remote signal to close the valve or gate.

c. For modulating service, when in remote the actuator shall accept a 4-20mADC position control signal, and shall position the valve 0-90 degrees or gate 0-100% of travel in proportion to the control signal.

d. Valve position shall be sensed by an 18-bit, optical, absolute position encoder with redundant position sensing circuits designed for Built-In-Self-Test [BIST]. Each of the position sensing circuits shall be redundant permitting up to 50% fault tolerance before the position is incorrectly reported. The BIST feature shall discern which failures signal a warning only and which require a warning plus safe shutdown of the actuator. Open and closed positions shall be stored in permanent, nonvolatile memory. The encoder shall measure valve position at all times, including both motor and handwheel operation and with or without power present. The absolute encoder will be capable of resolving ±7 degrees of output shaft position over 10,000 output drive rotations.

e. Discrete outputs to SCADA shall be provided for all limit and torque switches, and for Local/Off/Remote

switch in Remote position, as required by the Drawings.

I. Wiring and Terminals

1. Internal wiring shall be tropical grade insulated stranded cable of appropriate size for the control and three-phase power. Each wire shall be clearly identified at each end. All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.

2. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The terminal compartment of the actuator shall be provided with a minimum of four threaded cable entries.

3. Control logic circuit boards and relay boards must be mounted on plastic mounts to comply with double insulated standards.

4. A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:

   a. Serial Number

   b. External Voltage Values

   c. Wiring Diagram Number

   d. Terminal Layout

   This must be suitable for the contractor to inscribe cable core identification beside terminal numbers.

J. NFPA Hazardous Area Classification:

1. Reference the Construction Drawings for the respective NFPA Hazardous Area Classifications where the new electric motor actuators are identified.

   The General Contractor and Actuator Manufacturer shall be responsible for providing the Actuators, Local Actuator Control Panels and other respective appurtenances in compliance with the requirements to meet the NFPA Hazardous Area Classification criteria designed within the Drawings.

PART 3 - EXECUTION

A. Service Conditions

Valve Tag	Application	Fluid	Open/Close or Modulating	Separate (Remote) Control Station Required?	Fail Position on LOS	Profibus Required?
220-V-1	BFV	Air	Modulating	Yes	Last	No
220-V-4	BFV	Air	Modulating	Yes	Last	No
320-V-1A	BFV	Air	Modulating	Yes	Last	No
320-V-2A	BFV	Air	Modulating	Yes	Last	No
420-V-4A	BFV	Air	Modulating	Yes	Last	No
360-WG-1	Weir Gate	Water	Modulating	No	Closed	Yes
360-WG-2	Weir Gate	Water	Modulating	No	Closed	Yes
360-WG-3	Weir Gate	Water	Modulating	No	Closed	Yes
500-SG-1	Slide Gate	Water	Modulating	No	Last	Yes
560-V-15	BFV	Water	Modulating	No	Closed	Yes
560-V-16	BFV	Water	Modulating	No	Closed	Yes
560-V-17	BFV	Water	Modulating	No	Closed	Yes
561-WG-1	Weir Gate	Water	Modulating	No	Last	Yes
562-WG-1	Weir Gate	Water	Modulating	No	Last	Yes
562-SG-1	Slide Gate	Water	Modulating	No	Last	Yes
563-WG-1	Weir Gate	Water	Modulating	No	Last	Yes
563-SG-1	Slide Gate	Water	Modulating	No	Last	Yes
564-WG-1	Weir Gate	Water	Modulating	No	Last	Yes
564-SG-1	Slide Gate	Water	Modulating	No	Last	Yes
564-WG-2	Weir Gate	Water	Modulating	No	Last	Yes
564-SG-2	Slide Gate	Water	Modulating	No	Last	Yes
YP-V-1	BFV	Water	Modulating	No	Closed	Yes
YP-V-2	Existing BFV	Water	Modulating	No	Last	Yes
YP-V-3	Existing BFV	Water	Modulating	No	Last	Yes
YP-V-4	BFV	Water	Modulating	No	Last	Yes

B. Factory Performance Testing of Motor Actuator

Test each actuator prior to shipment in accordance with C542, Section 5.3. The application torque shall be maximum

torque required to open or close the valve at position including seating and unseating conditions.

C. Storage and Temporary Installation Before Start-Up

If actuators are stored or installed outside or in areas subject to temperatures below 40°F or are exposed to the weather prior to permanent installation, provide the manufacturer's recommended procedures for extended storage. Provide temporary covers over the actuator electrical components. Exercise each actuator from its fully open to fully closed position at least once every seven days. Inspect electrical contacts before start-up.

D. Floor Stands and Extension Stems

Where shown in the drawings, mount the electric motor actuators on floor stands with extension stems as specified in Section 15100.

E. Attaching Electric Actuators

The valve manufacturer shall mount the electric motor actuator and accessories on each valve and stroke the valve prior to shipment. Adjust limit switch positions and torque switches.

F. Painting and Coating

Provide factory applied powder coating for electric motor actuators. The coating system shall be suitable for an ASTM B117 salt spray test for a minimum of 1,500 hours.

G. Field Installation

Install the valve and actuator as indicated in the drawings in accordance with the manufacturer's instructions. Keep units dry, closed, and sealed to prevent internal moisture damage during construction. Provide additional hangers and supports for actuators which are not mounted vertically over the valve or which may impose an eccentric load on the piping system.

H. Attaching Electric Actuators – Slide Gates

The slide gate manufacturer shall mount the electric motor actuator and accessories on each slide gate and stroke the slide gate prior to shipment. Adjust limit switch positions and torque switches.

I. Field Testing of Motor Actuators

1. Test motor actuators as installed by measuring the current drawn (in amperes) by each motor for unseating, seating, and running conditions. The measured current shall not exceed the current measurement recorded during the factory performance test.

2. If the measured current drawn exceeds the above value, provide a larger motor or gear drive or adjust the actuator so that the measured amperage does not exceed the value.

3. Assure that limit switches are placed at their correct settings. Open and close valves twice and assure that limit switches function.

J. Warranty

1. The Manufacturer shall furnish a written warranty covering materials and workmanship for the equipment provided for a period of three (3) years. The warranty period shall begin at the date of substantial completion of the respective process in which the equipment is installed.

2. The manufacturer shall furnish, deliver, and install new parts to replace the defective parts. The manufacturer shall furnish all supervision, labor, equipment, and materials to repair or replace components which have failed as defined by the warranty at no cost to the Owner.

K. Additive Warranty

Reference Specification Section 01025 for two (2) years in additional warranty duration to warranty stated above.

L. Certification

Provide a written certification from the equipment manufacturer that the equipment has been properly installed according to the plans, specifications and manufacturer's specifications, and that the equipment is operating normally. Make all necessary corrections and adjustments at no additional cost to the County.

END OF SECTION

SECTION 15121 MISCELLANEOUS PIPE FITTINGS AND ACCESSORIES

PART 1 - GENERAL

A. Description

This section includes materials and installation of quick-connect couplings.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's catalog data and descriptive literature showing dimensions and materials of construction by ASTM reference and grade. Show coatings.

PART 2 - MATERIALS

A. Flange Insulation Kits

See Section 15050.

B. Insulating Unions

See Section 15050.

C. Metallic Quick-Connect Couplings

Type 2: Quick-connect couplings shall be male adapter/ASME B16.1 Class 125 flange. Bodies shall be Type 316 stainless steel. Provide quick- connect plug or cap for each coupling. Couplings shall be Ever-Tite Model FLA, CIVACON Model 633-LAS, or equal.

D. Nonmetallic Quick-Connect Couplings

1. Type 6A: Quick-connect couplers shall be female coupler/female thread type with locking handles. Provide dust plug and security chain with each coupler. Bodies shall be glass fiber reinforced polypropylene. Locking handles shall be Type 302 or 304 stainless steel. Gasket shall be Viton. Couplers shall be Murray Equipment Inc. 663D, Pacific Mechanical 561 Series, or equal.

2. Type 8A: Quick-connect adapters shall be male adapter/ female thread type. Provide adapter cap with locking handles. Bodies shall be glass fiber reinforced polypropylene. Locking handles shall be stainless steel. Gasket shall be Teflon. Adapters shall be Evertite Part A/DC, Banjo Corporation Male Adapter/Female Thread and Dust Cap, Murray Equipment Inc. Style A/DC, or equal.

PART 3 - EXECUTION

A. Installing Quick-Connect Couplings

Attach to piping per the relevant piping specification.

END OF SECTION

SECTION 15122 FLEXIBLE PIPE COUPLINGS AND EXPANSION JOINTS

PART 1 - GENERAL

A. Description

This section includes materials and installation of flexible gasketed sleeve-type compression pipe couplings for ductile-iron pipe; flexible expansion joints; expansion loops; and couplings for connecting different pipe materials.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following;

2. Submit manufacturer's catalog data on flexible pipe couplings and expansion joints. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings and joints are used. Show coatings.

3. Submit manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasketed sleeve-type compression pipe couplings.

4. Show materials of construction by ASTM reference and grade. Show dimensions.

5. Show number, size, and material of construction of tie rods and lugs for each thrust harness on the project.

PART 2 - MATERIALS

A. Coupling System Design and Component Unit Responsibility

The coupling manufacturer shall furnish the gaskets, bolts, nuts, glands, end rings, and hardware for pipe couplings of all types and shall design these components as an integral system. Design the gaskets for the coupling and appropriately size to provide a watertight seal at the design pressure and temperature. Ship gaskets, bolts, nuts, glands, end rings, and hardware for pipe couplings with the pipe coupling and clearly label indicating the origin of the material, including place and date of manufacture. Package the manufacturer's printed installation instructions with each pipe coupling.

B. Ductile-Iron Flexible Pipe Couplings

1. Couplings shall have center sleeves and end rings made of ductile iron conforming to AWWA C219, Section 4.

2. Sleeve bolts in exposed service shall be Type 304 stainless steel per AWWA C219, Section 4. Sleeve bolts in buried or submerged service shall be Type 316 stainless steel per AWWA C219, Section 4.

3. Couplings in air service shall have Viton gaskets rated to 250 degrees F.

C. Joint Harnesses

1. Tie bolts or studs shall be as shown in the following table. Bolt or stud material shall be Type 304 stainless steel conforming to ASTM A193, Grade B8. Nuts shall be Type 304 stainless steel conforming to ASTM A194, Grade B8. Lug material shall be Type 304 stainless steel conforming to ASTM A 240 Type 304. Lug dimensions for steel pipe shall be as shown in AWWA Manual M11 (2004 edition), Figure 13-20, using the number and size of lugs as tabulated below.

2. Lug or ear dimensions for ductile-iron pipe shall be as shown in the drawings.

TIE BOLTS OR STUD REQUIREMENTS FOR FLEXIBLE PIPE COUPLINGS FOR DUCTILE IRON PIPE

	Tie Bolt or Stud Minimum Requirements					
	150 psi(1)			300 psi(2) Pipe		
Nominal Pipe Size (inches)	No. Bolts or Studs	Size (inch)	Ear(3) Type	No. Bolts or Studs	Size (inch)	Ear(3) Type
4	2	5/8	A	2	5/8	A
6	2	5/8	A	2	5/8	A
8	2	5/8	A	2	5/8	A
10	2	5/8	A	4	5/8	A
12	2	5/8	A	4	5/8	A
14	4	5/8	A	5	3/4	A
16	4	5/8	A	5	3/4	B
18	4	3/4	B	8	3/4	B
20	4	3/4	B	8	3/4	B
24	5	7/8	B	8	7/8	B
30	4	1-1/8	B	14	7/8	B

TIE BOLTS OR STUD REQUIREMENTS FOR FLEXIBLE PIPE COUPLINGS FOR DUCTILE IRON PIPE						
	Tie Bolt or Stud Minimum Requirements					
	150 psi[1]			300 psi[2] Pipe		
Nominal Pipe Size (inches)	No. Bolts or Studs	Size (inch)	Ear[3] Type	No. Bolts or Studs	Size (inch)	Ear[3] Type
36	8	1	B	16	1	B
42	9	1	B	--	--	--
48	14	1	B	--	--	--
54	16	1	B	--	--	--

(1) Use ANSI B61.1 Class 125 flanges.
(2) Use ANSI B16.1 Class 250 flanges.
(3) Ear type as shown in the detail on the last page of Section 15122.

3. Select number and size of bolts based on the test pressure shown in the Piping Schedule in the drawings Section 15144. Stagger bolts equally around pipe circumference. Where odd number is tabulated, place odd bolt at top. For test pressures less than or equal to 150 psi, use the 150-psi design in the table above. For test pressures between 150 and 300 psi, use the 300-psi design in the table above.

4. Provide washer for each nut. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8-inch.

D. Flexible Pipe Couplings for Plain-End Ductile-Iron Pipe

1. Couplings for pipe 12 inches and smaller shall be cast iron, Dresser Style 153, Smith-Blair Type 441, Baker Series 228, or equal.

2. Couplings for pipe larger than 12 inches shall be cast iron or steel, Dresser Style 38 or 153, Smith-Blair Style 411, Baker Series 228, or equal.

3. Couplings in air service shall have Viton gaskets.

E. Transition Couplings

Couplings for connecting different pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Smith-Blair Series 413, Baker Series 212 or 220, or equal. Couplings shall have an internal full circumference ring pipe stop at the midpoint of the coupling. Inside diameter

of coupling pipe stop shall equal inside diameter of smaller diameter pipe.

F. Flanged Coupling Adapters for Cast- and Ductile-Iron Pipe

1. Adapters for cast- and ductile-iron pipe 12 inches and smaller shall be cast iron: Dresser Style 127, Smith-Blair Series 912, or equal.

2. Adapters for cast- and ductile-iron pipe larger than 12 inches shall be steel: Dresser Style 128, Smith-Blair Type 913, or equal.

3. Flange ends shall match the flange of the connecting pipe; see detail piping specifications.

4. Couplings in air service shall have Viton gaskets.

G. Type 4 Expansion Joints: Spherical Expansion Joints

1. Spherical design expansion joints shall be chlorobutyl with polyester fiber reinforcing and be provided with steel retaining rings and Type 304 stainless steel gusset plates and control rods. Expansion joints shall have flat-face flanges integral with the body to match 125/150-pound flanges. Expansion joints for hot water service shall be rated at a minimum of 150 psig at 212°F.

Joint Size	**Flange-to-Flange Length (inches)**	**Minimum Pressure Rating (150°F) (psi)**
4-8	6	225
10-12	8	225
14-20	10-12	125

2. Expansion joints shall be manufactured by Metraflex Metrasphere, Proco Series 240, or equal.

H. Type 5 Expansion Joints: Single Arch Rubber Type (24 Inches and Smaller)

1. Expansion joints shall be rubber, single arch type, with integral flat-face ANSI Class 125/150 flanges. Minimum working pressure shall be 150 psi for joints 12 inches and smaller, 120 psi for 14- and 16-inch joints, 110 psi for 18- and 20-inch joints, and 100 psi for 24-inch joints. Provide steel thrust plates, retaining rings,

and control rods. Products: Proco Style 220, General Rubber Style 1075, or equal.

I. Type 12 Expansion Joints: Metal Bellows Pump Connection Joints 1-1/2 Through 36 Inches

1. Provide multiple bellows, annular, flanged expansion joint constructed from single or multiple metal laminations. Provide flow liner. Provide thrust restraining rod system. Minimum pressure rating shall be 275 psi at a temperature of 200°F. Flanges shall be Class 150 per ANSI B16.5. Provide fixed, flat-face flanges. Materials of construction shall be as follows:

Item	Material	Specification
Bellows	Stainless steel	ASTM A240 or A666, Type 304 or 321
Flanges	Steel	ASTM A285, Grade C

2. Products: Hyspan Model 2504-092-3.0, Keflex Type 151-TR, or equal.

J. Expansion Joints in Air Service

Refer to Section 11373.

K. Depend-O-Lok Expansion Couplings

Provide Depend-O-Lok expansion couplings type FxE or type FxF (restrained) where shown in the drawings.

1. FxE couplings shall allow one pipe end to move freely while the other pipe end has restraining rings attached to secure the coupling. Maximum allowable expansion/contraction shall be 4-inches. Couplings shall be Type 316 stainless steel arched band type couplings in either one piece or two piece housings that provide full circumferential bearing against welded end-rings on the pipe. Coupling o-rings shall be suitable for an air pressure of 50 psi at a temperature of 250°F. Coupling sealing plates, bolts, nuts, washers, and restraining ring shall be type 316 stainless steel. Couplings shall be secured to one pipe end with stainless steel retaining rings shop welded by the pipe fabricator to the pipe end for the fixed side of the coupling.

2. FxF couplings shall Type 316 stainless steel arched band type couplings in either one piece or two piece housings that provide full circumferential bearing against welded end-rings on the pipe. Coupling gaskets shall be suitable for an air pressure of 50 psi at a temperature of 250°F. Coupling sealing plates, bolts, nuts, washers, and restraining ring shall be type 316 stainless steel. Couplings shall be secured to one pipe end with stainless steel retaining rings shop welded by the pipe fabricator to the pipe end for the fixed side of the coupling.

L. Bolts and Nuts for Flanges

See Section 15050.

M. Threaded Caps for Protection of Nuts and Bolt Threads

See Section 15050.

PART 3 - EXECUTION

A. Installation of Flexible Pipe Couplings, Segmented Sleeve Couplings, and Expansion Joints

1. Clean oil, scale, rust, and dirt from pipe ends. Clean gaskets in flexible pipe couplings before installing.

2. Install expansion joints per manufacturer's recommendations, so that 50% of total travel is available for expansion and 50% is available for contraction.

3. Lubricate bolt threads with graphite and oil prior to installation.

B. Painting and Coating

1. Coat buried flexible pipe couplings (including joint harness assemblies), transition couplings, segmented sleeve couplings, and flanged coupling adapters per Section 09900, System No. 21. Coat buried bolt threads, tie bolt threads, and nuts per Section 09900, System No. 24.

2. Coat flexible pipe couplings (including joint harness assemblies), transition couplings, segmented sleeve couplings, and flanged coupling adapters located indoors, in vaults and structures, and above ground with

the same coating system as specified for the adjacent pipe. Apply prime coat at factory.

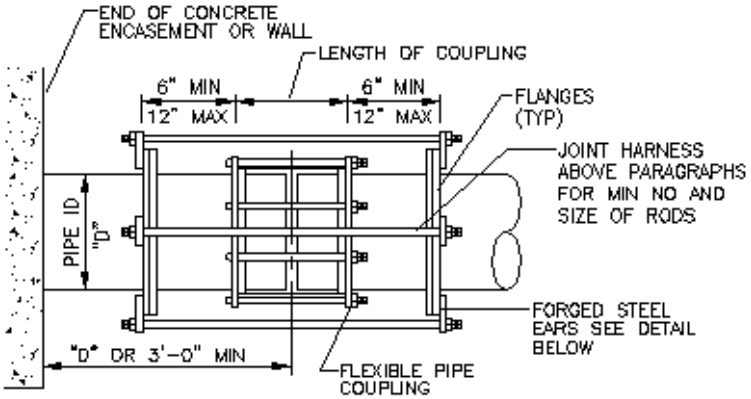
3. Line carbon steel and iron flexible pipe couplings and segmented sleeve couplings per Section 09900, System No. 7.

4. Alternatively, line and coat carbon steel and iron flexible pipe couplings and segmented sleeve couplings with fusion-bonded epoxy per Section 09961.

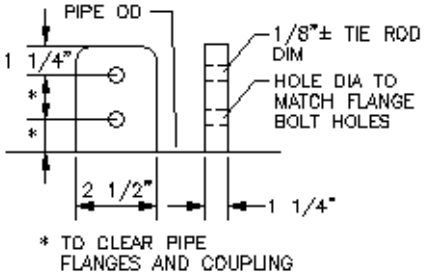
5. Coat couplings, expansion joints, expansion compensators, and alignment guides located above ground or in vaults and structures with the same coating system as specified for the adjacent pipe.

C. Hydrostatic Testing

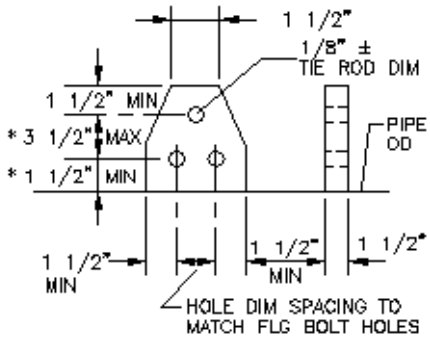
Hydrostatically test flexible pipe couplings, expansion joints, segmented sleeve couplings, and expansion compensators in place with the pipe being tested. Test in accordance with Section 15144.



FLEXIBLE PIPE COUPLING



FORGED STEEL EAR – TYPE "A"



FORGED STEEL EAR – TYPE "B"

FLEXIBLE PIPE COUPLING TIE RODS – DUCTILE IRON PIPE DETAIL

SCALE: NONE

END OF SECTION

SECTION 15123 CORPORATION STOPS AND SERVICE SADDLES

PART 1 - GENERAL

A. Description

This section includes materials and installation of service saddles and corporation stops.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit manufacturer's catalog data and descriptive literature showing dimensions and materials of construction by ASTM reference and grade. Show coatings.

PART 2 - MATERIALS

A. Corporation Stops

Corporation stops shall be brass body per Orange County Standards and Construction Specification Manual. Corporation stops shall be Ford FB1000, Mueller P25008, AY McDonald F701B-22, or equal.

B. Service Saddles for Ductile-Iron, Steel Pipe and PVC (AWWA C900 and C909)

1. Type 1 service saddles shall be of the double-strap type. Bodies shall be malleable iron (ASTM A47 or A197). Straps shall be forged steel (ASTM A105, A181, or A182). Tap sizes on the outlet shall be 3/4 inch through 2 inches to accommodate the connecting piping or corporation stops. Service saddles shall be Dresser Style 91, Rockwell Type 313, or equal.

2. Type 2 service saddles shall be of the double-strap type. Straps and bodies shall be bronze or silicon bronze. Tap sizes on the outlet shall be 3/4 inch through 2 inches to accommodate the connecting piping or corporation stops. Service saddles shall be James Jones J-979 (for ductile-iron and steel pipe), James Jones J-996 (for PVC pipe) Mueller, or equal.

3. Use Type 2 saddles unless plans direct otherwise.

C. Service Saddles for Schedule 40 and 80 PVC Pipe

Service saddles shall be malleable iron (ASTM A47 or A197) or bronze (ASTM B61 or B62), using interlocking lugs and a single bolt to hold the saddle in place. Tap sizes on the outlet shall be 3/4 inch or 1 inch to accommodate the connecting piping or corporation stops. Service saddles shall be Dresser Style 194, Rockwell Models 395 or 397, or equal.

PART 3 - EXECUTION

A. Installation of Service Saddles

Install service saddles with the gaskets seated on the pipe so that zero leakage is obtained. Tighten bolts to the torque recommended by the manufacturer.

B. Painting and Coating of Service Saddles

1. Coat buried service saddles per Section 09900, System No. 21.

2. Coat submerged service saddles per Section 09900, System No. 7.

3. Coat service saddles located above ground or in vaults and structures per Section 09900, System No. 10 Apply prime coat at factory. Color of finish coat shall match the color of the pipe to which the service saddle is connected.

END OF SECTION

SECTION 15141 DISINFECTION OF PIPING

PART 1 - GENERAL

A. Description

This section includes materials and procedures for disinfection of water mains by the continuous feed method. Disinfect piping in accordance with AWWA C651, except as modified below.

B. Job Conditions

1. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility.

2. Use potable water for chlorination.

3. Submit request for use of water from waterlines of Owner 48 hours in advance.

4. Chemicals for use in disinfection of potable water lines shall be certified as conforming to NSF 60.

PART 2 - MATERIALS

A. Liquid Chlorine

Inject with a solution feed chlorinator and a water booster pump. Follow the instructions of the chlorinator manufacturer.

B. Calcium Hypochlorite (Dry)

Dissolve in water to a known concentration in a drum and pump into the pipeline at a metered rate.

C. Sodium Hypochlorite (Solution)

Further dilute in water to desired concentration and pump into the pipeline at a metered rate.

D. Chlorine Residual Test Kit

For measuring chlorine concentration, supply and use a medium range, drop count, DPD drop dilution method kit per

AWWA C651, Appendix A. Maintain kits in good working order available for immediate test of residuals at point of sampling.

PART 3 - EXECUTION

A. Continuous Feed Method for Pipelines

Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the chlorine concentration in the pipeline is maintained at a minimum concentration of 50 mg/L. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

B. Disinfection of Valves, Blind Flanges, and Appurtenances

During the period that the chlorine solution or slug is in the section of pipeline, open and close valves to obtain a chlorine residual at hydrants and other pipeline appurtenances. Swab exposed faces of valves and blind flanges prior to bolting flanges in place with a 1% sodium hypochlorite solution.

C. Disinfection of Connections to Existing Pipelines

Disinfect isolation valves, pipe, and appurtenances per AWWA C651, Section 4.7. Flush with potable water until discolored water, mud, and debris are eliminated. Swab interior of pipe and fittings with a 1% sodium hypochlorite solution. After disinfection, flush with potable water again until water is free of chlorine odor.

D. Disinfection of Tapping Sleeves and Line Stopping

Flush exterior of pipe with potable water after removal of existing coating. Swab exterior of pipe with a 1% sodium hypochlorite solution. Disinfect per AWWA C651, Section 4.8. After completion of tapping and line stopping, swab interior of pipe, valves, and faces of flanges to be connected to bypass piping with a 1% sodium hypochlorite solution.

E. Confirmation of Residual

1. After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of 50 mg/L minimum exists along the pipeline by sampling at air

valves and other points of access, such as tapping valves.

F. Pipeline Flushing

After confirming the chlorine residual, flush the excess chlorine solution from the pipeline until the chlorine concentration in the water leaving the pipe is within 0.5 mg/L of the replacement water. Contractor is responsible for method of removing excess chlorine residual to 0.5 mg/L of the replacement water.

G. Bacteriologic Tests

Collect two sets of samples per AWWA C651, Section 5.1, deliver to a certified laboratory within six hours of obtaining the samples, and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline after chlorination and refilling. Collect at least one set of samples from every 1,200 feet of the new water main and line stopping insertion point, plus one set from the end of the line and at least one set from each branch. At each connection to an existing pipeline, take two additional samples.

H. Repetition of Procedure

If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

I. Test Facility Removal

After satisfactory disinfection, disinfect and replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

J. Piping to be Disinfected

1. Disinfect all potable water piping.

END OF SECTION

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SECTION 15144 PRESSURE TESTING OF PIPING

PART 1 - GENERAL

A. Description

This section specifies the hydrostatic, pneumatic, and leakage testing of pressure piping for wastewater treatment plants.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit test bulkhead locations and design calculations, pipe attachment details, and methods to prevent excessive pipe wall stresses.

3. Submit six copies of the test records to the Owner's Representative upon completion of the testing.

C. Test Pressures

Test pressures for the various services and types of piping are shown in the Piping Schedule in the drawings.

D. Testing Records

Provide records of each piping installation during the testing. These records shall include:

1. Date and times of test.

2. Identification of process, pipeline, or pipeline section tested or retested.

3. Identification of pipeline material.

4. Identification of pipe specification.

5. Test fluid.

6. Test pressure at low point in process, pipeline, or pipeline section.

7. Remarks: Leaks identified (type and location), types of repairs, or corrections made.

8. Certification by Contractor that the leakage rate measured conformed to the specifications.

PART 2 - MATERIALS

A. Vents and Drains for Aboveground Piping

Install vents on the high points of aboveground piping, whether shown in the drawings or not. Install drains on low points of aboveground piping, whether shown in the drawings or not. Provide a valve at each vent or drain point. Valves shall be 3/4-inch for piping 3 inches and larger and 1/2-inch for piping smaller than 3 inches. Valves shall be as specified in Section 15100, Type 100, unless otherwise shown in the drawings.

B. Manual Air-Release Valves for Buried Piping

Provide temporary manual air-release valves at test bulkheads for pipeline test. Construct the pipe outlet in the same manner as for a permanent air valve and after use, seal with a blind flange, pipe cap, or plug and coat the same as the adjacent pipe.

C. Test Bulkheads

Design and fabricate test bulkheads per Section VIII of the ASME Boiler and Pressure Vessel Code. Materials shall comply with Part UCS of said code. Design pressure shall be at least 2.0 times the specified test pressure for the section of pipe containing the bulkhead. Limit stresses to 70% of yield strength of the bulkhead material at the bulkhead design pressure. Include air-release and water drainage connections.

D. Testing Fluid

1. Testing fluid shall be reclaimed water, unless otherwise noted, or a pneumatic test is indicated on the Piping Schedule.

2. For potable water pipelines, obtain and use only potable water for hydrostatic testing.

3. Submit request for use of water from waterlines of Owner 48 hours in advance.

4. The Contractor may obtain potable and reclaimed water from the Owner at no charge.

E. Testing Equipment

Provide calibrated pressure gauges, pipes, bulkheads, pumps, compressors, chart recorder, and meters to perform the hydrostatic and pneumatic testing. The Contractor shall supply all temporary plugs, blocking, taps and testing equipment as required to test all the sections of piping installed.

PART 3 - EXECUTION

A. Testing Preparation

1. Pipes shall be in place, backfilled, and anchored before commencing pressure testing.

2. Conduct pressure tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.

3. For buried piping, the pipe may be partially backfilled and the joints left exposed for inspection during an initial leakage test. Perform the final pressure test, however, after completely backfilling and compacting the trench.

4. Provide any temporary piping needed to carry the test fluid to the piping that is to be tested. After the test has been completed and demonstrated to comply with the specifications, disconnect and remove temporary piping. Do not remove exposed vent and drain valves at the high and low points in the tested piping; remove any temporary buried valves and cap the associated outlets. Plug taps or connections to the existing piping from which the test fluid was obtained.

5. Provide temporary drain lines needed to carry testing fluid away from the pipe being tested. Remove such temporary drain lines after completing the pressure testing. Pipes shall remain full after testing.

6. Prior to starting the test, the Contractor shall notify the County's Representative.

B. Cleaning

1. Before conducting hydrostatic tests, flush pipes with water to remove dirt and debris. For pneumatic tests, blow air through the pipes. Maintain a flushing velocity of at least 3 fps for water testing and at least 2,000 fpm for pneumatic testing. Flush pipes for time period as given by the formula

$$T = \frac{2L}{3}$$

in which:

T = flushing time (seconds)

L = pipe length (feet).

2. For pipelines 24 inches or larger in diameter, acceptable alternatives to flushing are use of high-pressure water jet, sweeping, or scrubbing. Water, sediment, dirt, and foreign material accumulated during this cleaning operation shall be discharged, vacuumed, or otherwise removed from the pipe.

C. Testing and Disinfection Sequence for Potable Water Piping

1. Perform required disinfection after hydrostatic testing, except when pipeline being tested is connected to a potable waterline.

2. Locate and install test bulkheads, valves, connections to existing pipelines, and other appurtenances in a manner to provide an air gap separation between existing potable water pipelines and the pipeline being tested. Disinfect water and pipeline being tested before hydrostatic testing when connected to a potable waterline.

D. Length of Test Section for Buried Piping

The maximum length of test section for buried pipe is 1,000 feet. Provide intermediate test bulkheads where the pipeline length exceeds these limits.

E. Initial Pipeline Filling for Hydrostatic Testing

Maximum rate of filling shall not cause water velocity in pipeline to exceed 1 fps. Filling may be facilitated by removing automatic air valves and releasing air manually.

F. Testing New Pipe Which Connects to Existing Pipe

Prior to testing new pipelines that are to be connected to existing pipelines, isolate the new line from the existing line by means of test bulkheads, spectacle flanges, or blind flanges. After the new line has been successfully tested, remove test bulkheads or flanges and connect to the existing piping.

G. Hydrostatic Testing of Aboveground or Exposed Piping

1. Open vents at high points of the piping system to purge air while the pipe is being filled with water. Venting during system filling may also be provided by temporarily loosening flanges.

2. Subject the piping system to the test pressure indicated on the Piping Schedule in the drawings. Maintain the test pressure for a minimum of four hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show zero leakage or weeping. Correct leaks and retest until zero leakage is obtained.

H. Hydrostatic Testing of Buried Piping

1. Where any section of the piping contains concrete thrust blocks or encasement, do not make the pressure test until at least 10 days after the concrete has been placed. When testing mortar-lined or PVC piping, fill the pipe to be tested with water and allow it to soak for at least 48 hours to absorb water before conducting the pressure test.

2. Apply and maintain the test pressure by means of a positive displacement hydraulic force pump.

3. Maintain the test pressure for the following duration by restoring it whenever it falls an amount of 5 psi:

Pipe Diameter (inches)	**Hours**
18 and less	4
20 to 36	8
Greater than 36	24

4. After the test pressure is reached, use a meter to measure the additional water added to maintain the pressure. This amount of water is the loss due to leakage in the piping system. The allowable leakage volume is defined by the formula

$$L = \frac{HND(P)^{1/2}}{C}$$

in which:

L = allowable leakage (gallons)
H = specified test period (hours)
N = number of rubber-gasketed joints in the pipe tested
D = diameter of the pipe (inches)
P = specified test pressure (psig)
C = 7,400

5. The allowable leakage for buried piping having threaded, brazed, or welded (including solvent welded) joints shall be zero.

6. Repair and retest any pipes showing leakage rates greater than that allowed in the above criteria.

7. Test piping subject to the National Fire Code requirements per NFPA 24. Test such piping hydrostatically at not less than 200-psi pressure for two hours or at 50 psi in excess of the maximum static pressure when the maximum static pressure is in excess of 150 psi. The amount of leakage in piping shall be measured at the specified test pressure by pumping from a calibrated container. The amount of leakage at the joints shall not exceed 2 quarts per hour per 100 gaskets or joints irrespective of pipe diameter. The piping subject to this testing requirement is shown in the Piping Schedule in the drawings.

8. The allowable leakage for buried piping having threaded, brazed, or welded (including solvent welded) joints shall be zero.

9. Repair and retest any pipes showing leakage rates greater than that allowed in the above criteria.

I. Repetition of Test

If the actual leakage exceeds the allowable, locate and correct the faulty work and repeat the test. Restore the work and all damage resulting from the leak and its repair. Eliminate visible leakage.

J. Bulkhead and Test Facility Removal

After a satisfactory test, remove the testing fluid, remove test bulkheads and other test facilities, and restore the pipe coatings.

END OF SECTION

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SECTION 15150 HVAC CONDENSATE WASTE PIPING

PART 1 - GENERAL

A. SUMMARY

This Section includes condensate waste piping.

B. PERFORMANCE REQUIREMENTS

Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Condensate Piping: 10-foot head of water (30 kPa).

C. SUBMITTALS

Field quality-control inspection and test reports.

D. QUALITY ASSURANCE

1. Piping materials shall bear label, stamp, or other markings of specified testing agency.

2. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

PART 2 - EXECUTION

A. PIPING APPLICATIONS

1. Condensate piping shall be the following:

a. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

B. PIPING INSTALLATION

1. Basic piping installation requirements are specified in Division 15 Section 15055 "Mechanical Materials and Methods."

2. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section 15055 "Mechanical Materials and Methods."

3. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 15 Section 15055 "Mechanical Materials and Methods."

4. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

5. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

6. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

7. Install condensate drainage piping at the following minimum slopes, unless otherwise indicated:

    a. Horizontal Drainage Piping: 2 percent downward in direction of flow.

8. Install PVC piping according to ASTM D 2665.

9. Install underground PVC drainage piping according to ASTM D 2321.

10. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

C. JOINT CONSTRUCTION

1. Basic piping joint construction requirements are specified in Division 15 Section 15055 "Basic Mechanical Materials and Methods."

2. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

D. VALVE INSTALLATION

1. Backwater Valves: Install backwater valves in piping subject to backflow.

   a. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.

   b. Install backwater valves in accessible locations.

E. HANGER AND SUPPORT INSTALLATION

1. Note: install hangers to not conflict with process piping. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:

   a. Vertical Piping: MSS Type 8 or Type 42, clamps.

   b. Individual, Straight, Horizontal Piping Runs: According to the following:

      1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

      2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

      3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

d. Base of Vertical Piping: MSS Type 52, spring hangers.

2. Install supports according to Division 15 Section "Hangers and Supports."

3. Support vertical piping and tubing at base and at each floor.

4. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

5. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.

b. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.

6. Install supports for vertical PVC piping every 48 inches (1200 mm).

7. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

F. CONNECTIONS

1. Connect condensate piping to storm system as indicated on the drawings. Use transition fitting to join dissimilar piping materials.

2. Connect drainage piping to the following:

a. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

G. FIELD QUALITY CONTROL

1. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be

made. Perform tests specified below in presence of authorities having jurisdiction.

a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

4. Test piping according to procedures of authorities having jurisdiction.

a. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

b. Prepare reports for tests and required corrective action.

H. CLEANING

1. Clean interior of piping. Remove dirt and debris as work progresses.

2. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

3. Place plugs in ends of uncompleted piping at end of day and when work stops.

I. PROTECTION

Exposed PVC Piping: Protect piping exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

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SECTION 15201 GENERAL REQUIREMENTS FOR STEEL PIPING

PART 1 - GENERAL

A. Description

This section includes general requirements for materials, fabrication, installation, and testing of steel pipe.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit materials list showing material of pipe and fittings with ASTM reference and grade. Submit manufacturer's certification of compliance with referenced standards, e.g., ASTM A53, A135, and A587 and AWWA C200. Show piping service (fuel oil, gasoline, water, air, etc.).

3. For piping 6 inches and larger, submit piping layout drawings showing location and dimensions of pipe and fittings. Include laying lengths of valves, meters, in-line pumps, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe and provide the following information for each item:

   a. Material of construction, with ASTM or API reference and grade.

   b. Wall thickness of steel cylinder.

   c. Mortar lining thickness (if pipe has been specified to have a mortar lining).

   d. Mortar coating thickness, where mortar coating is required.

   e. Paint prime coating, where prime coat is required.

   f. Manufacturer's certificates of compliance with referenced pipe standards, e.g., ASTM A 53, ASTM A 135, API 5L, AWWA C200.

g. Show weld sizes and dimensions of grooved-end collars, flanges, reinforcing collars, wrapper plates, and crotch plates.

4. Submit coating application test records for field measuring paint coating thickness and holiday detection for each pipe section and fitting. Describe repair procedures used.

5. Submit dimensional shop drawings of all fittings, welds, flanges, appurtenances and respective detailing in correspondence to the Work illustrated in the Drawings.

PART 2 - MATERIALS

A. Steel Pipe Cylinders

1. The yield strength of the steel for pipe and fabricated fittings having grooved-end joints shall be minimum 35,000 psi.

2. Straight runs of pipe upstream of flowmeters shall be smooth. The inside diameters of such pipes shall match the inside diameters of the flowmeters.

3. Provide seamless pipe or pipe having straight longitudinal weld seams where pipe passes through rubber annular sealing devices.

B. Fittings

See Sections 15276 and 15255.

C. Joints

1. Provide plain-end pipe where flexible pipe couplings are to be provided. Provide lugs for thrust harnesses where shown in the drawings, per Section 15122.

2. Where piping connects to wall pipes, meters, valves, or other equipment, the pipe ends shall match the ends of the wall pipes, meters, valves, or equipment.

D. Outlets and Nozzles

1. Outlets of size 3 inches and smaller shall be of the thredolet type, per MSS SP-97 and AWWA Manual M11 (1989 edition), Figure 13-23. Outlets shall be 3,000-pound WOG forged steel per ASTM A105 or ASTM A216, Grade WCB.

Threads shall comply with ASME B1.20.1. Outlets shall be Bonney Forge Co. "Thredolet," Allied Piping Products Co. "Branchlet," or equal.

2. Alternatively, threaded openings not less than 2 inches or more than 3 inches in nominal size shall be a flat-bottom half-coupling conforming to ASME B16.11, Class 3000. Where the mounting surface is curved to a diameter of 36 inches or less, the mounting diameter shall be the same as that of the surface upon which it is to be mounted. Forge the threaded outlet and its plug from steel conforming to ASTM A105 or ASTM A181, Class 70.

3. For outlets 3 inches and smaller in piping smaller than 4 inches, use a tee with a threaded outlet.

4. For outlets larger than 3 inches, use a tee with a flanged outlet.

E. Grooved-End Couplings

1. Grooved-end couplings shall be ductile iron, ASTM A 536, Grade 60-40-18 or 65-45-12. Gaskets shall conform to ASTM D 2000 and be of the following materials:

Piping Service	Gasket Material
Reclaimed Water	EPDM

2. Bolts in exposed or buried service shall conform to ASTM A 193, Grade B8M, Class 2.

3. Couplings for connecting to grooved-end valves shall be Victaulic Style 44 to match the valve ends.

4. Grooved-end adapter flanges for pipe 18 inches and smaller having a maximum test pressure of 200 psi shall comply with ANSI B16.1, Class 125 dimensions. Flanges shall be Victaulic Style 741 or 742, Gustin-Bacon Figure 154, or equal.

F. Flanges

1. Forged flange material shall conform to ASTM A105, A 181, or A 182. Steel flange material shall conform to ASTM A283 (Grade C or D), A285 (Grade C), or A36.

2. Determine the pressure class of the flanges based on the test pressures shown in the Piping Schedule in the drawings. For test pressures 200 psi and less, use Class

150 flanges. For test pressures greater than 200 psi, use Class 300 flanges having the following facings unless otherwise indicated:

Test Pressure (psi)	Size Range (inches)	Flange Facing
200 to 375	48 and smaller	Flat

3. Flanges shall comply with AWWA C207, Class D or E as follows. Use welding neck flanges conforming to ANSI B16.5 in piping 10 inches and smaller and in all sizes where connecting to wrought steel elbows and tees. Flanges shall be flat faced. Use the following pressure classes of flanges based on the specified test pressures:

Test Pressure (psi)	Pipe Size (inch)	Flange Pressure Class
175 and less	4-12	Class D
175 to 200	4-12	Class E
150 and less	14-144	Class D
150 to 200	14-144	Class E

4. Provide flat-faced flanges as described above where connecting to cast-iron flanges and where otherwise indicated.

5. Blind flanges shall comply with AWWA C207, Table 7.

G. Flanges for Interconnection with Ductile Iron Pipe:

Flanges for interconnection with Ductile Iron Pipe shall have bolt pattern compatible for connection to AWWA C115, Class 125 Ductile Iron Pipe flanges.

H. Bolts, Nuts, and Gaskets for Flanges

See Section 15050.

I. Lubricant for Stainless Steel Bolts and Nuts

See Section 15050.

PART 3 - EXECUTION

A. Fabrication, Assembly, and Erection

1. Beveled ends for butt-welding shall conform to ASME B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding. When welding the reverse side, chip out slag before welding.

2. Fabrication shall comply with ASME B31.3, Chapter V. Welding procedure and performance qualifications shall be in accordance with Section IX, Articles II and III, respectively, of the ASME Boiler and Pressure Vessel Code.

3. The minimum number of passes for welded joints shall be as follows:

Steel Cylinder Thickness (inch)	**Minimum Number of Passes for Welds**
Less than 0.1875	1
0.1875 through 0.25	2
Greater than 0.25	3

Welds shall be full penetration.

4. Use the shielded metal arc welding (SMAW) submerged arc welding (SAW), flux-cored arc welding (FCAW), or gas-metal arc welding (GMAW) process for shop welding. Use the SMAW process for field welding.

5. Welding preparation shall comply with ASME B31.3, paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ASME B31.3, Table 341.3.2 and paragraph 341.4 for visual examination.

6. Identify welds in accordance with ASME B31.3, paragraph 328.5.

7. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

8. Welding electrodes shall comply with AWS A5.1

B. Shop Testing of Fabricated or Welded Components

1. After completion of fabrication and welding in the shop and prior to the application of any lining or coating, test each component according to the following requirements.

2. Test Method Requirements - Shop:

   a. Test each section of steel pipe with the joint rings attached in the shop by the hydrostatic test method.

   b. Test each section of fabricated bend that is fabricated from steel pipe previously tested. Use the hydrostatic test method. Test the mitered joints by the liquid penetrant method.

   c. Test each section of pipe with manholes and outlets attached after completion of the shop hydrostatic test as follows:

      (1) For d/D greater than 0.30, where d is nominal diameter of the outlet and D is nominal diameter of main pipeline, test section by the hydrostatic method plus soap and compressed air method at the collar.

      (2) For d/D less than 0.30, test the collar by the soap and compressed air method.

   d. Assemble and retest flanged insulating joints by the hydrostatic test method. Test for electrical conductivity across joint.

   e. Perform tests of production welds in accordance with AWWA C200 for each heat of steel used. A guided-bend test specimen shall be considered as having passed only if no crack or other open defect exceeding 1/8 inch measured in any direction is present in the weld metal or heat affected zone of the base material after the bending. A tension test specimen shall be considered as having passed only if failure occurs in the base metal at a stress in excess of the minimum specified tensile strength. Perform at least one set of welding tests as described in AWWA C200, Section 4.11.5 for each 1,000 lineal feet of spiral seam weld in addition to tests specified in Section 4.11.6 of the same standard.

f. Inspect welds in the expanded portion of the pipe bell in accordance with the magnetic particle test.

g. Test outlet reinforcing collars, wrapper plates, each slip-on flange, and grooved-end coupling collars by the soap and compressed air method.

h. Test backgouge and completed weld of manual process groove welds by the liquid penetrant method. Test completed fillet welds by the liquid penetrant method.

i. Perform 100% ultrasonic testing (where appropriate for such testing) or liquid penetrant testing on manual process circumferential welds and welds at collars and risers.

j. Perform radiographic testing on 20% of the circumferential welds of fabricated bends and reducers, including junctions between circumferential and longitudinal welds.

k. Test the longitudinal welds of the bell and spigot of each section of steel pipe or fabricated steel cylinder that is to be field welded by the magnetic particle test method.

C. Product Marking

Plainly mark each length of straight pipe and each special and fitting at the bell end to identify the design pressure or head, the steel wall thickness, the date of manufacture, and the proper location of the pipe item by reference to the layout schedule. For beveled pipe, show the degree of bevel and the point on the circumference to be laid uppermost.

D. Installing Flanged Piping

See Section 15050.

E. Installation of Stainless Steel Bolts and Nuts

See Section 15050.

F. Installing Grooved-End Piping

See Section 15050.

G. Installing Aboveground or Exposed Piping

See Section 15050.

H. Installing Buried Piping

1. Install in accordance with Section 02223.

I. Field Hydrostatic Testing

Hydrostatically test pipe and fittings in the field in accordance with Section 15144. See Piping Schedule for test pressures.

J. Painting and Coating

1. Coat pipe located above ground or in vaults and structures in accordance with Section 09900, System No. 7.

2. Pipe that is to be encased in concrete shall have no coating, unless shown otherwise in the drawings.

3. Coat the ends of plain-end buried pipe where flexible pipe couplings are to be installed per Section 09900, System No. 7. Apply coating in shop.

4. The coating thickness on pipe ends having grooved-end joints (gasket seating surface and the entire groove) and on the coupling key, shoulder, gasket pocket, and bolt pad mating surfaces of the groove-end couplings shall be 8 to 10 mils.

5. Coat exposed grooved-end couplings the same as the adjacent pipe.

6. Line and coat submerged grooved-end couplings with fusion-bonded epoxy per Section 09961.

7. Coat the interior metal surfaces of blind flanges per Section 09900, System No. 7.

K. Coating Buried and Submerged Bolts, Nuts, and Tie Rods

Coat submerged bolts, nuts, restraint devices, and tie rods per Section 09900, System No. 7. Provide threaded polyethylene nut protection caps per Section 15050.

L. Field Thickness Measurement and Repair of Paint Coatings for Steel Pipe

1. Field repair shop applied prime coats per Section 09900.

2. Test linings and coatings per ASTM G62, Method B, with a holiday detector set at 125 volts per mil coating thickness. Repair holidays and pinholes by applying the prime, intermediate, and finish coatings to each holiday or pinhole and retest.

3. Measure the lining and coating thickness on each pipe section using a calibrated coating thickness gauge. Make five separate spot measurements (average of three readings) spaced evenly over every 15 linear feet (or fraction thereof) to be measured. Make three gauge readings for each spot measurement of either the substrate or the paint. Move the probe a distance of 1 to 3 inches for each new gauge reading. Discard any unusually high or low gauge reading that cannot be repeated consistently. Take the average (mean) of the three gauge readings as the spot measurement. The average of five spot measurements for each area shall not be less than the specified thickness. No single spot measurement in any area shall be less than 80%, or more than 120%, of the specified thickness. One of three readings that are averaged to produce each spot measurement may underrun by a greater amount. If a section of the pipe, item, or piece of equipment does not meet these criteria, remove the entire lining or coating and recoat the entire item or piece of equipment.

4. Thickness determination shall meet the following requirements:

   a. No individual reading shall be below 75% of specified thickness.

   b. Individual spot readings (consisting of three point measurements within 3 inches of each other) shall have an average not less than 80% of specified thickness.

   c. The average of all spot readings shall be equal to or greater than nominal thickness specified.

5. Thickness determinations shall be conducted using a Type 1 magnetic thickness gauge as described in SSPC PA2 specification.

6. If the item has an insufficient film thickness, clean and topcoat the surface with the specified finish coatings to obtain the specified coverage. Sandblast or power-sand visible areas of chipped, peeled, or abraded coating, feathering the edges. Then coat in accordance with the specifications. Work shall be free of runs, bridges, shiners, laps, or other imperfections.

END OF SECTION

SECTION 15225 RUBBER AND PLASTIC HOSE AND TUBING

PART 1 - GENERAL

A. Description

This section includes materials and accessories for rubber and plastic hoses and tubing:

1. SBR hose for water service (Type 5).

2. Flexible white translucent or color-coded polyethylene tubing (Type 13).

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit manufacturer's catalog data and descriptive literature for hoses, tubing, and couplings. Show pressure rating and materials of construction for tube, carcass, and cover. Show design of hose and tubing ends.

3. Submit procedures for making up insert fittings and joints and compression fittings and joints.

PART 2 - MATERIALS

A. Hose and Tubing Identification

Hoses and tubing are identified in the drawings by size, type number, and in some cases (Types 1 through 5 hoses) by a suffix letter denoting the type of end connection. For example, a callout of 2" Type 1A means a 2-inch, abrasive slurry service hose, with grooved-end nipples at both ends.

B. Hose Design (Type 5)

Design hose for the material conveyed as described in the subsection on "Service Conditions." Provide hose design consisting of cover, carcass, and tube. Design carcass reinforcement to provide a minimum 4:1 safety factor for the working pressure specified in the subsection on "Service Conditions."

C. Type 5: SBR Hose for Potable Water Service

1. Cover: SBR.

2. Reinforcement: Minimum of two horizontal braids or two plies of synthetic fabric.

3. Tube: SBR.

4. Minimum Pressure Rating: 150 psi.

5. Products: Uniroyal H-3400, Goodall N-320, Goodyear, Gates “Steel Head,” or equal.

D. Type 13: Flexible White Translucent or Color-Coded Polyethylene Tubing (1/4 Through 5/8 Inch)

1. Provide odorless and tasteless flexible orange and yellow polyethylene tubing extruded from high molecular weight resin with smooth inside bore and smooth outside. Use the following color codes for the various service conditions in the project:

Tubing Service	**Color Code**
Sodium Hypochlorite	Yellow
Polymer	Orange

2. Minimum operating pressures shall be 120 psi for 1/4 through 3/8 inch, 90 psi for 1/2 inch, and 70 psi for 5/8 inch. Minimum operating pressure shall be 1/4 of the burst pressure of the tubing. Minimum bending radius shall be 2 inches. Joints and fittings shall be of the compression type utilizing a ferrule nut. Tubing shall comply with ASTM D1248, Type I, Class A, Category 4, Grade E.

3. Products: Parker “Parflex Polyethylene Tubing” with Parker “Fast & Tite” joints and fittings or equal.

4. Provide fitting material that are compatible with the chemical usage.

E. End Connections for Type 5 Hose

1. Type A: Schedule 80S, Type 316 stainless steel grooved-end nipples built into the hose. Grooved-end nipples shall be flexible, square cut grooved, per AWWA C606,

Table 3. Connect hoses to each other with grooved-end couplings.

2. Type B: Schedule 80S, Type 316 stainless steel nipples built into the hose. Ends shall be male threaded, per ASME B1.20.1. Connect hose sections to each other with unions.

3. Type C: Hose shank couplings of the quick-connect type. Fasten couplers and adapters to the hose with clamps. The couplers, adapters, and clamps shall be Type 316 stainless steel. Couplers shall be Evertite Part C, Civicon 633-C, Parker-Hannifin Style C, or equal. Adapters shall be Evertite Part E, Civicon 633-E, Parker-Hannifin Style E, or equal. Where hoses connect to piping, fasten hose shank adapters to the hose end and female couplers to the pipe end. Where hoses are connected in series, fasten one female coupler and one male adaptor to each hose. Fasten male adapters to both ends of a hose only where necessary to accommodate connections with pipes. Do not fasten female couplers to both ends of any hose.

4. Type D: Shaped to the dimensions of Class 125, ASME B16.1, flanges. Construct as an integral part of the hose utilizing the same tube, cover, and carcass material as the hose. Provide Type 316 stainless steel retaining ring for each flange. Bolts and nuts: ASTM A193 (Grade B8M) for bolts and ASTM A194 (Grade 8M) for nuts. Provide washer under each nut and bolthead. Washers shall be of the same material as the nuts.

5. Type E: Hose shank couplings shall be of the quick-connect type. Fasten couplers and hose adapters to the hose with clamps. Coupler and adapters shall be polypropylene: Dixon or equal. Clamps shall be Type 316 stainless steel. Where hoses connect to piping, fasten hose shank adapters to the hose end and female couplers to the pipe end. Where hoses are connected in series, fasten one female coupler by hose shank on one end and one male adapter by hose shank on the other end. Fasten male adapters to both ends of hose only where necessary to accommodate connections with pipes. Do not fasten female couplers to both ends of any hose.

F. Unions for Type 5 Hose

Unions shall be 3,000-pound WOG forged stainless steel, with dimensions conforming to MSS SP-83. Material shall conform to ASTM A182, Grade F316. Ends shall be threaded per ASME B1.20.1.

G. Insert Fittings for Tubing

1. When insert fittings are specified, they shall be of the single-barb type. The completed tubing and fitting system shall have the same operating pressure ratings as specified for the tubing.

2. Rigid PVC pipe to PVC tubing transition fittings shall be solvent cement socket by single barb fittings with stainless steel clamps.

H. Quantities

1. See drawings for total hose lengths or quantities. Provide hoses in maximum 50-foot-long sections.

2. See drawings for total tubing lengths or quantities for the sodium hypochlorite service provides tubing in minimum 300-foot lengths or sections.

PART 3 - EXECUTION

A. Storage

Store hoses in a protected room or building at a temperature range of 50°F to 70°F. Do not store hoses near sources of heat such as radiators or base heaters. Do not store hoses so that they are exposed to sunlight; provide covers to protect hoses from sunlight and from fluorescent or mercury lamps. Storage areas shall be cool and dark, free of dampness and mildew. Protect hoses from rodents and insects. Store hose that is shipped in coils so that the coils are in a horizontal plane.

B. Hose Installation

Prior to assembling hose and components such as fittings and connectors, carefully examine components for correct material, style, size, catalog number, and length. Examine hoses for cleanliness, obstructions, blisters, cover looseness or damage, kinks, cracks, cuts, or any other visible defects. Inspect the fitting and sealing surfaces

for burrs, nicks, corrosion, or other imperfections. Do not use any components that display such signs of nonconformance.

C. Service Conditions

1. Service and design conditions for hoses and tubing shall be as follows:

a. Type: 5

b. Minimum Working Pressure: 100 psig.

c. Material Conveyed: Reclaimed Water

d. Hose or Tubing Size: See drawings inches.

e. Type: 13

f. Minimum Working Pressure: 30 psig.

g. Material Conveyed: Sodium Hypochlorite (10% to 15%)

h. Hose or Tubing Size: See drawings inches.

i. Type: 13

j. Minimum Working Pressure: 30 psig.

k. Material Conveyed: Polymer

l. Hose or Tubing Size: See drawings inches.

D. Field Testing

1. Hydrostatically test hose for leakage in accordance with Section 15144. Leakage shall be zero. Perform pressure testing using water. Fill hoses with water with the outlet ends raised and any outlet valves open to allow the complete removal of air. When the air has been expelled, close outlet valves or install blind flanges or plugs on the outlets and lower the raised ends. Raise the pressure to the specified test pressure. Examine hose for leaks at couplings, fitting slippage, or any indication of weakness in the hose structure. Remove and replace the hose or couplings or fittings if there are any signs of leakage, fitting slippage, or weakness in the hose. Drain the water from the hoses after completion of the pressure tests. See the Piping Schedule in the drawings for test pressures. Some

chemicals, such as concentrated acids, may react with water and become even more corrosive than the standard acid. An example is sulfuric acid. Check the compatibility of the hose material you are specifying and describe the required cleaning procedure accordingly. Identify exactly which hose services need to be purged of moisture. If there is no problem adding the anticipated chemicals to the hoses containing moisture, then delete paragraph below.

2. After completing the pressure testing and draining the water out of the hoses and before filling the hoses with the specified chemicals, flush the following hoses with alcohol to remove moisture. Then blow clean, dry, oil-free air having a dew point of at least 40°F through the hoses. Circulate the air through the hoses until the exiting air has the same dew point as the applied air. Dispose of the effluent from the hoses in accordance with local water quality requirements.

END OF SECTION

SECTION 15240 DUCTILE-IRON PIPE

PART 1 - GENERAL

A. Description

This section describes materials, testing, and installation of ductile-iron pipe and fittings 64 inches and smaller.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Provide an affidavit of compliance with standards referenced in this specification, e.g., AWWA C151. Submit copy of report of pressure tests for qualifying the designs of all sizes and types of AWWA C153 fittings that are being used in the project. The pressure test shall demonstrate that the minimum safety factor described in AWWA C153, Section 5.5 is met.

3. Provide the following information:

   a. Mortar lining thickness.

   b. Wall thickness.

   c. Material test data for this project.

   d. Show deflections at push-on and mechanical joints.

   e. Submit joint and fitting details and manufacturer’s data sheets.

4. Submit calculations and test data proving that the proposed restrained joint arrangement can transmit the required forces with a minimum safety factor of 1.5.

5. Submit certificate that cement for mortar lining complies with ASTM C150, designating type and AWWA C104.

6. Submit test report on physical properties of rubber compound used in the gaskets.

7. Submit drawing or manufacturer's data sheet showing flange facing, including design of facing serrations.

8. Submit weld procedure specification, procedure qualification record, and welder's qualifications prior to any welding to ductile-iron pipe.

9. Submit leak free results of factory air tests for all fittings with welded bosses or outlets.

PART 2 - MATERIALS

A. Pipe

Pipe shall be cast ductile (nodular) iron, conforming to AWWA C151.

B. Pipe Wall Thickness

1. Minimum wall thickness for pipe having push-on or mechanical joints, restrained joints, plain ends, or cast flange ends shall be Class 150, unless otherwise shown in the drawings.

2. Minimum wall thickness for pipe having threaded flanges shall be Special Class 53.

3. Minimum pipe wall thickness required for corporation stops and tapped outlets shall be in accordance with Table A.1 of AWWA C151 for three full threads for design pressures up to 250 psi and four full threads for design pressures over 250 to 350 psi.

C. Fittings

1. Fittings 48 inches and smaller shall conform to AWWA C110 with a minimum pressure rating of 250 psi. Material shall be ductile iron. Flanges shall be flat faced.

2. Mechanical joint fittings conforming to AWWA C153 may be used in lieu of AWWA C110 fittings.

3. Material for fittings with welded-on bosses shall have a Charpy notch impact value of minimum 10 ft-lbs under the conditions defined in AWWA C151. Manufacturer shall submit leak free results of factory air tests for all such welded bosses or outlets.

4. Fittings in Air-1 service shall be unlined.

D. Flanges

1. Flanges shall be solid back, Class 125 per AWWA C115. Flanges on pipe shall be either cast or threaded. Material shall be ductile iron.

2. Flanged pipe and fittings shall be shop fabricated, not field fabricated. Threaded flanges shall comply with AWWA C115. Flanges shall be individually fitted and machine tightened in the shop, then machined flat and perpendicular to the pipe barrel. Flanges shall be backfaced parallel to the face of flange. Prior to assembly of the flange onto the pipe, apply a thread compound to the threads to provide a leak-free connection. There shall be zero leakage through the threads at a hydrostatic test pressure of 250 psi.

E. Pipe Lining-- Ceramic Epoxy

1. Line the interior of the following pipe and fittings with an amine cured novalac epoxy containing at least 20 percent by volume of ceramic quartz pigment, Protecto 401 ceramic epoxy: Line the interior of the pipes as identified in the Flow Stream Identification chart in the drawings.

2. Before application of the lining, prepare the pipe surfaces in accordance with the applicator's recommendations. Apply the lining to a thickness of 40 mils nominal dry film thickness. Do not line the face of flanges.

3. For bell sockets and spigot ends, coat the gasket area and spigot end up to 6 inches back from the end of the spigot with 6 mils nominal, 10 mils maximum of Protecto Joint Compound. Apply the joint compound with a brush without causing excess buildup in the gasket seat or on the spigot ends.

4. Test lining thickness using a magnetic film thickness gauge. Conduct testing in accordance with SSPC-PA-2, Film Thickness Rating. Test for pinholes with a non-destructive 2,500 volt test. Repair all defects prior to shipment.

F. Pipe Lining for Air Service

1. Ductile Iron pipe in air service, Air-1, shall be unlined.

G. Pipe Lining-Cement Mortar

1. Unless unlined pipe or ceramic epoxy lining is specified above, line the pipe interior and fittings with cement-mortar per AWWA C104. Lining thickness shall be the double thickness listed in AWWA C104, Section 4.8. Lining material shall conform to ASTM C 150, Type V. This shall include the following pipes: Line the interior of the pipes as identified in the Flow Stream Identification chart in the drawings.

2. Line blind flanges per Section 09900, System No. 7.

3. Remove and reconstruct lining in areas where quality is defective per AWWA C104.

H. Gaskets for Flanges

See Section 15050.

I. Gaskets for Mechanical, Push-On, and Restrained Joints in Water Service

Synthetic or natural rubber in accordance with AWWA C111.

J. Gaskets for Mechanical, Push-On, and Restrained Joints in Air Service

Provide Viton gaskets rated for 250 F.

K. Bolts and Nuts for Flanges

See Section 15050.

L. Outlets and Nozzles

1. Provide outlets 2 inches and smaller by using a threaded welded-on boss.

2. For outlets larger than 2 inches use a tee with a flanged outlet.

M. Joints

1. Joints in aboveground or submerged piping or piping located in vaults and structures shall be flanged.

2. Joints in buried piping shall be of the restrained type per AWWA C111 except where flanged joints are required to connect to valves, meters, and other equipment.

3. All buried joints shall be restrained.

4. Restrained joint devices shall be accordance with the Orange County Utilities Standards and Construction Specifications Manual List of Approved Products in Appendix A.

5. Restrained joints for piping 4 to 36 inches shall be American Cast Iron Pipe “Fast Grip Gaskets”, U.S. Pipe “Field Loc Gaskets” or equal. Joint restraint shall be certified to a rated pressure of 250 psi. Restrained joints for piping 36 inches to 64 inches shall be American Cast Iron Pipe “Flex-Ring”, or “Lok-Ring”, U.S. Pipe “TR Flex” or “HP Lok”, or equal.

6. Where thrust restraint is called for in the drawings, provide pipe with restrained joints capable of transmitting 1.5 times the thrust, as calculated by the following equation:

$$T = 1.5 * (0.785 * P * D^2)$$

where:

P = Pressure class of pipe in psi.
D = Outside diameter of pipe in inches.
T = Thrust in pounds.

7. Existing unrestrained bell & spigot joints are to be restrained using Series 1100HD restraint devices by EBBA Iron, Inc. Restraint may also be provided by a thrust collar constructed in accordance with the Orange County Utilities Standards and Construction Specifications, Figure A105-1 & -2. Existing unrestrained fittings and appurtenances are to be restrained using Series 1100SD by EBBA Iron, Inc.

N. Mechanical Joint Restraint System Using Follower Ring and Wedges

The restraining mechanism shall consist of a follower gland having a seal gasket and individually actuated wedges that increase their resistance to pullout as pressure or external forces increase. The system manufacturer shall provide all the components (follower ring, wedges, and gaskets) for the restraining device. The device shall be capable of full

mechanical joint deflection during assembly and the flexibility of the joint shall be maintained after burial. The joint restraint ring and its wedging components shall be constructed of ductile iron conforming to ASTM A 536, Grade 60-42-10. The wedges shall be ductile iron, heat-treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with mechanical joint bells conforming to AWWA C111 and AWWA C153. The design shall use torque limiting twist-off nuts to provide actuation of the restraining wedges. The mechanical joint restraint shall be available in the size range of 3 through 48 inches. Minimum rated pressure shall be 350 psi for sizes 16 inches and smaller and 250 psi in sizes 18 inches and larger. Products: Megalug Series 1100 as manufactured by EBAA Iron, Inc., or equal.

O. Ductile-Iron Pipe Weldments

1. All welding to ductile-iron pipe, such as for bosses, joint restraint, and joint bond cables, shall be done at the place of manufacture of the pipe. Perform welding by skilled welders experienced in the method and materials to be used. The manufacturer shall have a fully documented welding quality assurance system and maintain resident quality assurance records based on ANSI/AWS D11.2, the guide for Welding Iron Castings. The manufacturer shall maintain appropriate welding procedures specification, procedure qualification, and welder performance qualification test records.

2. Welds shall be of uniform composition, neat, smooth, full strength, and ductile. Completely grind out porosity and cracks, trapped welding flux, and other defects in the welds in such a manner that will permit proper and complete repair by welding.

3. Prior to the application of any coating or lining in the outlet area all weldments for branch outlets shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. Any weldment that shows signs of visible leakage shall be repaired and retested in accordance with the manufacturer’s written procedures.

PART 3 - EXECUTION

A. Delivery, Unloading, and Temporary Storage of Pipe at Site

1. Use unloading and installation procedures that avoid cracking of the lining.

2. Do not move pipe by inserting any devices or pieces of equipment into the pipe barrel. Field repair linings damaged by unloading or installation procedures.

B. Sanitation of Pipe Interior

1. During laying operations, do not place tools, clothing, or other materials in the pipe.

2. When pipe laying is not in progress, close the ends of the installed pipe by a child- and vermin-proof plug.

C. Installing Flanged Pipe and Fittings

Install in accordance with Section 15050. Cut the bore of the gaskets such that the gaskets do not protrude into the pipe when the flange bolts are tightened.

D. Installing Buried Piping

1. Install in accordance with Section 02223 and as follows.

2. Assemble restrained joints per manufacturer's instructions.

E. Joint Deflections for Buried Pipe

No pipe deflection of buried piping is allowed unless approved by the County’s Representative. Approval will be on a case by case basis.

F. Installing Aboveground or Exposed Piping

See Section 15050.

G. Painting and Coating

1. Prior to finish coating, trim excess gaskets protruding from flanged connections and caulk the joint.

2. Coat pipe located above ground and in vaults and structures as shown in the Piping Schedule in the drawings. Apply prime coat in the shop before transporting pipe to the jobsite.

3. Apply intermediate coats in the field before installing the pipe, then touch up after installation.

4. All field cut pipe ends shall be coated, no bare metal shall be permitted.

5. Provide asphaltic coating on buried pipe per AWWA C151.

6. Coat buried flanges and buried mechanical and restrained joint bolts, nuts, and glands per Section 09900, System No. 21.

7. Coat submerged pipe with fusion-bonded epoxy per Section 09961 or system 6 per Section 09900.

H. Interior Joint Recesses for Buried Piping 30 Inches and Larger

Working inside the pipe, remove foreign substances from joint recesses and pack with cement-mortar. Finish the surface with a steel trowel to match adjoining pipe.

I. Cleaning Pipe

Sweep pipe clean of all dirt and debris. If hardened mud exists in the pipe, remove with the use of pressurized water hoses.

J. Field Hydrostatic Testing

Test pressures are shown in the Piping Schedule in the drawings. Test in accordance with Section 15144.

K. Pipe Labeling

Label exposed pipe above grade or in buried vaults per Section 15075.

L. Buried Warning and Identification Tape

Provide detectable warning tape per Section 15075. Warning and identification shall read “CAUTION BURIED WATER PIPING BELOW” or similar wording.

END OF SECTION

SECTION 15242 GLASS-LINED DUCTILE-IRON PIPE

PART 1 - GENERAL

A. Description

This section describes materials, testing, and installation of glass-lined ductile-iron pipe and fittings, 4 through 20 inches in diameter having a maximum operating pressure of 300 psi.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions Section 01300, and the following.

2. Submit piping layout drawings showing location and dimensions of pipe and fittings. Include laying lengths of valves, meters, in-line pumps, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe and provide the following information for each item:

   a. Material of construction with ASTM reference and grade.

   b. Wall thickness of cylinder.

   c. Glass lining thickness.

   d. Paint primer coating, where shop primer coat is required.

   e. Manufacturer's certificates of compliance with referenced pipe standards, e.g., AWWA C151.

3. Submit glass lining applicator's data sheets for the glass lining. Show physical characteristics of lining. Show method of preparing pipe surface for glass application. Note that this specification requires pipe to be bored or machined.

4. Submit gasket manufacturer's recommended torques for tightening bolts on flanged connections.

5. Submit certification that pipe and fittings comply with these specifications and the referenced standards.

6. Submit manufacturer's catalog data for the flange gaskets.

7. Submit drawing or manufacturer's data sheet showing flange facing, including design of facing serrations.

PART 2 - MATERIALS

A. Pipe

Pipe shall be ductile iron, conforming to AWWA C151. Bore, machine, or abrasive blast pipe and fittings to remove voids, protrusions, or surface irregularities in the pipe interior to provide a smooth continuous surface for the glass lining.

B. Glass Lining

1. Glass lining for pipe and fittings shall consist of glasses and inorganic materials applied by heating the pipe and fittings to a temperature above 1400°F and fusing a smooth, vitreous surface to the interior of the pipe. The lining shall be a minimum of 10 mils thick. The lining shall bond sufficiently to the base metal to withstand a strain of 0.001 inch per inch without damage to the lining. The finished lined pipe shall not deviate more than 0.0125 inch per foot of length from a centerline perpendicular to the flange face or square end of the pipe. Minimum glass hardness shall be 5 on the Mohs scale.

2. Glass lining material shall be Ferrock MEH-32 as manufactured by Water Works Manufacturing Co., Marysville, California; Ceramic Coating Company, Newport, Kentucky; Vitco Company Type SG-14, Waterford, Pennsylvania; or equal.

C. Pipe Wall Thickness

Minimum wall thickness (after boring or abrasive blasting pipe for the glass lining) for pipe having threaded flanges shall be Special Class 53.

D. Fittings

1. Fittings shall conform to AWWA C110 with a minimum pressure rating of 250 psi. Elbows shall be long radius per ASME B16.1. Pressure rating of the fittings shall be Class 125 fittings. Flanges shall be flat faced.

2. Material for fittings with welded-on bosses shall have a Charpy notch impact value of minimum 10 foot-pounds under the conditions defined in AWWA C151.

E. Flanges

1. Flanges shall be solid back Class 125 per AWWA C115 with serrated facing. Pressure rating of the flanges shall be Class 125 flanges. Flanges on pipe shall be either cast or threaded.

2. Flanged pipe and fittings shall be shop fabricated, not field fabricated. Threaded flanges shall comply with AWWA C115. Flanges shall be individually fitted and machine tightened in the shop, then machined flat and perpendicular to the pipe barrel. Flanges shall be backfaced parallel to the face of flange. Prior to assembly of the flange onto the pipe, apply a thread compound to the threads to provide a leak-free connection. There shall be zero leakage through the threads at a hydrostatic test pressure of 250 psi without the use of the gasket.

3. Material for blind flanges shall be ductile iron.

F. Gaskets For Flanges

See Section 15050.

G. Bolts and Nuts For Flanges

See Section 15050.

H. Lubricant For Stainless Steel Bolts and Nuts

See Section 15050.

I. Joints

1. Joints shall be flanged unless otherwise noted in the drawings.

2. Restrained mechanical joints, where shown in the drawings, shall be American Cast Iron Pipe Company “Fast-Grip,” U.S. Pipe Field-lok gasket within Tyton joint pipe and fittings, or equal. Joint restraint shall be certified to four times rated pressure of 200 psi by Factory Mutual.

J. Mechanical Joint Restraint System Using Follower Ring and Wedges

The restraining mechanism shall consist of a follower gland having a seal gasket and individually actuated wedges that increase their resistance to pullout as pressure or external forces increase. The system manufacturer shall provide all the components (follower ring, wedges, and gaskets) for the restraining device. The device shall be capable of full mechanical joint deflection during assembly, and the flexibility of the joint shall be maintained after burial. The joint restraint ring and its wedging components shall be constructed of ductile iron conforming to ASTM A536, Grade 60-42-10. The wedges shall be ductile iron, heat-treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with mechanical joint bells conforming to AWWA C111 and AWWA C153. The design shall use torque limiting twist-off nuts to provide actuation of the restraining wedges. The mechanical joint restraint shall be available in the size range of 3 through 48 inches. Minimum rated pressure shall be 350 psi for sizes 16 inches and smaller and 250 psi in sizes 18 inches and larger. Products: Megalug Series 1100 as manufactured by EBAA Iron, Inc., or equal.

K. Ductile-Iron Pipe Weldments

1. All welding to ductile-iron pipe, such as for bosses, joint restraint, and joint bond cables, shall be done at the place of manufacture of the pipe. Perform welding by skilled welders who have experience in the method and materials to be used. Welders shall be qualified under the standard qualification procedures of the ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications.

2. Welds shall be of uniform composition, neat, smooth, full strength, and ductile. Completely grind out porosity and cracks, trapped welding flux, and other defects in the welds in such a manner that will permit proper and complete repair by welding.

3. Completed welds shall be inspected at the place of manufacture by the liquid penetrant method. Conform to the requirements specified in ASTM E165, Method A, Type I or Type II. The materials used shall be water washable and nonflammable.

PART 3 - EXECUTION

A. Factory Quality Control

1. Test glass lining with a low-voltage wet sponge holiday detector. The lining shall have no bubbles, pinholes, crazing, or scaling such that the total exposed base metal area exceeds 0.01% of the total glassed surface. The number of holidays or pinholes shall not exceed one per 10 square feet. If the lining fails to meet these requirements, remove the entire pipe lining and reline the entire pipe or fitting.

2. Measure the lining thickness at three locations on each pipe section using a coating thickness gauge calibrated at least once per eight-hour shift. Record each measured thickness value. Where individual measured thickness values are less than the specified minimum thickness, measure the lining thickness at 3-foot intervals along the pipe length. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than 2 mils below the specified minimum value. If a section of pipe does not meet these criteria, remove the entire pipe lining or coating and recoat the entire pipe section or fitting.

B. Installing Flanged Piping and Fittings

1. Install in accordance with Section 15050. Cut the bore of the gaskets such that the gaskets do not protrude into the pipe when the flange bolts are tightened.

2. Flanged pipe and fittings shall be shop fabricated, not field fabricated. Threaded flanges shall comply with AWWA C115 and shall be individually fitted and machine tightened in the shop. Prior to assembly of the flange onto the pipe, apply a thread compound to the threads to provide a leak-free connection. There shall be zero leakage through the threads at a hydrostatic test pressure of 250 psi without the use of the gasket.

3. Use torque wrenches to tighten bolts. Tighten to the torque level recommended for the gasket manufacturer. Wait 30 days after the initial torquing, then retighten.

C. Installation Of Stainless Steel Bolts and Nuts

See Section 15050.

D. Installing Aboveground Or Exposed Piping

See Section 15050.

E. Joint Deflections For Mechanical Joints

1. For restrained joint deflections, do not exceed 80% of the recommended maximum deflection.

2. Assemble joints in accordance with AWWA C600.

F. Painting and Coating

Coat pipe located above ground and in vaults and structures as shown in the Piping Schedule in the drawings. Apply prime coat in the shop before transporting pipe to the jobsite. Apply intermediate and finish coats in the field before installing the pipe, then touch up after installation.

G. Field Hydrostatic Testing

Test pressures are shown in the Piping Schedule in the drawings. Test in accordance with Section 15144.

H. Pipe Labeling

Label exposed pipe above grade or in buried vaults per Section 15075.

END OF SECTION

SECTION 15255 CARBON STEEL PIPE

PART 1 - GENERAL

A. Description

This section includes materials, fabrication, installation, and testing of carbon steel pipe having a maximum design pressure of 300 psi for manifold piping in facilities such as pumping stations, metering structures, flow control and pressure-reducing stations, and other piping associated with mechanical equipment.

B. Submittals

Submit shop drawings in accordance with Sections 15201.

PART 2 - MATERIALS

A. Steel Pipe Cylinders

1. Steel pipe shall be API 5L, Grade B; ASTM A 106, Grade B; ASTM A 135, Grade B; ASTM A 134; or AWWA C200. Pipe conforming to ASTM A 134 or AWWA C200 shall be made of steel conforming to ASTM A 283, Grade C or D, or ASTM A 285, Grade C.

2. Pipe shall be standard weight per ANSI B36.10.

3. See Section 15201 for additional requirements.

B. Fittings

1. Fittings shall comply with Sections 15201 and 15240.

2. Material for fabricated fittings 18 inches through 36 inches in diameter shall comply with Section 15201.

3. Grooved-end fittings smaller than 24 inches shall be square cut grooved, flexible type, with the groove dimensions as shown in AWWA C606, Table 3. Grooved-end fittings 24 inches and larger shall have AWWA C606 Type "D" collars for use with the grooved-end couplings.

4. Mortar lining thickness and internal diameter dimensions shall be as shown on the drawings.

C. Joints

1. Joints for aboveground, exposed, or submerged pipe shall be flanged grooved end, except where flanged joints are required to connect to valves, and other equipment.

2. Buried joints shall be flanged or butt strap welded, grooved end, except where flanged joints are required to connect to valves and other items.

3. Grooved-end joints for pipes 20 inches and smaller shall be flexible, square cut grooved, per AWWA C606, Table 3. Grooved-end joints for pipes 24 inches and larger shall have AWWA C606 Type "D" collars.

4. See Section 15201 for additional requirements.

D. Mortar Lining and Coating

1. Mortar lining thickness for pipe and fittings shall be 1/4 inch.

2. Apply mortar lining in accordance with AWWA C205, using the lining thicknesses specified above. Cement shall be ASTM C150, Type II.

3. Buried pipe shall be cement mortar coated per AWWA C205. Cement shall be ASTM C150, Type II. Mortar coating thickness shall be 1 inch minimum.

4. Hold back the cement mortar coating 12 inches (minimum) from the end of the plain-end joint where flexible pipe couplings are to be installed.

E. Outlets and Nozzles

See Section 15201.

F. Grooved-End Couplings

1. See Section 15201.

2. Couplings for pipe smaller than 24 inches shall be flexible type, square-cut groove, per AWWA C606: Victaulic Style 77, Gustin-Bacon Figure 100, or equal. Use Victaulic Style 44 couplings, or equal, for pipe 24 inches and larger having AWWA C606 Type "D" collars.

G. Flanges

See Section 15201.

H. Bolts and Nuts for Flanges

See Section 15050.

I. Lubricant for Stainless Steel Bolts and Nuts

See Section 15050.

J. Gaskets for Flanges

See Section 15050.

PART 3 - EXECUTION

A. Fabrication, Assembly, and Erection

See Section 15201.

B. Reinforcement

See Section 15201.

C. Shop Testing of Fabricated or Welded Components

See Section 15201.

D. Installing Flanged Piping

See Section 15050.

E. Buried Joints

1. Field-welded joints shall be made in compliance with AWWA C206 and the subsection on fabrication, assembly, and erection above.

2. Apply cement mortar to the inside and outside of buried joints per Section 4.6 of AWWA C205. Use cloth diapers to bridge the outside of the buried joint and maintain the specified mortar coating thickness. Pour and rod the mortar from one side only until it is visible on the opposite side.

F. Installation of Stainless Steel Bolts and Nuts

See Section 15050.

G. Installing Grooved-End Piping

See Section 15050.

H. Installing Aboveground or Exposed Piping

See Section 15050.

I. Installing Buried Piping

Install in accordance with Sections 02223.

J. Field Pressure Testing

See Section 15201.

K. Coating Buried and Submerged Bolts, Nuts, and Tie Rods

See Section 15201.

L. Field Measuring Paint Coating Thickness

See Section 15201.

END OF SECTION

SECTION 15276 STAINLESS STEEL PIPE

PART 1 - GENERAL

A. Description

This section includes materials and installation of stainless steel pipe and fittings 30 inches in diameter and smaller conforming to ASTM A312 or A778 and having a maximum design pressure of 150 psi.

B. Submittals

Submit shop drawings in accordance with Section 15201 and 01300.

PART 2 - MATERIALS

A. Pipe

1. Pipe smaller than 3 inches shall conform to ASTM A 312, Grade TP 304L. Pipe 3 inches and larger shall conform to ASTM A 312 or A778, Grade TP 304L.

2. Pipe sizes and wall thicknesses shall conform to ANSI B36.19 as follows:

Pipe Size	**Wall Thickness**
1 inch and smaller	Schedule 80S
1-1/4 inches through 3 inches	Schedule 40S
3-1/2 inches through 8 inches	Schedule 10S
Larger than 8 inches, through 30 inches	Schedule 10S

B. Fittings

1. Fittings 3 inches and smaller shall be threaded or socket welded, conforming to ANSI B16.11, 3,000-pound CWP. Material for threaded fittings shall conform to ASTM A 403, Class WP304 or ASTM A 182, Grade F304. Material for socket welded fittings shall conform to ASTM A 403, Class WP304L or ASTM A 182, Grade F304L.

2. Fittings for submerged pipe larger than 3 inches through 24 inches shall be butt-welded, conforming to ASTM A403, Class WP or ASTM A774, same material and wall thickness as the pipe, conforming to ANSI B16.9. Elbows shall be long radius.

3. Fittings for aboveground or exposed pipe larger than 3 inches through 24 inches shall be butt-welded or flanged, conforming to ASTM A403, Class WP or ASTM A774, same material and wall thickness as the pipe, conforming to ANSI B16.9. Elbows shall be long radius.

4. Fittings for pipe larger than 24 inches shall conform to ANSI B16.9, or shall be fabricated, per Section 15201. Material shall be the same as the pipe.

C. Pickling, Passivating, and Final Cleaning

Pipe and fittings shall be final cleaned, pickled, and passivated per ASTM A380. Passivation shall be the removal of exogenous (not inherent in the base metal) iron or iron compounds from the surface of the stainless steel by means of a chemical dissolution, by a treatment with an acid solution that will completely remove the surface contamination but will not significantly affect the stainless steel itself. After final cleaning, wet surfaces with water and inspect for rust spots after 24 hours. Reclean, pickle, and passivate per ASTM A380 if there is any evidence of rusting.

D. Quality Control

Include the "Hydrostatic Test" and "Flattening Test" requirements described in ASTM A 530.

E. Protective End Caps

Provide protective end caps on each piece of pipe or fabricated section, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each fitting, or ship and store fittings in sealed boxes or containers.

F. Unions

Unions shall be 3,000-pound WOG forged stainless steel, with dimensions conforming to MSS SP-83. Ends shall be threaded per ANSI B1.20.1 or socket-welding type. Material shall conform to ASTM A 182, Grade F304 for threaded end unions and Grade F304L for socket welded type.

G. Joints

1. Joints for pipes 3 inches and smaller shall be threaded or socket welded, same material as specified for fittings, 3,000-pound WOG, conforming to ANSI B16.11.

2. Joints for submerged pipe larger than 3 inches shall be butt-welded.

3. Joints for aboveground or exposed pipe larger than 3 inches shall be flanged or butt-welded.

4. See Section 15201 for additional requirements.

H. Outlets and Nozzles

1. Outlets of size 3 inches and smaller in piping 4 inches and larger shall be of the Thredolet type, per MSS SP-97 and AWWA Manual M11 (1989 edition), Figure 13-23. Outlets shall be 3,000-pound WOG stainless steel per ASTM A 182, Grade F304L, or ASTM A 403, Grade WP304L. Threads shall comply with ANSI B1.20.1. Outlets shall be Bonney Forge Co. "Thredolet," Allied Piping Products Co. "Branchlet," or equal.

2. See Section 15201 for additional requirements.

I. Thread Lubricant

Use Teflon thread lubricating compound or Teflon tape.

J. Flanges

1. Provide weld-neck flanges (conforming to ANSI B16.5) for piping 3 inches and smaller to connect to flanged valves, fittings, or equipment. Provide weld-neck or Van Stone flanges (per ASTM F2015) for piping larger than 3 inches. Flanges shall be Class 150 per ANSI B16.5. Flanges shall match the connecting flanges on the adjacent fitting, valve, or piece of equipment. Flanges shall be flat face.

2. Material for weld-neck flanges shall conform to ASTM A182, Grade F304L.

3. Material for Van Stone flanges shall be as follows:

Application	Material	Specification
Exposed	304 Stainless Steel	ASTM A 351, Grade CF8M
Submerged	304 Stainless steel	ASTM A 351, Grade CF8M

K. Bolts and Nuts for Flanges

See Section 15050.

L. Lubricant for Stainless Steel Bolts and Nuts

See Section 15050.

M. Gaskets for Flanges

See Section 15050.

N. Wye Strainers

Strainers 2 inches and smaller shall be stainless steel, wye pattern, with minimum pressure rating of 300-psi WOG. Material shall conform to ASTM A 351 or A 743, Grade CF8M. Screen shall be 20 mesh and same material as the strainer. Provide pet cock of the same material as the strainer body in the blowoff connection. Ends shall be threaded conforming to ANSI B1.20.1. Provide one spare screen for each strainer. Strainers shall be Sarco Type 316, Muessco No. 861, or equal.

PART 3 - EXECUTION

A. Fabrication, Assembly, and Erection

1. See Section 15201. Use an inert or shielding gas welding method. Do not use oxygen fuel welding. The interior of the pipe shall be purged with inert gas prior to the root pass.

2. Welded butt joints (both longitudinal and circumferential) shall comply with AWWA C220, Section 4. Do not allow heat tint to form in the heat affected zone (HAZ) or remove heat tint completely from the HAZ of the finished weld. The maximum depth of grinding or abrasive blasting to remove defects shall not exceed 10% of the wall thickness. Do not perform abrasive blasting with steel shot, grit, or sand.

3. No iron or steel surfaces shall come into contact with the stainless steel. This includes placing on steel tables, racks, pipe supports, etc. Do not use carbon steel wire brushes or grinders.

4. Welding electrodes shall comply with AWS A5.4. Bare wire shall comply with AWS A5.9. Use electrodes as follows:

Pipe Material	Welding Electrode Material
Type 304	E 308
Type 304L	E 347
Type 316	E 316
Type 316L	E 318

B. Reinforcement for Piping Larger than 24 Inches

See Section 15201.

C. Shop Testing of Fabricated or Welded Components

See Section 15201.

D. Installing Threaded Piping

Ream, clean, and remove burrs from threaded piping before making up joints. Apply thread lubricant to threaded ends before installing fittings, couplings, unions, or joints.

E. Installing Flanged Piping

See Section 15050.

F. Installation of Stainless Steel Bolts and Nuts

See Section 15050.

G. Installing Unions

Provide unions on exposed piping 3 inches and smaller as follows:

1. At every change in direction (horizontal and vertical).

2. 6 to 12 inches downstream of valves.

3. Every 40 feet in straight piping runs.

4. Where shown in the drawings.

H. Installing Aboveground or Exposed Piping

See Section 15050.

I. Installing Submerged Piping

See Section 15201.

J. Field Hydrostatic Testing

1. See Section 15201.

2. Do not allow test water to remain in the pipe for more than five days. Drain and dry the piping after completing the testing.

K. Painting and Coating

Do not coat stainless steel Van Stone flanges.

L. Coating Submerged Bolts, Nuts, and Tie Rods

See Section 15201.

END OF SECTION

SECTION 15278 STAINLESS STEEL TUBING

PART 1 - GENERAL

A. Description

1. This section includes materials and installation of stainless steel tubing and fittings 2 inches in diameter and smaller.

2. Stainless steel pipe conforming to Section 15276 may be substituted for stainless steel tubing. However, tubing (Section 15278) may not be substituted for pipe (Section 15276).

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit materials list showing material of pipe and fittings with ASTM reference and grade. Submit manufacturer's catalog data for swaged fittings and joints.

3. Submit fitting manufacturer's instructions for assembling fittings and joints.

PART 2 - MATERIALS

A. Tubing

1. Tubing shall conform to ASTM A269, Grade TP 316, seamless. Hardness shall not exceed Rockwell B80. Tube wall thicknesses shall be as follows:

Tube O.D. (inches)	Minimum Wall Thickness (inches)
1/8	0.028
3/16	0.028
1/4	0.028
5/16	0.035
3/8	0.035
1/2	0.042
5/8	0.058
3/4	0.065
7/8	0.072
1	0.083
1 1/4	0.109
1 1/2	0.134
2	0.165
3	

2. Tubing shall be free of scratches. Tubing shall be suitable for bending and flaring.

3. Tubing shall be heat-treated, which shall consist of quenching in water or rapidly cooling by other means at a rate sufficient to prevent precipitation of carbides, as demonstrated by the capability of passing practice ASTM A262, Practice E (Supplementary Requirement S4 in ASTM A269).

B. Fittings and Joints

1. Fittings and joints shall be of the SWAGELOK type as manufactured by Crawford Fitting Company, utilizing a nut and dual ferrule design to connect to tubing. Fitting and joint material shall comply with ASTM A479, Type 316, or ASTM A182, Grade F316. End connections shall be of the union type.

2. Joints connecting two straight tubes together shall be of the nut and ferrule union type.

C. Protective End Caps

Provide protective end caps on each piece of tubing, completely sealing the piece from contamination during shipment and storage. Provide the same type of seals on each

fitting, or ship and store fittings in sealed boxes or containers.

D. Outlets and Nozzles

Use a tee with nut and ferrule union ends to connect to the tubing and with an outlet to match the connecting valve or instrument.

E. Connections to Threaded-End Valves

When connecting tubing to threaded-end valves, provide tube to female NPT connectors. Provide a threaded Schedule 80S Type 316 stainless steel nipple (ASTM A312, seamless) between the connector and the valve end.

F. Spare Parts

1. Provide the following spare parts:

Quantity	Description
6	Nuts of each size used on the project
2	Hydraulic swaging units

2. Pack the spare parts in a wooden box; label with the manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained therein.

PART 3 - EXECUTION

A. Installing Tubing

1. Do not drag tubing out of tube racks. Do not drag tubing across any surface that could scratch it.

2. Keep tube cutters and saws sharp. Do not cut too deeply with each turn of the cutter or motion of the saw.

3. Deburr tube ends before inserting into fittings and joints. Clean both the inside and outside of fitting and pipe ends before making up joints. Do not miter joints for elbows or notch straight runs of pipe for tees. Do not kink tubing.

4. Bends in tubing shall be long sweep. Provide the straight length of tubing recommended by the fitting and joint manufacturer to allow the tube to be inserted into

the fitting. Shape bends with shaping tools. Form bends without flattening, buckling, or thinning the tubing wall at any point. Do not use bends to make turns greater than 45 degrees. Use fittings to make turns greater than 45 degrees.

B. Installing Exposed Tubing

1. Install tubing without springing, forcing, or stressing the tubing or any adjacent connecting valves or equipment.

2. Provide pipe hangers and supports as specified in Section 15064.

C. Installing Fittings and Joints

1. Follow the manufacturer's instructions for installing fittings and joints.

2. For fittings and joints larger than 1 inch, use the manufacturer's hydraulic swaging unit to make up the connections.

D. Field Hydrostatic Testing

1. See Section 15144.

2. Do not allow test water to remain in the tubing for more than five days. Drain and dry the tubing after completing the testing.

END OF SECTION

SECTION 15290 PVC PIPE, 3 INCHES AND SMALLER

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of PVC pipe and fittings of size 3 inches and smaller for use in process piping having a maximum design pressure of 150 psi and having a maximum design temperature of 105°F.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300 and the following.

2. Submit materials list showing materials of pipe and fittings with ASTM reference and grade. Submit manufacturer's certification of compliance with referenced standards, e.g., ASTM D1784, D1785, and D2467. Show wall thickness of pipe and fittings. Show fitting dimensions.

3. Submit data sheets for solvent cement and demonstrating compliance with ASTM D2564 and F656.

PART 2 - MATERIALS

A. Pipe

Pipe shall be Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D1784 and D1785.

B. PVC Pipe Coloring and Marking for Reclaimed Water

PVC pipe shall be purple (Pantone 522) and shall be marked on both sides of the pipe with the wording "CAUTION: RECLAIMED WATER--DO NOT DRINK." The lettering shall be minimum 1-inch-high black letters and shall be repeated every 36 inches. The purple coloring shall be achieved by adding pigment to the PVC material as the pipe is being manufactured.

C. Fittings

Fittings shall be Schedule 80 and shall conform to ASTM D2464 for threaded fittings and ASTM D2467 for socket-type fittings.

D. Flanges

PVC flanges shall be of the one-piece solid socket design and shall be made of the same material as the pipe. Pressure rating shall be at least 150 psi at a temperature of 73°F. Minimum burst pressure shall be 500 psi. Flanges shall match the dimensions of ASME B16.5, Class 150, steel flanges for outside diameter, bolt circle, and bolt holes. Do not use Van Stone flanges.

E. Unions

Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, per ASTM D1784.

F. Joints

Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to valves and equipment.

G. Solvent Cement

Solvent cement for socket joints shall comply with ASTM D2564 and F656.

H. Gaskets for Flanges

See Section 15050.

I. Bolts and Nuts for Flanges

See Section 15050.

J. Lubricant for Stainless Steel Bolts and Nuts

See Section 15050.

K. Wye Strainers

PVC wye strainers shall be manufactured of the same material as the pipe, with 30-mesh screens and Viton seals. Connecting ends shall be the socket type, solvent welded. Provide one spare screen for each strainer.

PART 3 - EXECUTION

A. General

1. Do not install PVC pipe when the temperature is below 40°F or above 90°F. Store loose pipes on racks with a maximum support spacing of 3 feet. Provide shades for pipe stored outdoors or installed outdoors until the pipe is filled with water.

2. Store fittings indoors in their original cartons.

3. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements that have exceeded the shelf life marked on the storage container.

4. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section of pipe.

5. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it.

B. Solvent-Welded Joints

1. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least one hour.

2. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent-welded pipe ends as recommended by the pipe manufacturer.

3. Wipe away loose dirt and moisture from the inside and outside of the pipe end and the inside of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.

4. The pipe and fitting socket shall have an interference fit. The diametrical clearance between pipe and entrance of the fitting socket shall not exceed 0.04 inch. Check the fit at every joint before applying solvent cement.

5. Make up solvent-welded joints per ASTM D2855. Application of cement to both surfaces to be joined and assembly of these surfaces shall produce a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire circumference.

6. Allow at least eight hours of drying time before moving solvent-welded joints or subjecting the joints to any internal or external loads or pressures.

7. Acceptance criteria for solvent-welded joints shall be as follows:

   a. Unfilled Areas in Joint: None permitted.

   b. Unbonded Areas in Joint: None permitted.

   c. Protrusion of Material into Pipe Bore, Percent of Pipe Wall Thickness: Cement, 50%.

C. Flanged Joints

1. Lubricate carbon steel bolt threads with graphite and oil before installation.

2. Tighten bolts on PVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be as shown in the following table:

Pipe Size (inches)	**Final Torque (foot-pounds)**
1/2 to 1-1/2	10 to 15
2 to 3	20 to 30

D. Installation of Stainless Steel Bolts and Nuts

See Section 15050.

E. Threaded Joints

1. Cut threaded ends on PVC to the dimensions of ASME B1.20.1. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe hold-down methods, saw cutting blade size, and saw cutting speed.

2. Pipe or tubing cutters shall be specifically designed for use on PVC pipe. Use cutters manufactured by Reed Manufacturing Company, Ridge Tool Company, or equal.

3. If a hold-down vise is used when the pipe is cut, insert a rubber sheet between the vise jaws and the pipe to avoid scratching the pipe.

4. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.

5. Apply Teflon® thread compound or Teflon® tape lubricant to threads before screwing on the fitting.

F. Installing Unions

Provide unions on exposed piping 3 inches and smaller as follows:

1. At every change in direction (horizontal and vertical).

2. 6 to 12 inches downstream of valves.

3. Every 40 feet in straight pipe runs.

4. Where shown in the drawings.

G. Installing Buried Pipe

1. Install in accordance with Section 02223 and as follows.

2. Trench bottom shall be continuous, smooth, and free of rocks. See the details in the drawings for trench dimensions, pipe bedding, and backfill.

3. After the pipe has been solvent-welded and the joints have set, snake the pipe in the trench per the pipe manufacturer's recommendations in order to allow for thermal expansion and contraction of the pipe.

4. Do not backfill the pipe trench until the solvent-welded joints have set. Support the pipe uniformly and continuously over its entire length on firm, stable soil. Do not use blocking to change pipe grade or to support pipe in the trench.

5. Install buried PVC pipe in accordance with ASTM D2774 and the pipe manufacturer's recommendations. Backfill materials in the pipe zone shall be imported sand per Section 02223. If water flooding is used, do not add

successive layers unless the previous layer is compacted to 90% relative compaction.

H. Installing Aboveground or Exposed Piping

1. See Section 15050.

2. Fill empty piping with water, provide temporary shading, or other means to keep the surface temperature of the pipe below 100°F.

I. Painting and Coating

Coat piping per Section 09900, System No. 41.

J. Hydrostatic Testing

Perform hydrostatic testing for leakage in accordance with Section 15144.

END OF SECTION

SECTION 15291 PVC PIPE (4 TO 8 INCHES) WITH SOLVENT-WELDED JOINTS

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of PVC pipe and fittings of size 4 through 8 inches for use in aboveground or otherwise exposed process piping having a maximum design pressure of 50 psi and a maximum design temperature of 105°F.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit materials list showing materials of pipe and fittings with ASTM reference and grade. Submit manufacturer's certification of compliance with referenced standards, e.g., ASTM D1784, D1785, D2467, and ANSI B31.3. Show wall thickness of pipe and fittings. Show fitting dimensions.

3. Submit data sheets for solvent cement and demonstrating compliance with ASTM D2564 and F656.

4. Submit piping layout drawings showing location and dimensions of pipe and fittings. Include laying lengths of valves, meters, in-line pumps, and other equipment determining piping dimensions. Label or number each fitting or piece of pipe. Show location and detail of every pipe hanger and pipe support.

5. Submit manufacturer's recommended torques for tightening bolts on flanged connections.

6. Submit manufacturer's recommended method of installing solvent welded and hot gas welded joints. Submit bonding procedure specification (BPS) developed in accordance with ANSI B31.3 (2006 edition), Chapter VII, Part 9, paragraph A328.2.

7. Submit the names of employees to be utilized on the project who have been qualified per the BPS to make solvent-welded joints and hot gas welded joints. Submit the results of the BPS qualification tests per ANSI

B31.3, Chapter VII, Part 9, paragraphs A328.2.4 and A328.2.5 for each such employee.

8. If any fabricated branch connections or tees are used, submit design calculations, service experience records, and performance test records per ANSI B31.3, Chapter VII, Part 2, paragraph A304.7.2.

C. Manufacturer's Service

Provide pipe manufacturer's services at the jobsite for the following minimum labor days, travel time excluded:

1. One labor day to instruct the Contractor's personnel in the preparation and execution of solvent-welded and hot gas welded joints for the sizes of pipes to be installed in the project.

2. One person to observe and advise during the assembly and installation of every pipe joint assembly in the project, including hot gas welding for repairing joints. The manufacturer's representative shall be qualified to make both solvent-welded joints and hot gas welded joints per the BPS.

PART 2 - MATERIALS

A. Pipe

Pipe shall be Schedule 80, Type I, Grade 1 (Class 12454-B), conforming to ASTM D1784 and D1785.

B. Fittings

1. Fittings shall be socket type, Schedule 80, and shall conform to ASTM D2467.

2. Fabricated branch connections or tees may be used only where the type or size of fitting is not described in ASTM D2467. Joints and seams in fabricated fittings shall be in accordance with ANSI B31.3 (2006 edition), Chapter VII, Part 9, paragraph A328.5.4. The design and fabrication of such branch connection and tees shall be in accordance with ANSI B31.3, Chapter VII, paragraphs A304.3 and A328.5.2. Minimum wall thickness shall be equivalent to that of Schedule 80 pipe.

C. Flanges

PVC flanges shall be of the one-piece solid socket design and shall be made of the same material as the pipe. Pressure rating shall be at least 150 psi at a temperature of 73°F. Minimum burst pressure shall be 500 psi. Flanges shall match the dimensions of ANSI B16.5, Class 150 steel flanges for outside diameter, bolt circle, and bolt holes. Do not use Van Stone flanges.

D. Joints

Pipe and fitting joints shall be socket welded except where flanged joints are required to connect to valves and equipment.

E. Solvent Cement

Solvent cement for socket joints shall comply with ASTM D2564 and F656.

F. Gaskets for Flanges

See Section 15050.

G. Bolts and Nuts for Flanges

See Section 15050.

H. Lubricant for Stainless Steel Bolts and Nuts

See Section 15050.

PART 3 - EXECUTION

A. General

1. Do not install PVC pipe when the temperature is below 40°F or above 90°F. Store loose pipes on racks with a maximum support spacing of 3 feet. Provide shades for pipe stored outdoors or installed outdoors until the pipe is filled with water.

2. Store fittings indoors in their original cartons.

3. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements that have exceeded the shelf life marked on the storage container.

4. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section of pipe.

5. Do not drag PVC pipe over the ground, drop it onto the ground, or drop objects on it.

B. Solvent-Welded and Hot Gas Welded Joints

1. Bonding requirements shall be in accordance with ANSI B31.3 (2006 edition), Chapter VII, Part 9. Bonding shall include both solvent welding or cementing and hot gas welding.

2. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air at the same temperature conditions as the pipe for at least one hour.

3. Cut pipe ends square and remove burrs, chips, and filings before joining pipe or fittings. Bevel pipe ends as recommended by the pipe manufacturer in the BPS.

4. Wipe away loose dirt and moisture from the inside and outside diameters of the pipe end and the inside diameter of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.

5. The pipe and fitting socket shall have an interference fit. The diametrical clearance between pipe and entrance of the fitting socket shall not exceed 0.04 inch. Check the fit at every joint before applying solvent cement.

6. Make field solvent-welded and hot gas welded joints only in the presence of the pipe manufacturer's representative who shall instruct and advise the Contractor's personnel in the assembly of the joints. Joint bonding shall be done in accordance with a BPS established by the pipe manufacturer. Qualification of the BPS shall be in accordance with ANSI B31.3, Chapter VII, Part 9, paragraph A328.2. Each person who will perform bonding shall be qualified in executing the BPS per paragraph A328.2.5.

7. Make up solvent-welded joints per ASTM D2855 and the BPS. Application of cement to both surfaces to be joined

and assembly of these surfaces shall produce a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire circumference.

8. Allow at least eight hours of drying time before moving solvent welded joints or subjecting the joints to any internal or external loads or pressures.

9. After completion of the solvent-welded joints, subject the piping system to a hydrostatic test pressure of 75 psi per Section 15144. Solvent-welded joints that show minor weeping at isolated points around the circumference of the joint may be repaired by the hot gas welding method. There shall be no more than one point of weeping for every 12 inches of circumference of the pipe. Remove solvent-welded joints that show excessive leakage and assemble new joints.

10. The hot gas welding method shall produce a continuous seal at the fillet formed by the junction of the fitting socket entrance and the pipe. Use a hot gas welding procedure per the BPS and the following to melt a plastic filler rod and the surfaces of the pipe in the fillet area. Force the softened rod into the softened fillet. Provide the hot gas weld around the entire circumference of the solvent-welded joint.

11. Terminate a hot gas weld by lapping the bead on top of itself for a distance of 3/8-inch to 1/2-inch. Do not terminate a hot gas weld by overlapping the bead side by side.

12. Provide three weld passes on each hot gas welded joint. Deposit the first bead at the bottom of the fillet. Deposit the second and third beads on each side of the first bead. Stagger the starting point for each bead and allow each weld pass to cool before proceeding with the next pass.

13. Upon completion of each hot gas welded bead, check that the filler rod has completely fused into the base pipe. If the filler rod can be removed or pulled back from the base material, then reject the entire hot gas weld. Reject any hot gas welds showing brown or black discoloration.

14. Upon completion of the hot gas welded joints, subject the piping system to a test pressure of 75 psi per Section 15144. Cut out, remove, and replace any joints

that are leaking. No rework of leaking hot gas welded joints will be permitted.

15. Acceptance criteria for solvent-welded and hot gas welded joints shall be in accordance with ANSI B31.3, Chapter VII, Part 9, Table A341.3.2.

C. Flanged Joints

1. Lubricate bolt threads with graphite and oil before installation.

2. Tighten bolts on PVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be as shown in the following table:

Pipe Size (inches)	**Final Torque (foot-pounds)**
4	20 to 30
6 to 8	33 to 50

D. Installation of Stainless Steel Bolts and Nuts

See Section 15050.

E. Installing Aboveground and Exposed Piping

1. See Section 15050.

2. Fill empty piping with water, provide temporary shading, or other means to keep the surface temperature of the pipe below 100°F.

F. Painting and Coating

Coat piping per Section 09900, System No. 41.

G. Final Hydrostatic Testing

Perform final hydrostatic testing for leakage in accordance with Section 15144 after all joints have been tested and defective joints have been repaired or replaced.

END OF SECTION

SECTION 15293 PVC DISTRIBUTION PIPE (14 INCHES AND LARGER)

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of PVC pipe having cast-iron pipe outside diameters and otherwise conforming to AWWA C905, as modified herein. Size range is 14 through 36 inches. The pressure classes shown in the drawings shall correspond to the following standard dimension ratios (SDRs):

Size Range (inches)	Pressure Class on Drawings (psi)	SDR per ASTM D2241
14 to 24	150	18
30 to 36	150	21

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Provide affidavit that the pipe complies with AWWA C905.

3. Submit copies of the manufacturer-required tests of the following conducted on project pipe:

   a. Quick-burst strength of pipe and couplings.

   b. Flattening resistance of pipe.

   c. Impact resistance of pipe.

   d. Acetone-immersion test of pipe material.

   e. Internal pressure and vacuum tests of joints per ASTM D3139.

   f. Laboratory tests of gaskets per ASTM F477.

   g. Record of additional tests after test sample failure.

4. Submit manufacturer's literature of gray iron and ductile-iron fittings including dimensions, thickness,

weight, coating, lining, and a statement of inspection and compliance with the acceptance tests of AWWA C110.

5. Submit manufacturer's catalog data, outline drawings, and material description of service connection saddles, corporation stops, and pipe plugs.

PART 2 - MATERIALS

A. Pipe

Material shall conform to ASTM D1784, Class 12454-A or 12454-B.

B. PVC Pipe Coloring and Marking for Reclaimed Water Service

PVC pipe shall be purple (Pantone 522) and shall be marked on both sides of the pipe with the wording "CAUTION: RECLAIMED WATER--DO NOT DRINK." The lettering shall be minimum 1 inch high, black, and shall be repeated every 36 inches. The purple coloring shall be achieved by adding pigment to the PVC material as the pipe is being manufactured.

C. Joints

Provide elastomeric seal joints conforming to ASTM D3139. Elastomeric gaskets shall comply with ASTM F477.

D. Fittings

Fittings shall conform to AWWA C110 with a minimum pressure rating of 250 psi. Size bells specifically for outside diameter of cast-iron equivalent PVC pipe including rubber-ring retaining groove.

E. Lining for Fittings

1. Line fittings per Section 15240.

F. Coating for Fittings

Provide asphaltic coating on buried fittings per AWWA C151.

G. Flanges

Flanges on outlets of fittings shall be Class 125 per ASME B16.1.

H. Gaskets for Flanges

See Section 15050.

I. Bolts and Nuts for Flanges

See Section 15050.

J. Sand for Pipe Zone Material

See Section 02223.

K. Outlets and Nozzles

1. For outlets 3 inches and smaller, provide a cast-iron tee with a 4-inch flanged outlet and a reducing companion flange.

2. For outlets larger than 3 inches, use a cast-iron tee with a flanged outlet.

L. Restrained Joints

All piping shall be mechanically restrained. Restrained joints shall be provided by restraining systems that incorporate a series of machined serrations on the inside diameter of a restraint ring to provide positive restraint. Restraining systems shall meet or exceed the requirements of UNI-B-13-94 and ASTM F1674 and the following:

1. Restraint devices for bell-and-spigot joints shall consist of a split restraint ring installed on the spigot, connected to a solid backup ring seated behind the bell.

2. Restraint devices for connection to ductile-iron mechanical joints shall consist of a split restraint ring installed behind the ductile-iron fitting follower gland and gasket and shall retain the full deflection capability of the joint.

3. The split restraint ring shall be machined to match the outside diameter of the pipe, provide full 360-degree support around the barrel of the pipe, and shall incorporate a series of machined serrations for gripping the outside surface of the pipe. The serrations shall be uniform and extend the full circumference of the clamp. The ring shall also incorporate a positive means of avoiding applying excessive clamping force to the pipe.

4. Materials used in the restraint device shall be ductile iron conforming to ASTM A536, Grade 60-42-12 or 65-45-12.

5. T-bolts, studs, and connecting hardware shall be high-strength, low alloy material in accordance with AWWA C111.

6. Design restraining devices to have a 2:1 safety factor based on the design strength of the pipe.

7. Restraining devices shall be UNI-Flange Block Buster Series 1300 or equal.

M. Flanged Coupling Adapters

See Section 15122.

N. Factory Testing of Pipe

1. Test the quick-burst strength of pipe produced from each extrusion outlet at the beginning of production of each specific material, style, or size; thereafter, test one sample every 24 hours. Test a minimum of five specimens total. Test in accordance with ASTM D1599. For bell-end pipe, include the bell (with any reinforcement sleeve) as part of at least two specimens.

2. Perform sustained pressure test in accordance with ASTM D2241 and D1599, except that test pressure may be 6% less than that given in Table 3 of ASTM D2241. If pipe has been tested previously, submit copy of test report.

3. Perform burst pressure test in accordance with ASTM D2241 and D1599, except that test pressure may be 6% less than that given in Table 4 of ASTM D2241.

4. Hydrostatically test each length of pipe including the joint in accordance with Section 5.1.8 of AWWA C905.

5. Test the flattening resistance and impact resistance of pipe produced from each extrusion outlet at the beginning of production of each specific material or size; thereafter, test one sample every 24-hour shift or every 100 pieces. Test a minimum of three specimens total. Test for flattening resistance per ASTM D2241, Section 7.6. Test for impact resistance per ASTM D256,

Method A. The minimum impact strength shall be 0.65 ft-lbs/inch.

6. Test the pipe produced from each extrusion outlet by the acetone-immersion method at the beginning of production of each specific material or size; thereafter, test one sample every 24-hour shift or every 100 pieces. Test per ASTM D2152.

7. Perform other factory testing per ASTM D2241 and AWWA C905.

8. The phrase "beginning of production" means the beginning of production of pipe for this project. Do not use test results from other projects.

9. When any product fails to meet a specified test requirement, perform additional tests to determine which products are acceptable of those produced from the same extruder or mold as of the last favorable test. Reject pipe that fails to meet any test requirement.

PART 3 - EXECUTION

A. Product Marking

Legibly mark pipe per AWWA C905, Section 6.1

B. Delivery and Temporary Storage of Pipe

1. Ship, store, and place pipe at the storage yard or installation site supporting the pipe uniformly. Avoid scratching the pipe surface. Do not stack higher than 4 feet or with weight on bells. Cover to protect from sunlight.

2. Unload pipe close to point of installation to avoid handling damage. Avoid scratching the pipe surface.

3. Remove and do not install pipe that is gouged, scratched forming a clear depression, or marred.

C. Handling Pipe

Hoist pipe with mechanical equipment using a cloth belt sling or a continuous fiber rope that avoids scratching the pipe. Do not use a chain or wire rope sling.

D. Installing Pipe in Trenches

1. Install in accordance with Section 02223, AWWA C605, and as follows.

2. When installing pipe in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure elevation at the pipe invert.

3. Pipe shall have a minimum cover of 3 feet unless otherwise shown in the drawings.

4. Backfill materials in the pipe zone shall be imported sand per Section 02223 Do not add successive layers unless the previous layer is compacted to 95% relative compaction per ASTM D1557.

5. Compact material placed within 12 inches of the outer surface of the pipe by hand tamping only.

6. Compact trench backfill to the specified relative compaction. Do not float pipe. Do not use high-impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe.

E. Assembly of Pipe Joint

1. The spigot and bell or bell coupling shall be dirt free and slide together without displacing the rubber ring. Lay the pipe section with the bell coupling facing the direction of laying.

2. Insert the rubber ring into the groove in the bell in the trench just before joining the pipes. First clean the groove. Observe the correct direction of the shaped ring. Feel that the ring is completely seated.

3. Lubricate the spigot over the taper and up to the full insertion mark with the lubricant supplied by the pipe manufacturer. If the lubricated pipe end touches dirt, clean the pipe end and reapply lubricant.

4. Insert the spigot into the bell and force it slowly into position.

5. Check that the rubber has not left the groove during assembly by passing a feeler gauge around the completed joint.

6. Install restraint harness for mechanical restraint of joints.

F. Wrapping Fittings and Restrained Joint Devices

Wrap buried cast-iron fittings and restrained joint devices with polyethylene per Section 09954.

G. Field Hydrostatic Testing

Test pressures are shown in the Piping Schedule in the drawings. Test in accordance with Section 15144.

H. Disinfection

Disinfect pipe in accordance with Section 15141.

END OF SECTION

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SECTION 15294 CPVC PIPE, 4 INCHES AND SMALLER

PART 1 - GENERAL

A. Description

This section includes materials, installation, and testing of chlorinated polyvinyl chloride (CPVC) pipe and fittings of size 4 inches and smaller for use in process piping having a maximum design pressure of 150 psi at a maximum operating temperature of 105°F and a maximum design pressure of 100 psi at a temperature of 140°F.

B. Submittals

1. Submit shop drawings in accordance with the General Conditions, Section 01300, and the following.

2. Submit materials list showing materials of pipe and fittings with ASTM reference and grade. Submit manufacturer's certification of compliance with referenced standards, e.g., ASTM D1784, F441, and F439. Show wall thickness of pipe and fittings. Show fitting dimensions.

3. Submit data sheets for solvent cement demonstrating compliance with ASTM F493.

PART 2 - MATERIALS

A. Pipe

Pipe shall be Schedule 80, Type IV, Grade 1 (Class 23477-B), conforming to ASTM D1784 and F441.

B. Fittings

Fittings shall be Schedule 80 and shall conform to ASTM F437 for threaded fittings and ASTM F439 for socket-type fittings.

C. Flanges

CPVC flanges shall be of the one-piece solid socket design and shall be made of the same material as the pipe. Pressure rating shall be at least 150 psi at a temperature

of 73°F. Minimum burst pressure shall be 500 psi. Flanges shall match the dimensions of ASME B16.5, Class 150, steel flanges for outside diameter, bolt circle, and bolt holes. Do not use Van Stone flanges.

D. Unions

1. Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type IV, Grade 1 CPVC, per ASTM D1784.

2. Union connections to other metal piping materials shall comply with MSS SP-107. The fitting end for connection to CPVC pipe shall be a female socket. Provide wrought or cast copper tailpieces for connection to copper piping and tubing. Provide Type 316 stainless steel tailpieces for connection to steel piping.

E. Joints

Pipe and fitting joints shall be socket-welded except where threaded and flanged joints are required to connect to unions, valves, and equipment.

F. Solvent Cement

Solvent cement for socket joints shall comply with ASTM F493. Use the type of solvent cement as recommended in ASTM F493, Appendix X2.

G. Gaskets For Flanges

See Section 15050.

H. Bolting and Nuts For Flanges

See Section 15050.

I. Lubricant For Stainless Steel Bolts and Nuts

See Section 15050.

J. Wye Strainers

CPVC wye strainers shall be manufactured of the same material as the pipe, with 30-mesh screens and Viton seals. Connecting ends shall be the socket type, solvent-welded. Provide one spare screen for each strainer.

PART 3 - EXECUTION

A. General

1. Do not install CPVC pipe when the temperature is below 40°F or above 90°F. Store loose pipes on racks with a minimum support spacing of 3 feet. Provide shades for pipe stored outdoors or installed outdoors until the pipe is filled with water.

2. Store fittings indoors in their original cartons.

3. Store solvent cement indoors or, if outdoors, shade from direct sunlight exposure. Do not use solvent cements that have exceeded the shelf life marked on the storage container.

4. Before installation, check pipe and fittings for cuts, scratches, gouges, buckling, kinking, or splitting on pipe ends. Remove any pipe section containing defects by cutting out the damaged section of pipe.

5. Do not drag CPVC pipe over the ground, drop it onto the ground, or drop objects on it.

B. Solvent-Welded Joints

1. Prior to solvent welding, remove fittings and couplings from their cartons and expose them to the air for at least one hour to the same temperature conditions as the pipe.

2. Cut pipe ends square and remove all burrs, chips, and filings before joining pipe or fittings. Bevel solvent-welded pipe ends as recommended by the pipe manufacturer.

3. Wipe away loose dirt and moisture from the inside and outside of the pipe end and the inside of the fitting before applying solvent cement. Clean the surfaces of both pipes and fittings that are to be solvent-welded with a clean cloth moistened with acetone or methylethyl ketone. Do not apply solvent cement to wet surfaces.

4. The pipe and fitting socket shall have an interference fit. Perform a dry fit test at each joint before applying solvent cement. The pipe shall enter the

fitting socket between one-third and two-thirds of the full socket depth when assembled by hand.

5. Make up solvent-welded joints per ASTM F493, Appendix X1. Application of cement to both surfaces to be joined and assembly of these surfaces shall produce a continuous bond between them with visual evidence of cement at least flush with the outer end of the fitting bore around the entire joint perimeter.

6. Allow at least eight hours of drying time before moving solvent-welded joints or subjecting the joints to any internal or external loads or pressures.

7. Acceptance criteria for solvent-welded joints shall be as follows:

   a. Unfilled Areas in Joint: None permitted.

   b. Unbonded Areas in Joint: None permitted.

   c. Protrusion of Material into Pipe Bore, Percent of Pipe Wall Thickness: Cement, 50%.

C. Flanged Joints

1. Lubricate carbon steel bolt threads with graphite and oil before installation.

2. Tighten bolts on CPVC flanges by tightening the nuts diametrically opposite each other using a torque wrench. Complete tightening shall be accomplished in stages and the final torque values shall be as shown in the following table:

Pipe Size (inches)	**Final Torque (foot-pounds)**
1/2 to 1 1/2	10 to 15
2 to 4	20 to 30

D. Installation Of Stainless Steel Bolts and Nuts

See Section 15050.

E. Assembling Threaded Joints

1. Cut threaded ends on CPVC to the dimensions of ASTM F1498. Ends shall be square cut. Follow the pipe manufacturer's recommendations regarding pipe holddown methods, saw cutting blade size, and saw cutting speed. Gauges, gauge tolerances, and gauging procedures shall comply with ASTM F1498, Sections 7 and 8. Perform field gauging on every field-cut threaded connection.

2. Pipe or tubing cutters shall be specifically designed for use on CPVC pipe. Use cutters manufactured by Reed Manufacturing Company, Ridge Tool Company, or equal.

3. If a hold-down vise is used when the pipe is cut, insert a rubber sheet between the vise jaws and the pipe to avoid scratching the pipe.

4. Thread cutting dies shall be clean and sharp and shall not be used to cut materials other than plastic.

5. Apply Teflon® thread compound or Teflon® tape lubricant to threads before screwing on the fitting.

6. Assemble threaded flanges and fittings per ASTM F1498, Sections 4, 7, and 8. Do not tighten threaded connections more than two turns past finger tightness for both internal and external threads.

F. Installing Unions

Provide unions on exposed piping 4 inches and smaller as follows:

1. At every change in direction (horizontal and vertical).

2. Six to twelve inches downstream of valves.

3. Every 40 feet in straight piping runs.

4. Where shown in the drawings.

G. Installing Buried Pipe

1. Install in accordance with Section 02223 and as follows.

2. Trench bottom shall be continuous, smooth, and free of rocks. See the details in the drawings for trench dimensions, pipe bedding, and backfill.

3. After the pipe has been solvent-welded and the joints have set, snake the pipe in the trench per the pipe manufacturer's recommendations in order to allow for thermal expansion and contraction of the pipe.

4. Do not backfill the pipe trench until the solvent-welded joints have set. Support the pipe uniformly and continuously over its entire length on firm, stable soil. Do not use blocking to change pipe grade or to support pipe in the trench.

5. Install buried CPVC pipe in accordance with ASTM D2774 and the pipe manufacturer's recommendations. Backfill materials in the pipe zone shall be imported sand per Section 02223. If water flooding is used, do not add successive layers unless the previous layer is compacted to 90% relative compaction.

H. Installing Aboveground or Exposed Piping

See Section 15050.

I. Painting And Coating

Coat piping per Section 09900, System No. 41.

J. Hydrostatic Testing

Perform hydrostatic testing for leakage in accordance with Section 15144.

END OF SECTION

SECTION 15299 FIBERGLASS-REINFORCED PLASTIC (FRP) DUCT, DAMPERS AND APPURTENANCES

PART 1 - GENERAL

A. Description

The odor control system duct work consists of dampers, actuators, gauges, piping, ductwork, and ancillary items, as indicated and specified.

The fiberglass reinforced plastic (FRP) ductwork shall be designed and fabricated for odor control service to carry warm, moisture-laden air with hydrogen sulfide, mercaptans and other organic and inorganic compounds typically associated with wastewater treatment.

B. References

1. American Society of Mechanical Engineers (ASME)

2. American National Standards Institute, Inc. (ANSI)

3. Underwriters' Laboratories (UL)

4. National Electric Code (NEC)

5. Air Moving and Conditioning Association (AMCA)

6. Sheet metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

7. National Institute of Standards (NIST)

8. National Electrical Manufacturers Association (NEMA)

9. American Standard of Testing Materials (ASTM)

10. ASTM D 3567 Practice for Determining Dimensions of Fiberglass (Glass- Fiber Reinforced-Thermosetting-Resin) Pipe and Fittings.

    a. ASTM C 582 Standard Specification for Contact - Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion -Resistant Equipment.

    b. ASTM D 3982 Standard Specification for Contact Molded Fiberglass Duct and Hoods or

c. ASTM D 231 0 "Standard Classification for Machine-Made "Fiberglass" Pipe.

d. ANSI/ABMA 11-90 (R1999) Load Ratings and Fatigue Life for Roller Bearings.

11. National Bureau of Standards (NBS).

a. NBS PS 15-69 "Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment

C. Submittals

1. Submit material for review in one submission. Partial submittals will not be reviewed.

2. Sales bulletins or other general publications are not acceptable as submittals for review. Submit only when necessary to provide supplemental technical data.

3. Shop Drawings: Submit the following in accordance with Section 01300:

a. Certified shop and working drawings.

(1) Drawings shall include plan views, sectional views, title block, and details of all related items. In cases where certain information is Proprietary and is omitted, provided a statement indicating that the information is proprietary and is being omitted.

(2) Files shall include Tag Names, Parts List (identifying each component), Dimensions, and connection sizes.

(3) Files shall be drawn to scale.

(4) Drawings shall be in conformance with all other requirements as specified in this specification.

b. Submit a certificate from the resin manufacturer listing the type of resin to be used, describing the manufacturer's brand name or designation, composition, characteristics and that the material used for this project will comply with the specification and meet all corrosion requirements.

c. Submit manufacturer's certification that fabrication complies with the referenced standards, e.g., ASTM D3567, C582, D3982, and D2310.

d. Submit manufacturer's catalog data for the duct and fittings. Show wall thickness of duct and fittings. Show fitting dimensions. Show glass and resin content of walls.

e. Submit calculations signed and sealed by a Florida licensed Professional Engineer, showing determination of duct and fitting wall thickness and reinforcement based on internal pressure, external loading, and the allowable values used in the design criteria.

f. Submit manufacturer's recommended torques for tightening bolts on flanged connections.

g. Provide ASTM E-84 Steiner Tunnel test results attached as part of the submittal packet.

h. Samples, representative of the ductwork, construction method and material used to be supplied on this project.

i. Clearly mark all drawings and data to show only items applicable to work. Show all data, schedules, bill of materials, rated capacities, material of construction, layouts and construction details of all components. Show dimensions, mounting and external connection details on all drawings.

j. Number and identify all equipment to correspond with terminology on drawings. Also use these numbers on all submittals sheets and shop drawings.

k. List of 5 operating installations to demonstrate compliance with the requirements.

   (1) Provide current (verified) contact information for each installation.

l. Paint manufacturer’s product data and specifications indicated conformance to shop painting requirements specified including statement of compliance for compatibility.

m. Manufacturer’s literature as needed to supplement certified data.

n. Submit details of:

(1) Resin Type

(2) Types and amounts of filler

(3) Corrosion liner description

(4) Reinforcement types for hand lay-up or chopped laminates

(5) For filament-wound laminates:

(6) Helix angle

(7) Glass content range

(8) Strand yield

(9) Strand by inch in the winding band

(10) Ply thickness

(11) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.

(1) For all Fabricated parts:

(a) Construction type

(b) Laminate thickness

(c) Ply sequences

(d) Glass content range

(12) For all secondary overlays (both interior and exterior):

(a) Laminate thickness

(b) Ply sequences and widths

(c) Construction details for all other special configurations and fabricated parts.

o. Submit manufacturer's documentation verifing AMCA licensed/Certified FRP dampers. Submit leakage and pressure drop information from testing performed in a n AMCA accredited lab

p. Shop and Field inspections reports.

q. Recommendations for short and long term storage.

r. Number of service technician days provided and per diem field service rate.

s. Manufacturer’s product data, specifications, and color charts for shop painting.

t. Provide a listing of the materials recommended for service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and as indicated.

u. Material Certification:

(1) Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

(2) Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

4. A copy of the contract drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. All changes and clarifications shall be indexed to a list detailing each change and clarification If no changes are required,

mark all drawings with “No changes required” or provide a statement that no changes are required.

a. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

5. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

D. Quality Assurance

1. Provide in accordance as specified herein.

2. Duct work and appurtenances shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

3. Shop tests as specified.

4. Ductwork and appurtenances regardless of manufacturer as a complete integrated system to ensure proper coordination, compatibility and operation of the system.

5. The duct manufacturer shall have a qualified Service Technician, at the job site to insure proper installation procedures are followed for a minimum of two days.

6. When duct system is complete the duct manufacturer shall have a qualified Service Technician inspect the duct

system and provide a written certification that it is installed properly and is ready for operation.

a. Service Technician must have a minimum of five (5) years of experience servicing the type and size of equipment specified, all within the last seven (7) years.

b. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

E. Delivery, Storage and Handling

Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

PART 2 - PRODUCTS

A. FRP Duct

1. Materials and Fabrication:

a. Type: Filament wound.

b. Minimum wall thickness, inches, in accordance with SMACNA Table 5-7 and as specified:

(1) 2-inch through 14-inch: 0.145

(2) 16-inch through 22-inch: 0.180

(3) 24-inch through 30-inch: 0.220

(4) 32-inch through 36-inch: 0.260

(5) 42-inch through 48-inch: 0.300

(6) 54-inch through 60-inch: 0.340

(7) Wall thickness of the duct furnished shall not at any point be less than specified minimum wall thickness when measured in accordance with ASTM D3567.

(8) Provide all buried duct designed per AWWA M-45 Standards and rated for H-20 Loading.

(9) Rectangular ductwork thickness: As specified in SMACNA and as specified and indicated. In no case shall the rectangular duct thickness be less than substituting the long side of the rectangular duct for the round equivalent thickness.

c. Provide all ducts designed for not less than 60 inches water column pressure, and 20 inches water column vacuum.

d. The design, applicable construction, and inspections shall be in accordance with SMACNA, and visual inspection criteria in accordance with ASME RTP-1. Table 6, Visual Level II.

e. Provide a minimum structural safety factor of 4 in the design of all ducting.

f. Maximum deflection of rectangular ducts under deadload and operating conditions: Not to exceed 1 percent of the width of the longest side.

g. Resin: Hetron 992FR, Derakane 510 or equal, selected to meet the exposures and temperatures of the air to be exhausted.

h. The resin system should provide a class 1 flame spread rating, Antimony, Nyacol or any other additives are not allowed.

i. Minimum barcol hardness: 36.

j. A thixotropic agent for viscosity control may be used as recommended by the resin manufacturer. No thixotropic agent is to be used in the corrosion liner or on surfaces to be in contact with the corrosive environment.

k. Flame spread rating: 25 or less per ASTM E-84.

l. Catalyst: DHD9 or High Point 90 per resin manufacturer.

m. Corrosion liner:

Inner surface: One ply of 10 ml thick minimum C-glass surfacing veil saturated with vinylester resin.

(1) Provide the surface veil overlapped a minimum of 1 inch with two (2) layers of 1-1/2 oz./sq. ft. chopped strand mat following the surface veil layers.

(2) Corrosion liner is to gel completely before proceeding with structural laminates. In no case shall the interruption exceed 12 hours.

(3) Total liner thickness: 100 mils minimum.

(4) No thixotropic agent or fire retardant additive is to be used in the liner resin.

(5) Corrosion liner: Not less than 20% or more than 30% glass by weight.

(6) Provide liner passing ASME RTP-1 Table 6, level II visual inspection. Total glass content 25% to 30 %.

n. Structural layer: Filament wound of Hetron 992FR, or Derakane 510 premium grade, vinylester resin and Type E 250 strand yield continuous glass roving.

(1) Band width: 2.25 inches using (7) strands per inch.

(2) Filament winding cycle thickness: 0.06 inches maximum.

(3) Glass content 55% to 65 %.

(4) Winding angle: 65 to 90 degrees ± 2 degrees for increased vacuum service.

o. Provide the exterior of all laminates containing sufficient resin to insure a relatively smooth surface free from exposed glass fibers or sharp projections.

p. Provide an ultraviolet stabilizer added to the final gelcoat.

q. Provide ductwork located outdoors with an exterior gelcoated colored surface.

(1) Color: White or as selected by Owner.

r. Provide ductwork located indoors with two (2) coats of PPG 42-7 Intumescent paint to provide a class 1 flame and smoke rating.

s. ASTM E-84 Steiner Tunnel test results shall be attached as part of the submittal packet.

t. Standard lengths: Provide in accordance with the manufacturers published product data sheets and approved shop drawings.

u. Duct stiffness: Minimum rated stiffness in accordance with ASTM D2412 for the pipe laying conditions.

v. Markings on duct and spool pieces shall be in accordance with shop drawings.

2. Manufacturers:

a. Spunstrand

b. Harrington Plastics

c. Ershigs/Belco Manufacturing

d. Augusta Fiberglass

e. Midwestern Fabricators

f. ECS Environmental

B. Fittings and Joints

1. Fittings:

a. Hand-lay up construction fabricated from the same resin and have the same strength as the FRP ductwork.

b. Internal diameter of all fittings: Equal to the adjacent duct.

c. Tolerance on angles of all fittings: +/- 1 degree for 24 inch [300 mm] diameter and smaller and +/- 1/2 degree for 30 inch [750 mm] diameter and larger.

d. Geometry of all fittings shall be per SMACNA standards.

2. Elbows:

a. Radius: 1.5 times the duct diameter.

b. 24-inch and smaller: Smooth radius.

c. 30-inch and larger: Mitered.

d. Bends 30 degrees and less: 1 miter, 2 piece

e. Bends 31 degrees to 60 degrees: 2 miter, 3 piece

f. Bends 61 degrees to 90 degrees: 4 miter, 5 piece

3. Turning Vanes

a. Provide turning vanes and splitters at all single mitered bends 46 degrees and greater and similar fittings that are not one-piece smooth radius fittings per SMACNA and ASHRAE standards.

b. Turning Vanes: Filament wound and reinforced with unidirectional glass, metallic vanes are not acceptable.

4. Flange Joints:

a. Provide flanged connections at flexible connectors, expansion joints, vessels, grease filters, fans, and other locations as indicated.

b. Flanges:

(1) Hand lay-up construction with dimensions in accordance with ASTM D3982 and the Duct Dimension Schedule.

(2) For locations to connect duct to ductile iron drain piping, flanges shall be furnished to connect to a standard solid back, Class 125 flange per AWWA C115.

c. Flanges shall be drilled in accordance with ASTM D3982. Backs of flange face shall be flat so that washer seats fully on bolt face and flange backing.

d. Flange Faces: Perpendicular to the axis of the duct within 1/2 degree.

e. Flange Faces: Flat to within +/- 1/32 inch for sizes 18-inch and smaller and flat within +/- 1/16 inch for sizes 20-inch and larger.

f. Gaskets: EPDM, full face, minimum 1/8-inch thick.

g. Hardware: Type 316 stainless steel.

5. Duct Joints:

a. Butt and wrap joint type connections.

b. Fittings: Butt and wrap joint type connections.

c. Apply adhesive material for field joining in rolls and resin containers no larger than five gallons.

d. Provide all joints per SMACNA standard, and per manufacturer’s laminate schedule and procedures.

C. Expansion Joints

1. Expansion Joints:

a. Provide expansion joints where indicated and where required for flexibility and to accommodate the pipe support system.

b. Provide flanged joints where connecting ductwork to vessels, grease filters, fans, equipment and other locations as indicated.

c. Provide slip-type joints where flanges joints are not specified or indicated.

d. Type: W-design configuration with integral flanges suitable for service with FRP duct under the conditions specified and indicated.

e. Material: EPDM

f. Backing Rings: 3/8 inch thick, 2 inches wide, Type 316 stainless steel.

g. Extension: 3 inches.

h. Compression: 2.5 inches.

i. Lateral Offset: 2.5 inches.

j. Thickness: 1/4 inch minimum.

k. Bolts, Nuts and Washers: Type 316 stainless steel.

2. Manufacturers:

a. RM-Holz

b. Metraflex

c. Garlock

d. Mercer

e. Or acceptable equivalent product

D. Duct Drains

1. Provide 1-1/2 inch minimum schedule 80 PVC pipe and Type 301 Ball Valve duct drains with traps as indicated on all low points in all main, branch and riser ducts to allow removal of condensate.

a. Provide piping in accordance with Section 15294 and valves in accordance with Section 15100.

b. Insulate all exterior above-grade drain, traps and piping with 1-inch of insulation.

c. Coating of pipe shall be in accordance with section 09900. Pipe labeling shall be in accordance with section 15075.

E. Dampers

1. Dampers to be AMCA licensed/Certified FRP Dampers.

2. Provide factory fabricated dampers conforming to AMCA 500D requirements and as specified.

3. Provide FRP dampers manufactured from the same materials and resin as specified for duct.

4. Materials and Construction:

   a. Blades: Two (2) piece, molded premium vinyl ester including blade stiffeners. Provide damper blade offset 5 degrees in the closed position to form a normal stop.

   b. Axle: Pultruded FRP made of the same resin as specified for the duct and continuous strand roving.

   c. Control Shaft: Provide axle extending 6 inches beyond frame, full length vinylester with Type 316 stainless steel pins embedded transverse of axle.

   d. Bearings: Molded PTFE with 10% carbon and graphite fill.

   e. O-Rings: Viton.

   f. Metallic parts in contact with the air stream are not acceptable.

5. Provide the following type of dampers for the service specified:

   a. Unless otherwise noted, all dampers are assumed to be for isolation purposes.

   b. Isolation damper:

      (1) Butterfly type, Swartout Model 914, Belco Model 203, ECS Model X02 or acceptable equal. Must be licensed to bear the AMCA seal.

      (2) Dampers shall be equipped with shaft seal, and full circumference extruded double tadpole blade seals.

      (3) Butterfly damper leakage: Shall be AMCA leakage rated not to exceed 0.75 CFM/SQ. FT. at 30 inches wg.

      (4) 30 inch wg. maximum pressure, 200 degrees F maximum temperature.

(5) All isolation dampers shall bear AMCA seal for both air leakage and performance

(6) Provide motor operator for each isolation damper.

c. Volume damper:

(1) Same as isolation damper except full circumference blade stop in lieu of blade seal.

(2) Provide manual operator for each volume damper.

6. Provide manual dampers with manual operator identified with OPEN and CLOSE positions.

7. Dampers shall be of self-supporting construction and shall not deflect or deform while free standing.

8. Dampers shall have flanged ends for connection to ductwork and equipment.

9. Manual Operators:

a. Dampers 16-inch and larger: Provided gear operators with an epoxy coating.

b. Dampers 14-inch and smaller: Provide hand quadrant actuators fabricated of Type 316 stainless steel with a 5-stage locking quadrant indicator.

c. Volume Dampers: Provide a fully adjustable slot with an extra hole drilled in the handle for contractor to "drill and pin-in place" once system is balanced so handle cannot vibrate loose.

d. Chain wheel operators: Provide galvanized steel chainwheels with galvanized steel chain and chain guides for all dampers with operator or gear operators higher than 6.5 feet above operating floor level.

(1) Provide chain that reaches to within 3 feet of the operating floor level.

(2) For dampers with gear operator mount with chainwheel in the vertical position.

10. Motor Operators:

    a. Provide 120 VAC electric or electronic actuators for isolation dampers.

    b. Provide direct-drive actuators except where indicated otherwise. Each actuator shall deliver the torque required for continuous uniform motion and shall have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds. Provide two-position actuators of spring return type. Actuators shall be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator with a hand crank for manual adjustments, as applicable. Each actuator shall have distinct markings indicating the full-open and full-closed position, and the points in-between.

    c. Actuators shall function as specified within 85 to 110 percent of their power supply rating. Actuators shall fail to their spring return positions on signal or power failure. Actuators shall have visible position indicators. Actuators shall open or close the devices to which they are applied within 60 seconds after a full scale signal input change.

    d. Damper actuators shall be rated for at least 150 percent of the motive power necessary to operate the connected damper. The actuator stroke shall be limited by an adjustable stop in the direction of the return stroke. Actuators shall be provided with mounting and connecting hardware.

F. Air Inlets

1. Material compatible with ductwork system specified.

2. Provide Type 316L stainless steel wire mesh bird screen for all fresh air intakes.

3. Each air exhaust shall have a volume damper as indicated and specified.

G. Duct System Supports

1. Duct Support:

a. Provide supports for all ducts designed and furnished by the duct system supplier in accordance with Division 15 and as specified herein.

b. Provide hanger spacing as indicated in ASTM D 3982.

c. Provide ductwork supported from structure by straps or rods. Provide Type 316L stainless steel angle iron brackets to support ducts where structure is not available.

d. For exterior duct, design and provide free standing duct supports to meet specified duct spacing requirements and specified loads.

e. Provide anchors, inserts or clamps to secure hangers to structures. Provide Type 316 stainless steel anchors, screws and bolts. Provide in accordance with manufacturers recommendations and Factory Mutual limitations and restrictions.

H. Exterior UV resistant Coating

1. Factory applied corrosion resistant gel coat with UV inhibitors. White or as selected by the Engineer shall be used as standard color.

I. Spare Parts

1. Provide in accordance with Division 1 and as specified herein.

2. Provide the following spare parts, all identical and interchangeable with similar parts installed in Work:

a. Two spare gaskets of all types, materials and sizes.

b. One (1) set of all special tools

PART 3 - EXECUTION

A. Installation

1. General:

a. Install ducts, dampers and appurtenances in accordance with manufacturer’s recommendations.

b. Prior to installation, inspect each duct length and all fittings, flush clean of any debris or dust, and straightened, if not true. All duct and fittings shall be equally cleaned before assembly.

c. Provide all materials and equipment required.

B. Ductwork

1. Assemble per SMACNA, or NIST Standards as specified hereinbefore.

2. Do not exceed 6-ft. spacing of hangers on horizontal ducts; 4-ft. on vertical ducts.

3. Support ductwork from structure by 16-gauge straps. Use hanger material compatible with ducts; use angle brackets to support vertical ducts.

4. Use anchors, inserts or clamps to secure hangers to structures; use stainless steel anchors if drilled-in type are installed.

5. Install duct connections to masonry openings airtight. Pack the space between the sleeve and framed prepared opening and the duct and the duct insulation with mineral wool or other FM approved fire resistant material.

6. Flanged connections to equipment, 3-in. minimum length.

7. FRP ductwork:

a. Joints, finished joints in accordance with ASTM D3982 Standards.

C. System Balancing:

1. The testing and balancing shall be performed by an independent certified testing and balancing company not associated with the manufacturer or the contractor that

is competent, experienced and has formerly done similar work and whose qualifications and performance shall be subject to the approval of the Engineer.

2. The testing and balancing company shall be responsible for all testing and balancing of all odor control ductwork up to and including the odor control fan.

3. Furnish the necessary labor, materials, instruments and devices required to test, adjust and balance the air system.

4. Adjust manual and automatic control devices to balance air flows so they perform as indicated and specified.

5. Balance air systems so each outlet is within 10-percent and each fan is within 5-percent of values indicated.

6. Submit a certified report to the Owner outlining balancing procedures used; report to include:

   a. Type of measuring devices used.

   b. Air quantities at each outlet, damper and fan.

   c. Fan speeds.

   d. Fan suction and discharge pressures.

   e. Air quantities through fan, by test and by summation of air quantities at outlets.

D. Field Touch-Up Painting

After installation and approved testing by the Engineer. Contractor shall apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

E. Contract Closeout

Provide in accordance with Section 01700.

END OF SECTION

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SECTION 15736 - SELF-CONTAINED AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

This Section includes packaged air-conditioning units with refrigerant compressors, water-cooled condensers, and controls; intended for indoor installations.

1.2 SUBMITTALS

A. Product Data: For each unit indicated.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Units shall be designed to operate with HCFC-free refrigerants.

1.4 WARRANTY

Manufacturer shall provide a warranty that for five years from date of Substantial Completion which covers all parts, labor, and refrigerant.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be

incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. McQuay International.

2. Lennox

3. Trane Co. (The); North American Commercial Group.[Basis of Design]

2.2 PACKAGED UNITS

A. Description: Self-contained, factory-assembled and -wired unit; consisting of cabinet, compressor, evaporator fan, evaporator coil, air filters, and controls; and fully charged with refrigerant and oil; with integral water-cooled condenser.

B. Disconnect Switch: Factory mounted.

C. Cabinet Frame and Panels: Structural-steel frame with galvanized-steel panels with baked-enamel finish in color selected by Architect, and with access doors or panels.

1. Insulation: Minimum 1/2-inch- (13-mm-) thick, acoustic foil faced duct liner on cabinet interior and control panel.

2. Drain Pan: Stainless steel.

3. Discharge Plenum: Cabinet extension with directional louvers.

4. Corrosion-Resistant Treatment: Baked Epoxy or Phenolic coating on unit exterior of unit including all coils. Final exterior of unit shall be finished with a painted surface that is acceptable to owner’s color requirement.

D. Evaporator Fan: Galvanized-steel, double-width, double-inlet, forward-curved centrifugal fan; statically and dynamically balanced.

1. Drive: Belt, with fan mounted on permanently lubricated bearings.

2. Fan Sheaves: Cast-iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed.

3. Motor Sheave: Variable and adjustable pitch selected so required rpm are obtained when set at mid position.

4. Motors: Multispeed, PSC type.

E. Compressor: Hermetically sealed, scroll type, 3600 rpm maximum, and resiliently mounted with positive lubrication and internal motor protection.

F. Evaporator Coil: Direct-expansion coil with seamless copper tubes expanded into aluminum fins.

G. Air-Cooled Condenser: Micro channel coils

H. Disposable Filters: 2-inch- (50-mm-) thick, glass-fiber, pleated panel filters.

I. Refrigeration System: Factory assembled and tested, and charged with HCFC-free refrigerant 410A; consisting of piping and accessories connecting compressor, evaporator oil, and condenser coil, and including the following:

1. Four-way reversing valve and suction line accumulator.

2. Expansion valve with replaceable thermostatic element.

3. Refrigerant dryer.

4. High-pressure switch.

5. Low-pressure switch.

6. Thermostat for coil freeze-up protection during low-ambient temperature operation or loss of air.

7. Low-ambient switch.

8. Brass service valves installed in discharge and liquid lines.

J. Control Package: Factory wired, including contactor, high- and low-pressure cutouts, internal-winding thermostat for compressor, control-circuit transformer, and noncycling reset relay.

1. Time-Delay Relay: Five-minute delay to prevent compressor cycling.

2. Adjustable Thermostat: Remote to control the following:

    a. Supply fan.

    b. Compressor.

3. System Selector Switch: off-cool-auto.

4. Fan Control Switch: Auto-on.

5. Additional Monitoring:

    a. Monitor constant and variable motor loads.

    b. Monitor cooling load.

    c. Monitor air distribution static pressure and ventilation air volumes.

K. Ventilation Options:

Motorized Outside-Air Damper: Motorized, 2-position blade damper allowing induction of up to 25 percent outside air; with spring-return, low-voltage damper motor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor units to a 6 inch thick min concrete pad.

B. Isolation: Mount cabinet on rubber-in-shear pads for mounting under base of unit.

3.2 CONNECTIONS

A. Install piping adjacent to unit to allow service and maintenance.

B. Unless otherwise indicated, connect piping with unions and shutoff valves to allow units to be disconnected without draining piping. Refer to piping system Sections for specific valve and specialty arrangements.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections , and to assist in field testing. Report results in writing.

B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

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SECTION 15738 - SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

A. SUMMARY

This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

B. SUBMITTALS

1. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

2. Operation and maintenance data.

C. QUALITY ASSURANCE

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

3. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

4. Units shall be designed to operate with HCFC-free refrigerants.

D. WARRANTY

Special Warranty: Manufacturer shall provide a warranty that for five years from date of Substantial Completion which covers all parts, labor, and refrigerant.

PART 2 - PRODUCTS

A. MANUFACTURERS

1. Manufacturers shall be the same as self-contained (packaged AC units) as identified in section 15736.

2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Lennox Industries Inc.

   b. Trane Co. (The); Unitary Products Group.

   c. York International Corp.

B. EVAPORATOR-FAN UNIT

1. Concealed Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

   a. Insulation: Faced, glass-fiber duct liner.

   b. Drain Pans: Galvanized steel, with connection for drain; insulated.

2. Floor-Mounting, Unit Cabinet: Enameled steel with removable panels on front and ends.

3. Insulation: Faced, glass-fiber, duct liner.

4. Drain Pans: Galvanized steel, with connection for drain; insulated.

1. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve. Provide black epoxy, heresite or phenolic coating providing a 1000 salt spray test.

5. Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

6. Fan Motor: Multispeed.

7. Filters: 1 inch (25 mm) thick, in fiberboard frames.

C. AIR-COOLED, COMPRESSOR-CONDENSER UNIT

2. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

3. Compressor: Hermetically sealed scroll type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

   a. Refrigerant Charge: R-410A.

4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler. Provide black epoxy, heresite or phenolic coating providing a 1000 salt spray test.

5. Fan: Aluminum-propeller type, directly connected to motor.

6. Motor: Permanently lubricated, with integral thermal-overload protection.

7. Low Ambient Kit: Permits operation down to 40 deg F (7 deg C).

8. Mounting Base: Steel/Fibermesh reinforced Concrete Pad.

D. ACCESSORIES

1. Thermostat: Programmable Low voltage with sub base to control compressor and evaporator fan.

2. Refrigerant Line Kits: copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

3. Low ambient controls.

PART 3 - EXECUTION

A. INSTALLATION

1. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

2. Install ground-mounted, compressor-condenser components on reinforced concrete base; 6 inches (100 mm) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

B. CONNECTIONS

A. Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

B. Connect supply and return water coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

C. Connect supply and return condenser connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

D. Install piping adjacent to unit to allow service and maintenance.

C. FIELD QUALITY CONTROL

E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

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SECTION 15815 - METAL DUCTS

PART 1 - GENERAL

A. SUMMARY

1. This Section includes metal, rectangular ducts and fittings for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 10-inch wg (minus 500 to plus 2500 Pa).

2. See Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

B. QUALITY ASSURANCE

NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

A. MANUFACTURERS

In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. SHEET METAL MATERIALS

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free

of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

3. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

4. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

C. SEALANT MATERIALS

1. Joint and Seam Tape: 2 inches (50 mm) wide; glass-fiber-reinforced fabric.

2. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

3. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

4. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

5. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

6. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

D. HANGERS AND SUPPORTS

1. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

a. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.

b. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

2. Hanger Materials: Galvanized sheet steel or threaded steel rod.

a. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

b. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.

3. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

4. Trapeze and Riser Supports: Galvanized-steel shapes and plates complying with ASTM A 36/A 36M.

E. RECTANGULAR DUCT FABRICATION

1. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

a. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
b. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

2. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

a. Manufacturers:

1) Ductmate Industries, Inc.

2) Nexus Inc.

3) Ward Industries, Inc.

3. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

a. Manufacturers:

1) Ductmate Industries, Inc.

2) Lockformer.

b. Duct Size: Maximum 30 inches (750 mm) wide and up to 2-inch wg (500-Pa) pressure class.

c. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

4. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of nonbraced panel area unless ducts are lined.

PART 3 - EXECUTION

A. DUCT APPLICATIONS

Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following: (Applies to ERV-1 and Exhaust Fans)

1. Supply Ducts: 2-inch wg (500 Pa).

2. Return Ducts (Negative Pressure): 1-inch wg (250 Pa).

B. DUCT INSTALLATION

1. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

2. Install ducts with fewest possible joints.

3. Install fabricated fittings for changes in directions, size, and shape and for connections.

4. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches (300 mm), with a minimum of 3 screws in each coupling.

5. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

6. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

7. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

8. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

9. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

10. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

11. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

12. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches (38 mm).

13. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and

firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."

14. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction.

C. SEAM AND JOINT SEALING

1. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

   a. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.

2. Seal ducts before external insulation is applied.

D. HANGING AND SUPPORTING

1. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

2. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.

3. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

4. Install concrete inserts before placing concrete.

5. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

   a. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

E. CONNECTIONS

1. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."

2. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

END OF SECTION

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SECTION 15820 DUCT ACCESORIES

PART 1 - GENERAL

A. SUMMARY

This Section includes the following:

1. Volume dampers.

2. Turning vanes.

3. Flexible connectors.

4. Back draft dampers.

B. SUBMITTALS

1. Product Data: For the following:

   a. Volume dampers.

   b. Turning vanes.

   c. Flexible connectors.

   d. Back draft dampers.

2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   a. Special fittings.

   b. Manual-volume damper installations.

C. QUALITY ASSURANCE

Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

A. MANUFACTURERS

In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

B. SHEET METAL MATERIALS

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

2. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

3. Stainless Steel: ASTM A 480/A 480M.

4. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

5. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063, temper T6.

6. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

7. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

C. VOLUME DAMPERS

1. Manufacturers:

   a. Greenheck

   b. Nailor Industries Inc.

   c. Ruskin Company.

2. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

3. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating and suitable for horizontal or vertical applications.

   a. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.

   b. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized sheet steel.

   c. Blade Axles: Galvanized steel.

   d. Bearings: [Oil-impregnated bronze] [Molded synthetic] [Stainless-steel sleeve].

   e. Tie Bars and Brackets: Galvanized steel.

4. Jackshaft: 1-inch- (25-mm-) diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

   a. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

5. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

D. TURNING VANES

1. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

2. Manufactured Turning Vanes: Fabricate 1-1/2-inch- (38-mm-) wide, [single] [double]-vane, curved blades of galvanized sheet steel set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into vane runners suitable for duct mounting.

   Manufacturers:

   a. Ductmate Industries, Inc.

   b. Duro Dyne Corp.

   c. METALAIRE, Inc.

   d. Ward Industries, Inc.

3. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

E. FLEXIBLE CONNECTORS

1. Manufacturers:

   a. Ductmate Industries, Inc.

   b. Duro Dyne Corp.

   c. Ventfabrics, Inc.

   d. Ward Industries, Inc.

2. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

3. Flexible Connector Fabric: Glass fabric double coated with neoprene.

   a. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

   b. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.

   c. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

F. BACKDRAFT DAMPERS

1. Manufacturers:

   a. Greenheck

   b. Prefco Products, Inc.

   c. Ruskin Company.

2. General Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch (150-mm) width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

3. Frame: 0.063-inch (1.6 mm) thick extruded aluminum with welded corners and mounting flange.

4. Blades: 0.050-inch (1.3 mm) thick aluminum sheet.

5. Blade Seals: Vinyl

6. Blade Axles: 304 Stainless Steel.

7. Tue Bars and Brackets: 304 Stainless Steel.

8. Return Spring: Adjustable tension.

9. Coating: Hi-Pro Polyester

PART 3 - EXECUTION

A. APPLICATION AND INSTALLATION

1. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

2. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

3. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

4. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

5. Provide test holes at fan inlets and outlets and elsewhere as indicated.

B. ADJUSTING

1. Adjust duct accessories for proper settings.

2. Adjust fire and smoke dampers for proper action.

3. Final positioning of manual-volume dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION

SECTION 15855 DIFFUSERS, REGISTERS & GRILLES

PART 1 - GENERAL

A. SUMMARY

This Section includes registers, and grilles.

B. SUBMITTALS

Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

A. MANUFACTURERS

In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2. Products: Subject to compliance with requirements, provide one of the products specified.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

5. See plans for schedule of basic of design.

B. SOURCE QUALITY CONTROL

Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

A. INSTALLATION

1. Install diffusers, registers, and grilles level and plumb.

2. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

B. ADJUSTING

After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 15900 – HVAC CONTROLS

PART 1 - GENERAL

A. SUMMARY

1. SUMMARY

   a. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

2. SUBMITTALS

   a. Product Data: For each control device indicated.

   b. Shop Drawings:

      1) Schematic flow diagrams.

      2) Power, signal, and control wiring diagrams.

      3) Details of control panel faces.

      4) Damper schedule.

      1) DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.

      2) Control System Software: Schematic diagrams, written descriptions, and points list.

   d. Software and firmware operational documentation.

   e. Field quality-control test reports.

   f. Operation and maintenance data.

3. QUALITY ASSURANCE

   a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

A. SECTION INCLUDES

a. General Description

b. Architecture/Communication

c. Operator Interface

d. Application and Control Software

e. System Controllers

f. General Programmable Controllers

g. Terminal Unit Programmable Controllers

B. GENERAL DESCRIPTION

1. The Building Automation System (BAS) shall be a web-based Trane Tracer SC™ or equivalent. Supervisory controller or System Controller shall be capable of communication via BACnet MS/TP and LonTalk™ protocol simultaneously at the system level to allow for seamless integration with future equipment expansions and with the site SCADA network. User interface shall be web based with access available via any standard internet browser. Systems employing local workstations or proprietary PC software to facilitate remote access shall not be acceptable.

2. The BAS shall interface with the existing SCADA network via MODBUS communication protocol and serve up control points which shall be visible through the SCADA interface for monitoring and alarming purposes. Refer to mechanical plans for points of interface specific to each building.

   a. Interface between BAS and SCADA network shall be facilitated by a LynxSpring JENsys PC1000 series controller. PC1000 shall communicate with SCADA system via MODBUS TCP protocol.

C. ARCHITECTURE/COMMUNICATION

1. The BAS installed in accordance with this contract shall be comprised of a high speed Ethernet network utilizing

BACnet/IP communications between System Controllers and Workstations. Communications between System Controllers and sub-networks of Custom Application Controllers shall utilize BACnet MS/TP communications.

a. Each System Controller shall perform communication to a network of Custom Application Controllers using BACnet MS/TP as prescribed by the BACnet standard.

a. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.

b. Above indicated requirement for LonTalk™ capability does not constitute approval for substitutions of LonTalk™ systems. The basis of design for this project is a BACnet “top to bottom” installation. The purpose of the requirement is to provide flexibility to the system owner and facilitate a change of desired protocol in the future if applicable.

2. The Owner will provide all communication media, connectors, repeaters, network switches, and routers necessary for the high speed Ethernet network. An active Ethernet port will be provided adjacent to each System Controller and for connection to this high speed Ethernet network.

D. OPERATOR INTERFACE

1. A dedicated PC shall not be required to access the operator interface. The interface shall be Web-Based. Systems employing local workstations or proprietary PC software to facilitate remote access shall not be acceptable.

2. The operator interface shall reside on the Enterprise wide network, which is same high-speed communications network as the System Controllers. The Enterprise wide network will be provided by the owner and support the Internet Protocol (IP).

a. Operator Interface

a. The operator interface shall be accessible via a web browser.

b. The operator interface shall support the following Internet web browsers:

1) Internet Explorer 8.0+

2) Firefox 4.0+

3) Chrome 10.0+

c. The operator interface shall support the following mobile web browsers:

1) iOS (iPad/iPhone) V4.0+

2) Android (Tablet) V4.0+

3) Android (Phone) V2.3+

d. System Security

1) Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.

2) User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.

3) Each operator shall be allowed to change their user password

4) The System Administrator shall be able to manage the security for all other users

5) The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.

6) User logon/logoff attempts shall be recorded.

7) The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.

8) All system security data shall be stored in an encrypted format.

e. Database

1) Database Save. A system operator with the proper password clearance shall be able to archive the database on the designated operator interface PC.

2) Database Restore. The system operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

f. On-Line Help and Training

1) Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.

2) On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.

g. System Diagnostics

1) The system shall automatically monitor the operation of all network connections, building management panels, and controllers.

2) The failure of any device shall be annunciated to the operators.

h. Equipment & Application Pages

1) The operator interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:

a) Animated Equipment Graphics for each major piece of equipment and floor plan in the System. This includes:

(1) Each Chiller, Air Handler, VAV Terminal, Fan Coil, Boiler, and Cooling Tower. These graphics shall show all points dynamically as specified in the points list.

(2) Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or

damper positions. Graphics shall be capable of launching other web pages.

b) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.

c) Historical Data (As defined in Automatic Trend Log section below) for the equipment or application without requiring a user to navigate to a data log page and perform a filter.

i. System Graphics: Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.

1) Functionality: Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point and-click navigation between zones or equipment, and to edit set points and other specified parameters.

2) Graphic imagery: graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.

3) Animation: Graphics shall be able to animate by displaying different Image lies for changed object status.

4) Alarm Indication: Indicate areas or equipment in an alarm condition using color or other visual indicator.

5) Format: Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-

in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

j. Custom Graphics

1) The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.

2) Graphical Navigation: The operator interface shall provide dynamic color graphics of building areas, systems and equipment.

3) Graphical Data Visualization: The operator interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.

4) Custom background images: Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.

k. Graphics Library: Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.

l. Manual Control and Override.

1) Point Control: Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.

2) Temporary Overrides: The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.

3) Override Owners: The system shall convey to the user the owner of each override for all priorities that an override exists.

4) Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.

m. Engineering Units

1) Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.

2) Unit selection shall be able to be customized by locality to select the desired units for each measurement.

3) Engineering units on this project shall be IP.

b. Scheduling: A user shall be able to perform the following tasks utilizing the operator interface:

a. Create a new schedule, defining the default values, events and membership.

b. Create exceptions to a schedule for any given day.

c. Apply an exception that spans a single day or multiple days.

d. View a schedule by day, week and month.

e. Exception schedules and holidays shall be shown clearly on the calendar.

f. Modify the schedule events, members and exceptions.

c. Trend Logs

a. Trend Logs Definition:

1) The operator interface shall allow a user with the appropriate security permissions to define a trend log for any data in the system.

2) The operator interface shall allow a user to define any trend log options as described in the Application and Control Software section.

b. Trend Log Viewer:

1) The operator interface shall allow Trend Log data to be viewed and printed.

2) The operator interface shall allow a user to view trend log data in text-based (time –stamp/value).

3) The operator shall be able to view the data collected by a trend log in a graphical chart in the operator interface.

4) Trend log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.

5) Each data point trend line shall be displayed as a unique color.

6) The operator shall be able to specify the duration of historical data to view by scrolling and zooming.

7) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.

c. Export Trend Logs

1) The operator interface shall allow a user to export trend log data in CSV or PDF format for use by other industry standard word processing and spreadsheet packages.

d. Alarm/Event Notification

a. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.

b. Alarm/Event Log: The operator shall be able to view all logged system alarms/events from any operator interface.

1) The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in a minimum of 4 categories based on severity.

2) Alarm/event messages shall use full language, easily recognized descriptors.

3) An operator with the proper security level may acknowledge and clear alarms/events.

4) All alarms/events that have not been cleared by the operator shall be stored by the building controller.

5) The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.

c. Alarm Processing

1) The operator shall be able to configure any object in the system to generate an alarm when transitioning in and out of a normal state.

2) The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

e. Reports and Logs

a. The operator interface shall provide a reporting package that allows the operator to select reports.

b. The operator interface shall provide the ability to schedule reports to run at specified intervals of time.

c. The operator interface shall allow a user to export reports and logs from the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Acceptable formats include:

1) CSV, HTML, XML, PDF

d. Provide a means to list and access the last 10 reports viewed by the user.

e. The following standard reports shall be available without requiring a user to manually configure the report:

1) All Points in Alarm Report: Provide an on demand report showing all current alarms.

2) All Points in Override Report: Provide an on demand report showing all overrides in effect.

3) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.

4) Points report: Provide a report that lists the current value of all points

E. APPLICATION AND CONTROL SOFTWARE

1. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator interface.

a. Scheduling: Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:

a. Weekly Schedule: Provide separate schedules for each day of the week.

b. Exception Schedules: Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.

c. Holiday Schedules: Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

d. Optimal Start: The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified

occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less then and greater than 24 hours. Provide the ability to modify the start algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

b. Trend Log Application

a. Trend log data shall be sampled and stored on the System Controller panel and shall capable of being archived to a BACnet Workstation for longer term storage.

1) Trend logs shall include interval, start-time, and stop-time.

2) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.

b. Automated Trend Logs

1) The system controller shall automatically create trend logs for defined key measurements for each controlled HVAC device and HVAC application.

2) The automatic trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.

3) The following is a list of key measurements required for Automatic Trending:

c. Alarm/Event Log

a. Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.

b. Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.

c. An alarm/event shall be capable of triggering any of the following actions:

1) Route the alarm/event to one or more alarm log

a) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.

2) Route an e-mail message to an operator(s)

3) Log a data point(s) for a period of time

4) Run a custom control program

d. Point Control: User shall have the option to set the update interval, minimum on/off time, event notification, custom programming on change of events.

e. Timed Override: A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, operator interface, or the local operator display. The amount of time that the override takes precedence will be selectable from the operator interface.

f. Anti-Short Cycling: All binary output points shall be protected from short cycling.

F. SYSTEM CONTROLLERS

1. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section (Trane Tracer SC™ or approved equivalent)

a. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.

b. The controller shall provide a USB communications port for connection to a PC

c. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

d. All System Controllers shall have a real time clock.

e. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

   a. Assume a predetermined failure mode.

   b. Generate an alarm notification.

   c. Create a retrievable file of the state of all applicable memory locations at the time of the failure.

   d. Automatically reset the System Controller to return to a normal operating mode.

f. Environment: Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40 F to 122 F.

g. Clock Synchronization:

   a. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.

   b. All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.

   c. All System Controllers shall automatically adjust for daylight savings time if applicable.

h. Serviceability

   a. Provide diagnostic LEDs for power, communications, and processor.

   b. The System Controller shall have a display on the main board that indicates the current operating mode of the controller.

   c. All wiring connections shall be made to field removable, modular terminal connectors.

   d. The System controller shall utilize standard DIN mounting methods for installation and replacement.

i. Memory: The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller

j. Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage

k. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs.

G. GENERAL PROGRAMMABLE CONTROLLERS

1. Controllers shall be Trane UC600 fully programmable units or approved equivalent. Application specific controllers not capable of accepting custom programs shall not be acceptable. Controller operation shall not be dependent upon presence of a BAS. If no BAS exists, communication with the BAS is lost, the controller shall be capable of standalone operation utilizing local programming and set points.

2. Operation:

a. Shall operate a schedule in a standalone application using a Real Time Clock.

a. The Controller shall have a built in schedule (assessable with or without a display)

b. Support will be for at least 3 schedules with up to 10 events for each day of the week.

c. Each of the 3 schedules can be Analog, Binary or Multi-State

d. The controller shall support a minimum of 25 exceptions each with up to 10 events.

b. For ease of troubleshooting, the Controller shall support data trend logging

a. 25,000 samples minimum

b. Trends shall be capable of being collected at a minimum sample rate of once every second

c. Trends shall be capable of being scheduled or triggered.

c. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.

d. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

a. Storage conditions:

1) Temperature: -67°F to 203°F (-55°C to 95°C)

2) Humidity: Between 5% to 100% RH (non-condensing)

b. Operating conditions:

1) Temperature: -40°F to 158°F (-40°C to 70°C)

2) ‘Humidity: Between 5% to 100% RH (non-condensing)

c. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum

d. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 F to 158 F [-40 C to 70 C].

e. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements:

a. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.

b. Shall support flexibility in sensor type, the Controller shall be of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.

c. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.

d. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.

e. The controller support pulse accumulator for connecting devices like energy meters.

f. In order to support a wide range of devices, the Controller’s binary output shall be able to drive at least 10VA each.

g. Any I/O that is unused by functionality needed for the equipment shall be available to be used by custom program on the Controller and by any other controller on the network.

h. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.

i. The Controller shall provide a dedicated static pressure input.

f. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:

a. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.

b. Expansion I/O can be mounted up to 200m from control

c. Expansion I/O can be added in as small as 4 point increments.

d. To keep BACnet MS/TP network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus (point expansion via the BACnet MS/TP network is not allowed)

g. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.

a. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.

b. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box

c. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller’s zone sensor.

d. For configuration, programming, and testing of controller programs must, for safety purposes, be able to be accomplished with the power off to the equipment and the controller.

e. The Controller software tool service port shall utilize standard of-the-shelf USB printer cable.

f. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.

g. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.

h. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).

i. To aid in service replacement, the Controller shall allow for setting its BACnet address must be rotary switches that correspond to a numerical value for the address to allow the setting of the address without the need of a service tool or the control being powered (DIP switch methodologies are not allowed).

j. Controller data shall persist through a power failure.

h. Software Retention: All Controller operating parameters, set points, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.

i. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

j. Controller must meet the following Agency Compliance:

a. UL916 PAZX, Open Energy Management Equipment

b. UL94-5V, Flammability

c. FCC Part 15, Subpart B, Class B Limit

d. BACnet Testing Laboratory (BTL) Listed

e. cUL Marked for international compliance

f. CE Marked for international compliance

PART 3 - EXECUTION

A. INSTALLATION

1. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.

a. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

2. Install guards on thermostats in the following locations:

a. Where indicated.

3. Install automatic dampers according to Division 15 Section "Duct Accessories."

4. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

5. Install labels and nameplates to identify control components according to Division 15 Section "Mechanical Identification."

6. Install refrigerant instrument wells, valves, and other accessories according to Division 15 Section "Refrigerant Piping."

7. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.

8. Install electronic and fiber-optic cables according to Division 16 Section "Voice and Data Communication Cabling."

9. ELECTRICAL WIRING AND CONNECTION INSTALLATION

10. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways and Boxes."

11. Install building wire and cable according to Division 16 Section "Conductors and Cables."

12. Install signal and communication cable according to Division 16 Section "Voice and Data Communication Cabling."

    a. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

    b. Install exposed cable in raceway.

    c. Install concealed cable in raceway.

    d. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

    e. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

    f. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

    g. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

13. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

14. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

B. FIELD QUALITY CONTROL

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

2. Perform the following field tests and inspections and prepare test reports:

    a. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

    b. Test and adjust controls and safeties.

    c. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

    d. Test each point through its full operating range to verify that safety and operating control set points are as required.

    e. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

    f. Test each system for compliance with sequence of operation.

    g. Test software and hardware interlocks.

3. DDC Verification:

    a. Verify that instruments are installed before calibration, testing, and loop or leak checks.

    b. Check instruments for proper location and accessibility.

c. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

d. Check instrument tubing for proper fittings, slope, material, and support.

e. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

f. Check temperature instruments and material and length of sensing elements.

g. Check control valves. Verify that they are in correct direction.

h. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.

i. Check DDC system as follows:

j. Verify that DDC controller power supply is from emergency power supply, if applicable.

k. Verify that wires at control panels are tagged with their service designation and approved tagging system.

l. Verify that spare I/O capacity has been provided.

m. Verify that DDC controllers are protected from power supply surges.

4. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

C. DEMONSTRATION

a. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION

SECTION 15950 TESTING, ADJUSTING & BALANCING

PART 1 - GENERAL

A. SUMMARY

This Section includes TAB to produce design objectives for the following:

1. Air Systems:

    a. Constant-volume air systems.

2. HVAC equipment quantitative-performance settings.

3. Verifying that automatic control devices are functioning properly.

4. Reporting results of activities and procedures specified in this Section.

B. SUBMITTALS

1. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

2. Warranties specified in this Section.

C. QUALITY ASSURANCE

1. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

2. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

    a. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

    b. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

3. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. PROJECT CONDITIONS

1. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

2. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

E. COORDINATION

1. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

2. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

F. WARRANTY

1. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:

2. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

a. The certified TAB firm has tested and balanced systems according to the Contract Documents.

b. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - (No Products)

PART 3 - EXECUTION

A. EXAMINATION

1. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

   a. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

2. Examine approved submittal data of HVAC systems and equipment.

3. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

4. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

5. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under

conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

6. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

7. Examine system and equipment test reports.

8. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

9. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

10. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

11. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

12. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

13. Examine strainers for clean screens and proper perforations.

14. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

15. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

16. Examine system pumps to ensure absence of entrained air in the suction piping.

17. Examine equipment for installation and for properly operating safety interlocks and controls.

18. Examine automatic temperature system components to verify the following:

    a. Dampers, valves, and other controlled devices are operated by the intended controller.

    b. Dampers and valves are in the position indicated by the controller.

    c. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.

    d. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.

    e. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.

    f. Sensors are located to sense only the intended conditions.

    g. Sequence of operation for control modes is according to the Contract Documents.

    h. Controller set points are set at indicated values.

    i. Interlocked systems are operating.

    j. Changeover from heating to cooling mode occurs according to indicated values.

19. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

B. PREPARATION

1. Prepare a TAB plan that includes strategies and step-by-step procedures.

2. Complete system readiness checks and prepare system readiness reports. Verify the following:

   a. Permanent electrical power wiring is complete.

   b. Hydronic systems are filled, clean, and free of air.

   c. Automatic temperature-control systems are operational.

   d. Equipment and duct access doors are securely closed.

   e. Balance, smoke, and fire dampers are open.

   f. Isolating and balancing valves are open and control valves are operational.

   g. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

   h. Windows and doors can be closed so indicated conditions for system operations can be met.

C. GENERAL PROCEDURES FOR TESTING AND BALANCING

1. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

2. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

3. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

1. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

2. Prepare schematic diagrams of systems' "as-built" duct layouts.

3. For variable-air-volume systems, develop a plan to simulate diversity.

4. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

5. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

6. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

7. Verify that motor starters are equipped with properly sized thermal protection.

8. Check dampers for proper position to achieve desired airflow path.

9. Check for airflow blockages.

10. Check condensate drains for proper connections and functioning.

11. Check for proper sealing of air-handling unit components.

    a. Check for proper sealing of air duct system.

E. PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

1. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Measure fan static pressures to determine actual static pressure as follows:

        1) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

        2) Measure static pressure directly at the fan outlet or through the flexible connection.

        3) Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

        4) Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

    b. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

        1) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

    c. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

    d. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

e. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

f. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

2. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

   a. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

      1) Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

   b. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

3. Measure terminal outlets and inlets without making adjustments.

   a. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

4. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

   a. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without

generating noise levels above the limitations prescribed by the Contract Documents.

b. Adjust patterns of adjustable outlets for proper distribution without drafts.

F. PROCEDURES FOR CONDENSING UNITS

1. Verify proper rotation of fans.

2. Measure entering- and leaving-air temperatures.

3. Record compressor data.

G. PROCEDURES FOR HEAT-TRANSFER COILS

1. Electric-Heating Coils: Measure the following data for each coil:

a. Nameplate data.

b. Airflow.

c. Entering- and leaving-air temperature at full load.

d. Voltage and amperage input of each phase at full load and at each incremental stage.

e. Calculated kilowatt at full load.

f. Fuse or circuit-breaker rating for overload protection.

2. Refrigerant Coils: Measure the following data for each coil:

a. Dry-bulb temperature of entering and leaving air.

b. Wet-bulb temperature of entering and leaving air.

c. Airflow.

d. Air pressure drop.

e. Refrigerant suction pressure and temperature.

H. PROCEDURES FOR TEMPERATURE MEASUREMENTS

1. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

2. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

3. Measure outside-air, wet- and dry-bulb temperatures.

I. TEMPERATURE-CONTROL VERIFICATION

1. Verify that controllers are calibrated and commissioned.

2. Check transmitter and controller locations and note conditions that would adversely affect control functions.

3. Record controller settings and note variances between set points and actual measurements.

4. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

5. Check free travel and proper operation of control devices such as damper and valve operators.

6. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

7. Check the interaction of electrically operated switch transducers.

8. Check the interaction of interlock and lockout systems.

9. Check main control supply-air pressure and observe compressor and dryer operations.

10. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

11. Note operation of electric actuators using spring return for proper fail-safe operations.

J. TOLERANCES

Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.

2. Air Outlets and Inlets: 0 to minus 10 percent.

3. Heating-Water Flow Rate: 0 to minus 10 percent.

K. FINAL REPORT

1. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

2. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

   a. Include a list of instruments used for procedures, along with proof of calibration.

3. Final Report Contents: In addition to certified field report data, include the following:

   a. Pump curves.

   b. Fan curves.

   c. Manufacturers' test data.

   d. Field test reports prepared by system and equipment installers.

   e. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

4. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

a. Title page.

b. Name and address of TAB firm.

c. Project name.

d. Project location.

e. Architect's name and address.

f. Engineer's name and address.

g. Contractor's name and address.

h. Report date.

i. Signature of TAB firm who certifies the report.

j. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

k. Summary of contents including the following:

    1) Indicated versus final performance.

    2) Notable characteristics of systems.

    3) Description of system operation sequence if it varies from the Contract Documents.

l. Nomenclature sheets for each item of equipment.

m. Data for terminal units, including manufacturer, type size, and fittings.

n. Notes to explain why certain final data in the body of reports varies from indicated values.

o. Test conditions for fans and pump performance forms including the following:

    1) Settings for outside-, return-, and exhaust-air dampers.

    2) Conditions of filters.

    3) Cooling coil, wet- and dry-bulb conditions.

    4) Face and bypass damper settings at coils.

5) Fan drive settings including settings and percentage of maximum pitch diameter.

6) Inlet vane settings for variable-air-volume systems.

7) Settings for supply-air, static-pressure controller.

8) Other system operating conditions that affect performance.

5. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

a. Quantities of outside, supply, return, and exhaust airflows.

b. Water and steam flow rates.

c. Duct, outlet, and inlet sizes.

d. Pipe and valve sizes and locations.

e. Terminal units.

f. Balancing stations.

g. Position of balancing devices.

END OF SECTION

SECTION 15990 - HVAC COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

A. SUMMARY

Commissioning shall be the responsibility of the contractor. Contractor shall engage a certified commissioning agent to perform all commissioning, and coordinate commissioning activities between all trades.

B. DEFINITIONS

1. Consultant: Includes Consultant identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

2. BoD: Basis of Design.

3. BoD-HVAC: HVAC systems basis of design.

4. CxA: Commissioning Authority.

5. OPR: City's Project Requirements.

6. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

7. TAB: Testing, Adjusting, and Balancing.

C. CONTRACTOR'S RESPONSIBILITIES

1. Contractor:

a. Engage and include in contractor’s cost services required by CxA.

b. Attend procedures meeting for TAB Work.

c. Certify that TAB Work is complete.

2. Mechanical Contractor:

a. Attend TAB verification testing.

b. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

3. HVAC Instrumentation and Control Contractor: With the CxA, review control designs for compliance with the OPR and BoD, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.

4. TABContractor:

a. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.

1) Verify the following:

a) Accessibility of equipment and components required for TAB Work.

b) Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.

c) Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.

d) Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.

e) Air and water flow rates have been specified and compared to central equipment output capacities.

2) Identify discontinuities and omissions in the Contract Documents.

3) This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in

Division 15 Section "Testing, Adjusting, and Balancing."

b. Additional Responsibilities: Participate in tests specified in Division 15 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation."

5. Electrical Contractor:

a. With the Mechanical Contractor, coordinate installations and connections between and among electrical and HVAC systems.

b. Attend TAB verification testing.

D. COMMISSIONING DOCUMENTATION

1. The following are in addition to documentation specified in Division 1 Section "General Commissioning Requirements."

2. BoD HVAC: Owner will provide BoD-HVAC documents, prepared by Architect and approved by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

3. Test Checklists: CxA shall develop test checklists for HVAC systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. In addition to the requirements specified in Division 1 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

a. Calibration of sensors and sensor function.

b. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.

c. Control sequences for HVAC systems.

d. Strength of control signal for each set point at specified conditions.

e. Responses to control signals at specified conditions.

f. Sequence of response(s) to control signals at specified conditions.

g. Electrical demand or power input at specified conditions.

h. Power quality and related measurements.

i. Expected performance of systems, subsystems, and equipment at each step of test.

j. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.

k. Interaction of auxiliary equipment.

l. Issues log.

E. SUBMITTALS

1. The following submittals are in addition to those specified in Division 1 Section "General Commissioning Requirements."

2. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

3. Certificate of Readiness: CxA shall compile certificates of readiness from each Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

4. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed. Certification shall include completed checklists provided by TAB Contractor as specified in Division 15 Section "Testing, Adjusting, and Balancing."

5. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.

6. Corrective Action Documents: CxA shall submit corrective action documents.

7. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

A. TESTING PREPARATION

1. Prerequisites for Testing:

a. Certify that HVAC systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.

b. Certify that HVAC instrumentation and control systems have been completed and calibrated; are operating according to the OPR, BoD, and Contract Documents; and that pretest set points have been recorded.

c. Certify that TAB procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

d. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.

e. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

f. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.

g. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.

h. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

i. Annotate checklist or data sheet when a deficiency is observed.

j. Verify equipment interface with monitoring and control system and TAB criteria; include the following:

    1) Supply and return flow rates for VAV and constant volume systems in each operational mode.

    2) Operation of terminal units in both heating and cooling cycles.

    3) Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.

    4) Building pressurization.

    5) Total exhaust airflow and total outdoor-air intake.

    6) Operation of indoor-air-quality monitoring systems.

k. Verify proper responses of monitoring and control system controllers and sensors to include the following:

    1) For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device,

check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.

2) Report deficiencies and prepare an issues log entry.

l. Verify that HVAC equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 15 Sections.

2. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. For individual room cooling tests, provide temporary heaters to impose a cooling load indicated in BoD. Operational modes include the following:

a. Occupied and unoccupied.

b. Warm up and cool down.

c. Smoke control.

d. Fire safety.

e. Temporary upset of system operation.

f. Partial occupancy conditions.

g. Special cycles.

B. TAB VERIFICATION

1. TAB Contractor shall coordinate with CxA for work required in Division 15 Section "Testing, Adjusting, and Balancing." TAB contractor shall copy CxA with required reports, sample forms, checklists, and certificates.

2. TAB Preparation:

a. TAB Contractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 15 Section "Testing, Adjusting, and Balancing."

1) CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.

3. Verification of Final TAB Report:

a. CxA shall select, at random, 10 percent of report for field verification.

b. CxA shall notify TAB Contractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The TAB contractor shall use the same instruments (by model and serial number) that were used when original data were collected.

c. Failure of an item is defined as follows:

1) For all readings other than sound, a deviation of more than 10 percent.

a) For sound pressure readings, a deviation of 3 dB. (Note: Variations in background noise must be considered.)

d. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.

4. If deficiencies are identified during verification testing, CxA shall notify the HVAC Contractor and consultant in writing, and shall take action to remedy the deficiency. Consultant shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

5. CxA shall certify that TAB Work has been successfully completed.

C. TESTING

1. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

2. Perform tests using design conditions whenever possible.

   a. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

   b. Alter set points when simulating conditions is not practical and when written approval is received from CxA.

   c. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

3. Scope of HVAC Contractor Testing:

   a. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.

   b. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

4. HVAC Instrumentation and Control System Testing:

   a. Field testing plans and testing requirements are specified in Division 15 Sections "HVAC Instrumentation and Controls" and "Sequence of Operation." The CxA, HVAC contractor, and the HVAC

Instrumentation and Controls contractor shall collaborate to prepare testing plans.

b. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.

5. HVAC Distribution System Testing: HVAC contractor shall prepare a testing plan to verify performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:

   a. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

   b. Tracking checklist for managing and ensuring that all pipe sections have been tested.

6. Vibration and Sound Tests: HVAC contractor shall prepare testing plans to verify performance of vibration isolation and seismic controls. CxA shall witness and certify tests and inspections.

7. Deferred Testing:

   a. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.

   b. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

8. Testing Reports:

a. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.

b. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.

c. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

9. If it is determined that the system is constructed according to the Contract Documents, Owner will decide whether modifications required to bring the performance of the system to the OPR and BoD documents shall be implemented or if tests will be accepted as submitted. If corrective Work is performed, Owner will decide if tests shall be repeated and a revised report submitted.

END OF SECTION

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DIVISION 16 – ELECTRICAL

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SECTION 16000 ELECTRICAL – GENERAL PROVISIONS

PART 1 GENERAL

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install complete and make operational, electrical and process instrumentation systems at the Orange County Eastern Water Reclamation Facility (Phase V Improvements) as shown on the Drawings and as specified herein.

2. The work shall include furnishing, installing and testing the equipment and materials specified in other Sections of the Division 16 Specifications and shown on the Drawings.

3. The work shall include furnishing and installing the following:

   a. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions of these specifications.

   b. Conduit, wiring and terminations for all field-mounted instruments furnished under other Divisions of these specifications, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions of these specifications.

   c. A complete raceway system for the Data Highway Cables and specialty cable systems. Install the Data Highway Cables and other specialty cable systems [furnished under Division 13] in accordance with the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the computer system supplier and the cable manufacturer to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install cables in separate raceways.

   d. Conduit, wiring and terminations for variable frequency drives, harmonic filters, transformers and power factor correction capacitors furnished under other Divisions of these specifications.

e. Power wiring for all heating, ventilating, and air conditioning (HVAC) equipment furnished under other Divisions of these Specifications, including power wiring for 120V unit heater motors, thermostats, fan motors, dampers and other HVAC inline unit wiring shown on the Drawings.

f. Furnish and install precast manholes, precast handholes and light pole bases.

g. Furnish and install manhole and handhole frames and covers.

h. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.

i. Extension of telephone service from the Telephone Company for fire alarm systems as required.

j. Modifications to existing control systems including installation of auxiliary motor starter contacts, relays, switches, etc, as required to provide the control functions or inputs as shown on the Drawings. Obtain the existing equipment shop drawings from the Owner before attempting to make any modifications to the existing equipment wiring. Verify all existing wiring and connections for correctness. If record drawings are not available, trace all circuits in the field and develop the wiring diagrams necessary for completion of the work. Document all changes made to the wiring diagrams and return a marked-up set of Record Drawings to the Owner after the work is complete.

k. Coordinate the sequence of demolition with the sequence of construction to maintain plant operation in each area. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment.

l. Modifications to existing motor control centers, switchboards, panelboards and motor controllers including installation of circuit breakers, etc, or disconnection of circuits as required to provide the power supplies to new and existing equipment to maintain the plant in operation.

4. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the

existing site, buildings and structures in which work under this Division is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the site, buildings and structures and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

5. Provide all electrical demolition work associated with the removal of equipment from the existing facilities, including disconnecting and removing all electrical wiring and conduit to equipment being removed under other sections. Survey the existing electrical systems with representatives from other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

6. Buildings or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signaling systems. Remove only specific electrical equipment noted for removal and turn over to the Owner. All other miscellaneous electrical materials, equipment, etc, will be demolished and removed from the site as specified in Division 2.

7. Provide all electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment.

8. All power interruptions to electrical equipment shall be scheduled at the Owner's convenience with requests submitted by the Contractor to the Owner using Owner’s Construction Administration Request (C.A.R.) documenting all planned activities. C.A.R. notice shall be submitted a minimum of seven (7) days in advance of interruption. Each interruption shall have Owner’s prior approval.

9. The Contractor shall maintain the existing plant in operation at all times. Temporary power connections as required shall be provided by the Contractor at no additional expense to the Owner. All temporary wiring shall be in accordance with the NEC. Any temporary equipment feeders (120V, 480V, 15KV) shall be installed in conduit. The Contractor shall provide to the Engineer details, methods, materials etc. prior to making temporary connections. Furnish and install all equipment and materials including control equipment, motor

starters, branch and feeder circuit breakers, panelboards, transformers, etc., for temporary power.

10. Field verify all existing underground electrical conduit, concrete duct banks, manhole, pull boxes, etc. and mechanical piping. The Contractor shall include in his bid all costs associated with relocation or removal of underground equipment as required for construction of the new facilities.

11. The Contractor shall prepare and furnish electrical and instrumentation conduit layout shop drawings for yard electrical, within and under all roads, buildings and structures to the Engineer for approval prior to commencing work. Layouts shall include but not be limited to equipment, pull boxes, manholes, conduit routing, dimensioning, methods and locations of supports, reinforcing, encasement, materials, conduit sizing, equipment access, potential conflicts, building and yard lighting, and all other pertinent technical specifications for all electrical and instrumentation conduits and equipment to be furnished. All layouts shall be drawn to scale on 24 x 36 sheets. Refer to Division 16000, Part 1, submittal paragraph C8 for additional requirements.

12. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

13. A single manufacturer shall provide the unit substations, switchgear, motor control centers, and variable frequency drives. This manufacturer shall also provide a short circuit/coordination study as specified herein. Other miscellaneous distribution power equipment: disconnect switches, panelboards, and transformers shall be provided by a single manufacturer which may or may not be the same as the switchgear manufacturer mentioned above.

14. Contractor shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuits shall be used unless approved in writing by the Engineer. Any temporary added shall be removed at job completion.

15. Complete coordination with other contractors. Contractor shall coordinate with all other contractors’ equipment submittals and obtain all relevant submittals.

16. Mount transmitters, process instruments, operator stations, etc. furnished under other Divisions of these specifications.

17. Concrete electrical duct encasement, including but not limited to excavation, concrete, conduit, reinforcement, backfilling, grading and sod is included in Division 16. All work shall be done in accordance with Divisions 2 and 3 of these specifications.

18. Excavation, bedding material, forms, concrete and backfill for underground raceways; forms and concrete for electrical equipment furnished herein is included in Division 16. All work shall be done in accordance with Divisions 2 and 3 of these specifications.

19. The Contractor shall include in the base bid the following miscellaneous wiring, including installation costs. Assume all conduit to be exposed at elevations up to 20 feet. Buried conduit shall be assumed to be installed up to 30-inches below grade. Installation shall include all necessary pullboxes, supports, warning tape, concrete encasement, etc. Contractor shall maintain a running total of the below footage used during construction. Any unused footage (material and labor installation) shall be credited at the end of the project at a rate submitted at the beginning of construction.

    a. 1,000 feet of 4#12 AWG in 3/4-inch RAC conduit – exposed.

    b. 1,000 feet of 2#14 AWG in 3/4-inch RAC conduit – exposed.

    c. 1,000 feet of Profibus DP cable in 1-inch RAC conduit – exposed.

    d. 500 feet of 4#12 AWG in 3/4-inch PVC schedule 40 conduit – buried and encased in concrete.

    e. 500 feet of 2#14 AWG in 3/4-inch PVC schedule 40 conduit – buried and encased in concrete.

    f. 500 feet of Profibus DP cable in 1-inch PVC schedule 40 conduit – buried and encased in concrete.

B. Related Work

1. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in Division 2.

2. Cast in place concrete work, including concrete encasements for electrical duct banks, equipment pads, light pole bases and reinforcing steel, is specified in Division 3.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, shop drawings for equipment, materials and other items furnished under Division 16.

2. Shop drawings shall be submitted for the following equipment and materials specified under Division 16:

   a. Raceways, Boxes, Fittings and Hangers

   b. Wires and Cables

   c. Medium Voltage Cables

   d. Miscellaneous Equipment (as specified in Section 16191)

   e. Surge Protective Devices

   f. Uninterruptible Power Supplies

   g. Switchgear

   h. Medium Voltage Distribution Equipment

   i. Unit Substations

   j. Panelboards

   k. Motor Control Centers

   l. Lighting Fixtures and Lamps

   m. Switches, Receptacles and Covers

   n. Lightning Protection System

   o. Precast Manholes and Handholes, Frames and Covers

   p. Grounding Hardware and Connections

   q. Fire Alarm System

3. Submittals shall be required for the following items:

   a. Qualifications of Electrical Contractor Superintendent

b. Preliminary Short Circuit Study

c. Final Power System Study

d. Training Plans

e. Testing and Service Reports

4. Installation working drawings shall be submitted for all conduit routing layouts. Contractor shall utilize the Contract AutoCad drawings for base files and show conduit routing using the layers described herein. Colors, line types and line widths shall be appropriate for plotting using AIA standards. Dashed lines shall indicate the conduit is concealed or buried. Solid lines shall indicate the conduit is exposed. The conduits and any major pulling points shall be drawn in model space. The associated text shall be drawn in paper space at a size not less than 0.1-inch. Provide associated type written conduit schedules for easy cross check. Schedules may be included on the drawings or in a separate spreadsheet/table.

   a. E-POWR-CNDT: medium voltage, 480-volt power

   b. E-LITE-CNDT: 120/208/240-volt power or lighting

   c. E-CTRL-CNDT: 120-volt control, instrumentation, signal, communication or fiber

   d. E-ANNO-TEXT: Annotation text

   e. Layouts shall be shown at an appropriate scale for clarity. If the Contract drawings need to be re-scaled to adequately represent the conduit routing, the Contractor shall do so. Contractor may submit separate drawings for power, lighting and control for one area to avoid re-scaling of drawings.

   f. Layouts shall include locations of process equipment, motor control centers, transformers, panelboards, control panels and equipment, motors, switches, motor starters, large junction or pull boxes, instruments and any other electrical devices connected to concealed or buried conduits.

   g. Contractor layouts of conduit routing shall comply with installation specifications 16110 and 16600 for raceway and underground systems. It is expected for major conduit corridors that there would be two separate ductbanks, with a minimum spacing of 12-inches between the two different ductbank systems. One ductbank would contain 480-volt and 120-volt

power and control, while the other ductbank would contain fiber optic, Ethernet, Profibus, shielded instrumentation wiring or other signal / communication wiring. It is the Owner's desire to utilize above ground pull boxes on the underground system rather than underground pull boxes or manholes in order to avoid the high water table of the site.

h. Submittal shall include a disc with the AutoCad drawings along with full size (34-inch by 22-inch) hardcopy prints on high quality paper.

i. Concrete floors and/or walls containing concealed conduits shall not be poured until conduit layouts are approved.

5. The manufacturers name and product designation or catalog numbers shall be submitted for the following material utilized:

   a. Testing Equipment

   b. Ground System Resistance Test Equipment

6. Contractor shall check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to the Specifications and the Drawings. This statement shall also list all exceptions to the Specifications and the Drawings. Shop drawings not so checked and noted shall be returned.

7. The Engineer's check shall be for conformance with the design concept of the project and compliance with the Specifications and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and the Drawings.

8. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.

9. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM", "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED".

10. Operation and Maintenance Data

a. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists, etc, to instruct operating and maintenance personnel unfamiliar with such equipment.

b. Manuals shall include the following as a minimum:

1) A comprehensive index.

2) A complete "As-Built" set of approved shop drawings.

3) A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.

4) A table listing of the "as left" settings for all timing relays and alarm and trip setpoints.

5) System schematic drawings "As-Built", illustrating all components, piping and electric connections of the systems supplied under this Section.

6) Detailed service, maintenance and operation instructions for each item supplied.

7) Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

8) The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.

9) Complete parts list with stock numbers, including spare parts.

D. Reference Standards

1. Electric equipment, materials and installation shall comply with the latest edition of National Electrical Code (NEC) and with the latest edition of the following codes and standards:

a. National Electrical Safety Code (NESC)

b. Occupational Safety and Health Administration (OSHA)

c. National Fire Protection Association (NFPA)

d. National Electrical Manufacturers Association (NEMA)

e. American National Standards Institute (ANSI)

f. Insulated Cable Engineers Association (ICEA)

g. Instrument Society of America (ISA)

h. Underwriters Laboratories (UL)

i. Factory Mutual (FM)

j. International Electrical Testing Association (NETA)

k. Institute of Electrical and Electronic Engineers (IEEE)

2. All electrical equipment and materials shall be listed by Underwriter's Laboratories, Inc., and shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use.

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

E. Priority of the Contract Documents

1. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.

2. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.

3. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.

4. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Engineer.

5. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times.

F. Enclosure Types

1. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

   a. NEMA 1 for dry, non-process indoor locations.

   b. NEMA 12 for "DUST" locations.

   c. NEMA 4X for outdoor locations, rooms below grade (including basements and buried vaults), "DAMP", "WET" and “PROCESS” locations.

   d. NEMA 4X for "CORROSIVE" locations.

   e. NEMA 7 (and listed for use in the area classifications shown) for "Class I Division 1 Group D", "Class I Division 2 Group D" and "Class II Division 1" hazardous locations shown on the Drawings.

G. Hazardous Areas

1. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502, 503, 504 and 510.

2. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.

H. Codes, Inspection and Fees

1. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

2. Obtain all necessary permits and pay all fees required for permits and inspections.

I. Tests and Settings

1. Test systems and equipment furnished under Division 16 and repair or replace all defective work and equipment. Refer to the individual equipment sections for additional specific testing requirements. Employ the services of an independent recognized power systems testing company, other than the manufacturer of the switchgear or motor control centers, to perform the tests specified herein.

2. Field testing and commissioning shall be performed in accordance with the latest revisions of NETA Standard ATS "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" unless otherwise modified by these Sections.

3. A typed test report for each component tested shall be submitted to the Engineer for the project record files. The firm doing the testing shall include, in the report, their opinion whether or not the equipment being tested complies with the specification. Any discrepancies shall be noted in the concluding summary of the report. Test report forms shall be in compliance with NETA standards. A minimum of three complete copies shall be provided. Reports shall be signed by the person in responsible charge of the field testing, an officer of the firm performing the tests and an officer of the Electrical Contractor.

4. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

5. In addition to the specific testing requirements listed in the individual sections, the following minimum tests and settings shall be performed.

   a. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.

   b. Check the full load current draw of each motor. Where power factor correction capacitors are provided the capacitor shall be in the circuit at the time of the measurement. Check ampere rating of thermal overloads for motors and submit a typed

record to the Engineer of the same, including MCC cubicle location and driven load designation, motor service factor, horsepower, and Code letter. If incorrect thermal overloads are installed replace same with the correct size overload.

c. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.

d. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.

e. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.

f. Check rotation of motors prior to testing the driven load. Disconnect the driven equipment if damage could occur due to wrong rotation. If the rotation is incorrect for the driven equipment correct motor connections at the motor terminal box.

g. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by control schematic and wiring diagrams.

h. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed.

i. Verify all terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 clockwise rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.

j. Verify correct wire termination positions across tie circuits, transfer switches, or other devices that have two sources of three-phase power by performing a hot phase test. That is, in addition to verifying clockwise rotation, a voltage reading across both incoming circuits should measure 0 volts when phase “A” of one side is compared to phase “A” of the other side.

k. Check all wire and cable terminations. Verify to the Engineer connections meet the equipments torque requirements.

l. Field set all transformer taps as required to obtain the proper secondary voltage.

m. Infrared hot spot inspection shall be made of all new electrical equipment and existing electrical

equipment that is refed. Equipment includes, but is not limited to switchgear, motor control centers, transformers, disconnect switches, power and control panels, etc. This shall be done under representative load conditions before the equipment is used by the Owner and again 3 months before expiration of the 1 year warranty period.

6. Make the following minimum tests and checks prior to energizing electrical equipment. Submit test reports upon completion in accordance with Section 01300.

   a. Test and calibrate protective relays and circuit breakers.

   b. Over potential, high potential, insulation resistance, partial discharge and shield continuity tests for medium voltage cables as specified in Section 16121.

   c. Mechanical inspection of air interrupter switches and circuit breakers to assure proper operation.

7. Testing shall be scheduled and coordinated in writing with the Engineer at least 2 weeks in advance. The testing firm shall provide all material, labor, equipment and technical supervision to perform the tests and inspection. Provide certified calibration sheets including dates for all equipment to be used for testing with notice of scheduled testing. Calibration sheets shall also indicate that the units have been calibrated within six months of the testing date. The Contractor shall have qualified personnel present during the testing.

J. Power System Studies

1. General:

   a. The major electrical equipment manufacturer (i.e. switchgear and motor control centers) shall provide a computerized Power System Study for the electrical power distribution and motor control equipment. The study shall verify adequacy of **all of the existing 480 volt equipment being refed** as well as new additions being implemented under these Specifications. A comprehensive power system study for the Phase IVC improvement project was completed by Eaton Services and Systems in August 2011. Reference Eaton report number TQSIMI110464.1 (Revision 4). This report in hardcopy form can be made available to the successful bidder.

b. The study shall also include the utility company's protective devices, the emergency generators, the main switchgear, all feeders from the main switchgear, all substations and distribution and all associated MCC's. Graphic indication of coordination shall be furnished in the form of a clearly labeled and identified composite drawing showing time-current curves of system protective devices. Time-current curves of each device shall also be furnished.

c. The Contractor/Manufacturer shall be responsible for obtaining and verifying with the Power Company in writing all information needed to conduct this study. Provide this correspondence and information including contacts and phone numbers with the study submittal.

d. The Contractor shall set all protective devices and relays based on this coordination study to provide coordinated, selective protection for all equipment supplied or affected by the installation under this Contract. Devices shall be set in accordance with the approved coordination study, prior to equipment energization.

e. The Contractor/Manufacturer shall provide data necessary to perform the study. This includes feeder cable sizes, approximate feeder length, motor data, switchgear data, existing protective relay settings and any other information relevant to the study.

f. A summary of the short circuit analysis shall be provided to the Contractor at the time shop drawings for all of the new equipment is submitted for approval. This preliminary short circuit submittal shall be required in order to approve the equipment submittal.

g. The manufacturer shall be made aware that there is no available up-to-date single line diagram for the existing facility. The Contractor/Manufacturer shall provide and/or update the existing single line diagram as required in order to perform the coordination and short-circuit study.

h. The Contractor shall provide and install equipment specific arc flash warning labels per the arc flash study performed herein.

2. Scope:

a. The power system study consists of four major parts. The first part is the preliminary short circuit

study. The preliminary short circuit study shall verify new and existing equipment is being applied within design ratings. Shop drawings for new equipment will not be reviewed until the preliminary short circuit study is approved by the Engineer.

b. The second and third parts of the power system study include the final short circuit and protective device coordination study. New equipment will not be energized until this study is approved by the Engineer and devices are set in the field in accordance with the study.

c. The fourth and final part of the power system study is the arc flash study. The arc flash study labels will be added after the equipment is energized and all changes, upgrades or modifications have been made, to ensure field labeling will be accurate.

d. The short circuit study shall be in accordance with ANSI Standard C37.010 and C37.13, shall be performed to check the adequacy, and to verify the correct application of circuit protective devices and other system components specified. The study shall address the case when the system is being powered from the normal source as well as from the on-site generating facilities. Minimum as well as maximum possible fault conditions shall be adequately covered in the study.

e. Fault contribution of all motors shall be considered. The Contractor shall be responsible for obtaining all required data of equipment. All back-up calculations shall become part of the final report. The calculations shall be in sufficient detail to allow easy review.

3. Contents:

a. The study shall include representation of the power company's systems, the base quantities selected, impedance source-data, calculation methods and tabulations, one-line and impedance diagrams, conclusions and recommendations. Short circuit momentary duties, shall be calculated on the basis of an assumed bolted three-phase short circuit at each medium voltage bus, low voltage switchboard bus, switchboards, motor control centers, distribution panelboards, pertinent branch circuit panelboards, and other significant locations through the systems. The short-circuit tabulations shall include significant X to R ratios, asymmetry factors, KVA, and symmetrical fault current.

b. A protective device time current coordination study shall be included with coordination plots of key and/or limiting devices, tabulated data, rating, and/or settings selected. The study shall present an engineering balance between the competing objectives of protection and continuity of service for the system specified, taking into account the basic factors of sensitivity, selectivity and speed.

c. Separate plots shall be provided for each mode of "normal" and "stand-by" operation. Maximum fault values shall be shown in each case. Both power sources shown in one plot will not be accepted.

d. Existing protective device settings shall be reviewed to ensure selectivity under the new conditions. Recommended changes shall be indicated in the report. The Contractor shall be made aware of required changes immediately.

e. Transformer damage curves in accordance with ANSI C57.109.

f. Feeder cable damage curves.

g. Required settings for breakers and relays shall be maximized to provide the most effective protection possible whether the system is fed from the normal or emergency source.

h. Tabulations indicating recommended set points for all protective devices shall be provided. This shall include the normal as well as the emergency source.

i. Generator short circuit decrement curves and thermal limit curves shall be included.

j. Tabulation of arc flash information.

k. An executive summary outlining the distribution system, the information received from the utility company, assumptions made to complete the study, statement of the adequacy of the distribution equipment to safely clear or close on any fault, and identification of any problem areas with recommendations for resolving the problem.

4. Motor Starting Study:

a. A motor starting study for all large electric drives (100 horsepower and above) to determine voltage dip or power inrush limitations at selected locations due to starting of motors shall be provided. This applies to both the normal and the emergency mode.

5. General Information for Time-Current Curves Presentations:

   a. The coordination plots shall include complete titles, representative one-line diagrams, legends, associated power company's relay or system characteristics, significant motor starting characteristics, complete parameters for power, and substation transformers, and complete operating bands for low-voltage circuit breaker trip devices.

   b. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pick-up settings required.

   c. The short-time region shall indicate the medium voltage relay instantaneous elements, the magnetizing in-rush, and ANSI withstand transformer parameters, the low-voltage circuit breaker instantaneous trip devices, fuse manufacturing to tolerance bands, and significant symmetrical and asymmetrical fault currents.

   d. Each primary protective device required for a delta-to-wye connected transformer shall be selected so that the characteristic or operating band is within the transformer parameters; which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line-to-ground faults.

   e. Low-voltage power circuit breakers shall be separated from each other and the associated primary protective device, where feasible, by a 16 percent current margin for coordination and protection in the event of secondary line-to-line faults.

   f. Protective relays shall be separated, where feasible, by a 0.3 second time margin when the maximum three-phase fault flows, to assure proper selectivity.

6. Arc Flash Study:

   a. The study shall utilize the fault current values calculated in the short circuit study and the clearing time of the upstream protective device in the coordination study to calculate the incident energy at each fault location.

   b. Study shall be in accordance with IEEE Standard 1584 and NFPA 70E.

c. Study shall calculate the incident energy and flash protection boundary at all significant locations in the electrical distribution system (switchgear, switchboards, motor control centers, panelboards) where work could be performed on energized parts. Include any 208 volt or 240 volt equipment that is fed from transformers greater than 125 kVA.

d. Incident energy calculations shall include maximum and minimum fault contribution scenarios, since protective device clearing times can vary greatly depending upon the fault current.

e. Tabulations shall be provided showing each fault location, the arcing fault magnitude, protective device clearing time, duration of the arc, arc flash boundary, working distance, incident energy and hazard risk category.

7. The power system study shall be bound in a standard 8-1/2" x 11" size report and submitted in accordance with Section 01300. The completed short circuit study shall be submitted to and approved by the Engineer before any of the equipment is shipped. All protective devices shall be adjusted, tested, and calibrated in the field, prior to energizing the equipment, per the settings listed in the study. This work shall be performed by the manufacturer as described in this section and prior to final acceptance by the Owner.

8. All protective devices, existing and new shall be calibrated and tested as recommended by and under the supervision of the distribution gear manufacturer's representative as specified in this section.

9. The power system study shall be stamped and signed by a professional engineer registered in the state in which the equipment is to be installed.

10. Arc Flash Warning Labels:

a. Provide machine printed 3.5-inch x 5-inch (nominal) thermal transfer type label of high adhesion polyester for each location identified in the arc flash study.

b. Labels shall include the following machine printed information (hand lettering is not acceptable): equipment name, flash hazard boundary, incident energy, boundaries for shock hazard, limited approach, restricted approach and prohibited approach, PPE (personal protective equipment) category and date.

c. One label shall be required at each applicable section of low voltage switchgear, switchboard, motor control center, or panelboard. One label shall be required at each medium voltage switch or breaker.

K. Interpretation of Drawings

1. In general the Drawings do not show conduit routing. The Contractor shall be responsible for the planning and routing of all conduits in compliance with the specifications and Drawing details.

2. Drawings noting equipment identification and associated circuitry is found on the following drawings:

a. Single line power diagrams show power, grounding and control circuitry requirements associated with substations, switchgear, switchboards, motor control centers, distribution panels, transformers, and feeders to lighting panels.

b. Panelboard schedules show branch circuit conduit and wire requirements.

c. Riser diagrams show circuitry for instrumentation and control devices along with miscellaneous signal or communication wiring.

3. Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

4. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.

5. Unless otherwise approved by the Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.

6. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.

7. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation. Any adjustments required in the field shall be provided at no additional cost to the Owner and coordinated and approved by the Engineer.

8. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations

shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

9. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the approved equipment at no additional cost to the Owner.

10. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

11. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by ½-inch spacers to provide a clearance between wall and equipment.

12. All floor mounted electrical equipment shall be placed on 4-inch thick (3/4-inch, 45 degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.

13. The Contractor shall harmonize the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc, required to accomplish this shall be furnished and installed by the Contractor without additional expense to the Owner. In case interference develops, the Engineer is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

14. Raceways and conductors for the fire alarm and lightning protection, are not shown on the Drawings. Provide raceways and conductors as required by the system manufacturer for a complete and operating system. Raceways shall be installed concealed in all finished spaces and may be installed exposed or conducted in process spaces.

15. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Homeruns, as shown on the Drawings, are to assist the Contractor in identifying raceways to be run exposed and raceways to be run concealed. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in all process spaces. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.

L. Phase Balancing

1. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly balanced loads across all phases.

2. Field balancing of circuits shall not alter the conductor color coding requirements as specified in Section 16120.

M. Size of Equipment

1. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

2. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

N. Record Drawings

1. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings".

2. Record Drawings shall accurately show the installed condition of the following items:

a. One-line Diagram(s).

b. Equipment elevations (front views).

c. Raceways and pullboxes.

d. Conductor sizes and conduit fills.

e. Panel Schedule(s).

f. Control Wiring Diagram(s).

g. Lighting Fixture Schedule(s).

h. Lighting fixture, receptacle and switch outlet locations.

i. Underground raceway and duct bank routing.

j. Plan view, sizes and locations of switchgear, distribution transformers, substations, motor control centers and panelboards.

3. Submit a schedule of control wiring raceways and wire numbers, including the following information:

a. Circuit origin, destination and wire numbers.

b. Field wiring terminal strip names and numbers.

4. In addition to the schedule, provide point-to-point connection diagrams showing the same information submitted in the schedule of control wiring raceways including all designations and wire numbers.

5. Submit the record drawings, schedule of control wiring raceways and wire numbers and the point-to-point connection diagrams to the Engineer. The schedule of control wiring raceways and wire numbers and the point-to-point connection diagrams shall be computer generated (i.e. no hand-written or drawn schedules, drawings, or diagrams will be accepted).

O. Equipment Interconnections

1. Review shop drawings of equipment furnished under other Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with the Record Drawings.

2. Furnish and install all equipment interconnections.

P. Materials and Equipment

1. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.

2. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

3. Warrant all equipment furnished under Division 16 in accordance with the General Conditions. Refer to individual equipment sections for additional warranty items.

Q. Equipment and Device Identification

1. Identify all electrical equipment furnished under Division 16 and all equipment control panels furnished under other Divisions with nameplates as described herein. Equipment includes switchgear, switchboards, motor control centers, panelboards, transformers, variable frequency drives, disconnect switches, separately mounted motor starters, transfer switches, control panels, control stations, named terminal cabinets, etc. The designation of the equipment shall correspond to the designation shown on the Drawings.

   a. A minimum of two nameplates shall be required at electrical equipment. The first nameplate shall identify the equipment or the name of the equipment it serves. For example a panelboard identification nameplate would have the identification of “LP-575” while a local disconnect switch for a pump motor would have the identification of “EFFLUENT PUMP 390-P-3”. The second nameplate shall identify the power source, i.e. “FED FROM MCC-17”.

2. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high black letters on a white background.

3. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate, the nameplate shall be permanently fastened to the adjacent mounting surface. Cemented nameplates shall not be drilled.

4. All voltages (e.g. 12,470 volts, 480 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Signs shall be red background with white engraved lettering, lettering shall be a minimum of 1" high.

5. All receptacles, wall switches, lighting fixtures, photo cells, emergency lights, exit lights, instruments, etc. shall be identified with the panel and circuit to which

it is connected. For example a receptacle fed from circuit 4 from panel LP-575 would have the label “LP-575/4”. Identification shall be with machine generated labels with 1/4-in high letters.

R. Demolition

1. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.

2. Remove unused exposed conduit and wiring back to point of concealment including abandoned conduit above accessible ceiling finishes. Remove unused wiring in concealed conduits back to source (or nearest point of usage).

3. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide stainless steel blank covers for abandoned outlets which are not removed.

4. Disconnect and remove abandoned panelboards, transformers, disconnect switches, control stations, distribution equipment, etc.

5. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.

6. Disconnect electrical circuits in the way of demolition work and re-establish circuits to remaining outlets, fixtures, equipment, etc. Disconnect electrical systems in walls, floors and ceilings scheduled for removal.

7. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

8. New lighting shall be in place or safe lighting levels maintained for plant operation during the construction period.

9. Repair adjacent construction and finishes damaged during demolition and extension work.

10. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.

11. Coordinate outages in systems with the Owner. Where duration of proposed outage cannot be allowed by the

Owner, provide temporary connections as required to maintain service.

12. Removal and relocation of existing conduit, wire and equipment have not been detailed on the Drawings. Survey the affected areas before submitting bid proposal.

13. Trace out existing wiring that is to be relocated, or removed and perform the relocation or removal work as required for a complete operating and safe system.

14. Continuous service is required on all circuits and outlets affected by these changes, except where the Owner will permit an outage for a specific time. Obtain Owner's consent before removing any circuit from continuous service.

15. Remove exposed conduits, wireways, outlet boxes, pull boxes and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide stainless steel blank covers for abandoned outlets which are removed.

16. All equipment, materials, controls, motor starters, branch and feeder breakers, panelboards, transformers, wiring, raceways, etc, furnished and installed to temporarily keep circuits energized shall be removed when the permanent installation is fully operational.

17. Electrical Removal

    a. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.

    b. Conduits and wires shall be abandoned or removed where shown. All wires in abandoned conduits shall be removed, salvaged and stored. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitably plugged and the area repaired in a flush, smooth and approved manner. Exposed conduits and their supports shall be disassembled and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.

    c. Wall switches, receptacles, and other miscellaneous electrical equipment, shall be removed and disposed of off the site as required. Care shall be taken in removing all equipment so as to minimize damage to

architectural and structural members. Any damage incurred shall be repaired.

S. Disposition of Removed Materials and Equipment

1. In general, it is intended that material and equipment indicated to be removed and disposed of by the Contractor shall, upon removal, become the Contractor's property and shall be disposed of off the site by the Contractor, unless otherwise directed by the Owner. Any fees or charges incurred for disposal of such equipment or materials shall be paid by the Contractor. A receipt showing acceptable disposal of any legally regulated materials or equipment shall be given to the Owner.

2. Ballasts in each existing lighting fixture shall be assumed to contain PCB's unless specifically marked with a label indicating "No PCBs". Remove ballasts from each lighting fixture and pack them in accordance with EPA PCB regulations. Ship ballasts in approved containers to an EPA approved recycling facility and pay all shipping, packaging and recycle costs.

3. The following electrical equipment shall be removed and shall be moved by the Contractor to a location on the site for storage as directed by the Owner:

   a. Two - Blower Control Panels at Basin 5
   b. Aqua Aerobics filter feed pump control panel
   c. PLC-03A and associated fiber termination enclosure
   d. Panel LP-T and associated transformer and disconnect switch.

T. Safety Requirements

1. The Contractor shall make every effort to keep all employees and/or subcontractors aware of the danger inherent in working in dangerous proximity to the existing power lines. The minimum recommended precautionary measures are as follows:

   a. Make sure that all persons responsible for operating cranes, draglines and other mobile equipment have a copy of, and are familiar with the State Department of Commerce Regulations for Use of Cranes, Draglines and Similar Equipment near Power Lines, as well as the U.S. Department of Labor OSHA Regulations, before commencing operation of said equipment.

   b. Make sure that all cranes, draglines and other mobile equipment have attached to them the black and yellow Department of Commerce warning signs required by the said Regulations of State Department of Commerce.

c. Warn all employees on the ground, new and old employees alike, of the danger of holding on to or touching a cable or other piece of equipment or machinery that is located or working close to any overhead power line.

d. If, during the course of construction, it becomes necessary for the contractor, or subcontractor, and their employees, to operate cranes, draglines, or their mobile equipment, in dangerous proximity of any overhead power lines, or in such a manner that such equipment might come close to any overhead power lines, the Contractor shall give the Power Company or overhead power line owner prior notice of such proposed operation.

U. Qualification

1. The Electrical Contractor shall have regularly engaged in the installation of medium voltage systems for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

2. Provide a field superintendent who has had a minimum of ten (10) years previous successful experience on medium voltage projects of comparable size and complexity. Superintendent shall be present at all times that work under this Division is being installed or affected. A resume of the Superintendent’s experience shall be submitted to the Engineer before starting work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

A. Sleeves and Forms for Openings

1. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

2. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

3. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be

exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

4. Seal all openings, sleeves, penetration and slots as specified in Section 16110.

B. Cutting and Patching

1. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified in Section 03740. Sawcut concrete and masonry prior to breaking out sections.

2. Core drill holes in existing concrete floors and walls as required.

3. Install work at such time as to require the minimum amount of cutting and patching.

4. Do not cut joists, beams, girders, columns or any other structural members.

5. Cut opening only large enough to allow easy installation of the conduit.

6. Patching to be of the same kind and quality of material as was removed.

7. The completed patching work shall restore the surface to its original appearance or better.

8. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

9. Remove rubble and excess patching materials from the premises.

10. When existing conduits are cut at the floor line or wall line, they shall be filled with grout of suitable patching material.

C. Installation

1. Any work not installed according to the Drawings and this Division or without approval by the Engineer shall be subject to change as directed by the Engineer. No extra compensation will be allowed for making these changes.

2. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall

not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged unit(s) or systems shall remain on site and returned to the manufacturer after the replacement unit(s) or systems have been delivered to the site. Under no circumstances will electrical equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied and all cost associated with replacement shall be borne by the Contractor.

3. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion.

4. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting requirements in Division 9, at no additional cost to the Owner.

D. Manufacturers Service

1. Provide manufacturer's services for testing and start-up of the following equipment:

   a. Unit Substations (1 day 1 trip minimum)

   b. 480 Volt Switchgear (1 day 1 trip minimum)

   c. 480 Volt Motor Control Centers (4 days 4 trips minimum)

   d. Fire Alarm System (3 days 3 trips minimum)

   e. Variable Frequency Drives (3 days 3 trips minimum)

2. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturers warranty repairs.

3. The manufacturers of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:

   a. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and

maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "as-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity.

b. The Field Service Engineers shall provide engineering support during the energization and check-out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the manufacturer's performance specifications.

c. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.

d. A final report shall be written and submitted to the Contractor within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The reports after review by the Contractor shall be submitted to the Engineer.

E. Training

1. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment specified under Division 16.

   a. Unit Substations (2 days 1 trip minimum)

   b. 480 Volt Switchgear (2 days 1 trip minimum)

   c. 480 Volt Motor Control Centers (2 days 1 trip minimum)

   d. Fire Alarm System (2 days 1 trip minimum)

   e. Variable Frequency Drives (2 days 1 trip minimum)

2. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

3. Provide detailed O&M manuals to supplement the training courses. The manuals shall include specific details of

equipment supplied and operations specific to the project.

4. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance including trouble-shooting of each system.

5. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule. The training shall be conducted with record "as-built" drawings sufficient for a class of eight personnel.

6. Within 120 days of contract award to the Contractor, submit an overview of the proposed training plan. This overview shall include, for each course proposed:

   a. An overview of the training plan.

   b. Course title and objectives.

   c. Prerequisite training and experience of attendees.

   d. Recommended types of attendees.

   e. Course Content - A topical outline.

   f. Course Duration.

   g. Course Location - Training center or jobsite.

   h. Course Format - Lecture, laboratory demonstration, etc.

   i. Schedule of training courses including dates, duration and locations of each class.

   j. Resumes of the instructors who will actually implement the plan.

7. The Engineer will review the training plan submittal with the Owner.

F. Power System Study

1. Provide a complete system Power System Study including preliminary short circuit, final short circuit, protective device coordination and arc flash study as specified herein.

2. Provide and install arc flash warning labels at equipment identified within the arc flash study.

G. Cleaning

1. Remove all rubbish and debris from inside and around electrical equipment and enclosures.

2. Remove dirt, dust or concrete spatter from the interior and exterior of equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

END OF SECTION

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SECTION 16110 RACEWAYS, BOXES, FITTINGS AND SUPPORTS

PART 1 GENERAL

A. Scope of Work

1. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

B. Related Work

1. Refer to Section 16600 for additional requirements.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, the manufacturers' names and product designation or catalog numbers with cut-sheets of all materials specified. Indicate in the submittal, the areas where specific materials are used.

2. Above ground raceway routing in accordance with Section 16000, PART 1, paragraph C,4.

PART 2 PRODUCTS

A. Materials

1. Rigid Aluminum Conduit

   a. Rigid aluminum conduit shall be 6063 alloy and shall be as manufactured by New Jersey Aluminum Corp.; Reynolds Aluminum International Services Inc.; Alumax Extrusions, Inc; VAW of America, Inc. or equal.

   b. Rigid aluminum conduit shall be for use under the provisions of NEC Article 344.

2. Electrical Metallic Tubing

   a. Electrical metallic tubing shall be hot-dipped galvanized steel as manufactured by the Allied Tube and Conduit Corp.; Triangle PWC Inc.; Wheatland Tube Co.; Bridgeport or equal.

   b. Electrical metallic tubing shall be for use under the provisions of NEC Article 358.

3. Rigid Nonmetallic Conduit

   a. PVC conduit shall be rigid polyvinyl chloride

schedule 80 as manufactured by Carlon; An Indian Head Co.; Cantex; Queen City Plastics or equal.

b. PVC conduit used in underground concrete encased duct banks shall be rigid polyvinyl chloride schedule 40 as manufactured by Carlon; An Indian Head Co.; Cantex; Queen City Plastics or equal.

c. PVC conduit shall be for use under the provisions of NEC Article 352.

4. Liquidtight Flexible Metal Conduit, Couplings and Fittings

a. Liquidtight flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.

b. Fittings used with liquidtight flexible metal conduit shall be of the 3-piece screw-in type malleable iron as manufactured by the O.Z. Gedney Co. or equal.

c. Liquidtight flexible metal conduit shall be for use under the provisions of NEC Article 350.

5. Flexible Metallic Tubing

a. Flexible metallic tubing shall be for use under the provisions of NEC Article 360.

b. Flexible metallic tubing shall be hot-dipped galvanized steel strips shaped into interlocking convolutions firmly joined to one another assuring a complete lock similar to Tristeel as manufactured by Triangle - PWC, Inc. or equal.

c. Flexible metallic tubing shall be used only indoors for connection to lighting fixtures in NEMA 1 administration and office areas.

d. Furnish and install insulated bushings at terminations for conductor protection.

6. Flexible Couplings

a. Flexible couplings shall be type ECGJH as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Killark Electric Manufacturing Co. or equal.

7. Boxes and Fittings

a. Pressed steel switch and outlet boxes shall be hot-dipped galvanized with hot-dipped galvanized tile rings as manufactured by the Raco Manufacturing Co.; Adalet Co.; O.Z. Manufacturing Co. or equal.

b. NEMA 1 and NEMA 12, junction boxes, pull boxes etc., shall be sheet steel unless otherwise shown on the Drawings. Boxes shall be galvanized and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets (refer to Section 16191 for additional requirements). Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; ASCO Electrical Products Co., Inc., or equal. All boxes shall be shop primed and painted by the box manufacturer.

c. NEMA 4X stainless steel, junction boxes and pull boxes shall be 316 stainless steel with 316 stainless steel hardware and gasketed covers. Boxes shall have continuously welded seams and welds shall be ground smooth. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets (refer to Section 16191 for additional requirements.) Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; ASCO Electrical Products Co., Inc., or equal.

d. Explosion-proof boxes shall be designed for Class 1, Group D, Division 1 hazardous locations. They shall be cast aluminum, with stainless steel hinged covers and stainless steel hardware and bolts; Type EJB-N4 as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Adalet-PLM or equal.

e. 15KV boxes, junction boxes, etc. Construction shall be per Paragraphs b and c above with the following additional requirements: padlockable, hinged covers, identification "DANGER HIGH VOLTAGE - KEEP OUT", "12,470 VOLTS", signs shall be red with white lettering (minimum 1" high).

f. Cast aluminum boxes and fittings shall be copper free aluminum with cast aluminum covers and stainless steel screws as manufactured by the Killark Electric Co..; Crouse-Hinds Co.; Appleton Electric Co.; or equal.

g. Cast aluminum device boxes shall be Type FD. All cast aluminum boxes and fittings shall be copper-free aluminum with cast aluminum covers and stainless steel screws as manufactured by the Killark Electric Co.; Crouse-Hinds Co.; L. E. Mason Co. or equal.

h. Cast aluminum fittings (C's, T's, LB's, etc.) shall be of the mogul design (with rollers) as manufactured by Appleton Electric Co. or equal.

i. Conduit hubs shall be of the grounding type as manufactured by Myers Electric Products, Inc. or equal.

j. Conduit wall seals for new concrete walls below grade shall be O.Z./Gedney Co., Type WSK; Spring City Electrical Manufacturing Co., Type WDP or equal.

k. Conduit wall seals for cored holes shall be Type CSML as manufactured by the O.Z./Gedney Co. or equal.

l. Conduit wall and floor seals for sleeved openings shall be Type CSMI as manufactured by the O.Z./Gedney Co. or equal.

m. Combination expansion-deflection fittings embedded in concrete shall be Type XD as manufactured by the Crouse-Hinds Co.; O.Z./Gedney Co.; Spring City Electrical Mfg. Co. or equal.

n. Combination expansion-deflection fittings installed exposed shall be Type XJ as manufactured by Crouse-Hinds Co.; O.Z. Gedney Co.; Spring City Electrical Mfg. Co. or equal.

o. Explosion proof fittings shall be as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; O.Z./Gedney Co. or equal.

p. Conduit sealing bushings shall be O.Z./Gedney, Type CSB or equal.

q. Elbows and couplings shall be aluminum.

r. Electrical metallic tubing fittings shall be of the steel, raintight, concrete-tight, insulated throat (connectors), compression type as manufactured by the Appleton Electric Co.; Crouse-Hinds Co. or equal.

8. Conduit Mounting Equipment

a. In dry indoor non-process areas, hangers, rods, backplates, beam clamps, channel, fasteners, anchors, nuts, washers, etc., shall be hot-dipped galvanized steel.

b. 316 Stainless steel channel with 316 stainless steel hardware (hangers, rods, backplates, beam clamps, fasteners, anchors, nuts, washers, etc.) shall be used in process areas, as shown on the drawings, in areas designated “PROCESS”, "WET", "DAMP" and "CORROSIVE" on the Drawings and in outdoor locations. All channel and hardware shall be resistant to the chemicals present in the area in which it is used.

c. Expansion anchors (minimum 3/8" diameter) shall be 316 stainless steel and equal to Kwik-Bolt as manufactured by the McCullock Industries, Minneapolis, MI; Wej-it by Wej-it Expansion Products, Inc., Bloomfield, CO; or Kwik-Bolt II as manufactured by the Hilti Fastening Systems, Inc, Tulsa, OK. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1-in behind the steel reinforcement. Apply anti-seize compound to all nuts and bolts. Supports installed without the approved compound shall be dismantled and correctly installed, at no cost to the Owner.

9. Wall and Floor Slab Opening Seals

a. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp.; Pro Set Systems; Neer Mfg. Co.; Specified Technologies, Inc. or equal.

10. Cold Galvanizing Compound

a. Cold galvanizing compound shall be 95% zinc rich paint as manufactured by ZRC Products Company, a Division of Norfolk Corp. or equal.

11. Corrugated Innerduct

a. Innerduct shall be UL listed, corrugated,

manufactured from High Density Polyethylene (HDPE), colored orange, sized per Drawings and as manufactured by Innerduct.com, or equal.

PART 3 EXECUTION

A. Raceway Applications

1. Except where otherwise shown on the Drawings, or specified, all wiring shall be in rigid aluminum conduit.

2. Where transitioning from underground to above grade and conduit will be exposed, conduit shall be rigid aluminum. Refer to Section 16600 for additional requirements.

3. Schedule 80 PVC conduit shall be used where shown on the Drawings and in chemical rooms, chlorinator rooms and chlorine storage areas or areas designated "CORROSIVE" on the Drawings.

4. Schedule 80 PVC shall be used underground where concrete encasement is not called for. Where schedule 80 PVC is used all elbows shall be rigid aluminum. On this project, all underground shall be encased.

5. PVC conduit shall be used for concrete encased underground duct banks except that all elbows shall be rigid aluminum.

6. Electrical metallic tubing and fittings may be used only in NEMA 1 administration and office areas. Electrical metallic tubing and fittings shall not be embedded in concrete, installed outdoors, in process areas, shops, maintenance areas, electrical rooms, etc. On this project, no EMT is expected to be used.

7. All conduit of a given type shall be the product of one manufacturer.

B. Box Applications

1. Unless otherwise specified herein or shown on the Drawings, all boxes shall be metal.

2. Exposed switch, receptacle and lighting outlet boxes and condulet fittings shall be cast aluminum.

3. Concealed switch, receptacle and lighting outlet boxes shall be pressed steel. Welded seamed boxes will not be permitted.

4. Terminal boxes, junction boxes and pull boxes shall have

NEMA ratings suitable for the location in which they are installed, as specified in Section 16000.

C. Fittings Applications

1. Combination expansion-deflection fittings shall be used where conduits cross structure expansion joints. Refer to Structural Drawings for expansion joint locations. Provide bonding jumpers around fittings.

2. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Drawings.

3. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

D. Installation

1. No conduit smaller than 3/4 inch electrical trade size shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as required or directed.

2. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.

3. The ends of all conduits shall be tightly plugged to exclude dust and moisture during construction.

4. Conduit supports, other than for underground raceways, shall be spaced at intervals of 8-ft or less, as required to obtain rigid construction.

5. Single conduits shall be supported by means of aluminum one-hole pipe clamps in combination with aluminum one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.

6. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete expansion anchors shall be provided.

7. All conduits on exposed work, within partitions and above suspended ceilings, shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run perfectly straight and true.

8. Conduit terminating in pressed steel boxes shall have double locknuts (aluminum) and insulated grounding bushings.

9. Conduit terminating in gasketed enclosures shall be terminated with grounding type conduit hubs.

10. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings with lay-in type lugs.

11. Conduits shall be installed using threaded fittings unless otherwise specified herein.

12. Liquidtight flexible metal conduit shall be used for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present.

13. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

14. Aluminum fittings and boxes shall be used with aluminum conduit. Aluminum conduit shall not be imbedded in concrete containing chlorides, unwashed beach sand, sea water, or coral bearing aggregates. Aluminum conduit shall be isolated from other metals with heat shrink tubing (Raychem or equal) or plastic-coated hangers. Strap wrenches shall be used for tightening aluminum conduit. Pipe wrenches, channel locks, chain wrenches, pliers, etc. shall not be used.

15. All threads on aluminum conduit and fittings shall be cleaned and coated with “No-Oxide” compound before installing.

16. Aluminum conduit installed in concrete or below grade shall be completely covered with two (2) coats of bitumastic paint or with heat shrink tubing (Raychem or equal).

17. Where conduits pass through openings in walls or floor slabs, the remaining openings shall be sealed against

the passage of flame and smoke.

18. PVC conduit to non-metallic and metallic box connections shall be made with sealing rings, with a stainless steel retainer as manufactured by Thomas & Betts Co.

19. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.

20. Expansion fittings shall be used on exposed runs of PVC conduit where required for thermal expansion. Installation and number of fittings shall be as provided per the NEC and approved by the PVC conduit manufacturer.

21. All conduit entering or leaving a motor control center, switchboard or other multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other manufacturer designated area, directly below the vertical section in which the conductors are to be terminated.

22. Conduit sealing and drain fittings shall be installed in areas designated as NEMA 7.

23. Spare conduits and conduit stubouts for future construction shall be provided with threaded PVC end caps at each end.

24. No unbroken run shall exceed 300 feet in length. This length shall be reduced by 75 feet for each 90 degree elbow.

25. Aluminum conduit entering manholes and below grade pull boxes shall be terminated with grounding type bushings and connected to a 3/4" x 20' rod with a #6 bare copper wire.

26. Underground circuits shall be installed directly to the respective motor control centers, lighting panels, etc., except stainless steel pull boxes shall be wall mounted on structures to eliminate excessive bends. With prior written approval, below grade pull boxes may be used. Splices shall not be made in above or below grade pull boxes unless otherwise indicated on the plans and approved in writing by the Engineer.

27. All conduits shall have a 4-inch concrete housekeeping pad at all slab and grade penetrations. The housekeeping pad shall have 45 degree, 3/4-inch chamfer at all exposed edges.

28. All risers from underground, concrete pads, floors, etc.

shall be provided with heat shrink tubing (Raychem Co. or equal) from a point 1 foot-0-inch below bottom of slab or grade to a point not less than 6 inches above grade or surface of slab.

29. Existing conduits are to be reused only where specifically noted on the drawings. Mandrels shall be pulled through all existing conduits which will be reused and through all new conduits 2-in in diameter and larger prior to installing conductors.

30. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment.

31. Where no size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of NEC Article 314.

32. Conduits shall not cross pipe shafts, access hatches or vent duct openings. They shall be routed to avoid such present or future openings in floor or ceiling construction.

33. The use of running threads is prohibited. Where such threads are necessary, a 3-piece cast aluminum union shall be used.

34. Conduits passing from heated to unheated spaces, and at all exterior spaces, refrigerated spaces, cold air plenums, etc, shall be sealed with "Duxseal" as manufactured by Manville or seal fitting to prevent the accumulation of condensation.

35. All field cut ends of hot dipped galvanized mounting channel shall be cleaned and painted with cold galvanizing compound before installation.

36. All underground control and instrumentation conduits shall be separated from power conduits by a minimum of 12 inches unless specifically noted otherwise. Crossing of control and instrumentation conduits with power conduits shall be kept to a minimum and where they must cross they shall cross at 90 degree angles.

END OF SECTION

SECTION 16120 WIRES AND CABLES (600 VOLTS MAXIMUM)

PART 1 GENERAL

A. Scope of Work

1. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

2. Install data highway, fiber optic, coaxial and I/O cables furnished under Division 13.

B. Submittals

1. Submit to the Engineer, in accordance with Section 01300, samples of proposed wire. Each sample shall have the size, type of insulation and voltage stenciled on the jacket.

2. Approved samples will be sent to the project location for comparison by the Resident Engineer with the wire actually installed.

3. Installed unapproved wire shall be removed and replaced at no additional cost to the Owner.

C. Delivery, Storage and Handling

1. Carefully handle all conductors to avoid kinks and damage to insulation.

PART 2 PRODUCTS

A. General

1. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.

2. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.

3. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.

4. All wire of a given type shall be the product of a single manufacturer.

B. Materials

1. 600 Volt or Less Wire and Cable

    a. Wire for lighting, receptacles, and other circuits not exceeding 150 volts to ground shall be NEC type XHHW-2. Below grade and underground the wire shall be type XHHW-2.

    b. Wire for circuits over 150 volts to ground shall be NEC type XHHW-2 for sizes 4/0 AWG and smaller, and shall be NEC type RHW-2 for sizes 250 MCM (kcmil) and larger.

    c. Wire for control circuits shall be #14 AWG minimum NEC type XHHW-2 stranded.

    d. Equipment grounding conductors shall be installed in all raceways. Equipment grounding conductors shall be the same NEC type as the phase conductor, green and sized per NEC Table 250.122. Ground grid conductors shall be tinned copper and uninsulated unless shown otherwise on the Drawings.

    e. Types XHHW-2 and RHW-2 wire shall be as manufactured by the Southwire Co., Pirelli Cable Corp., Okonite Co., or equal.

    f. Multi-conductor control cable shall be stranded, #14 AWG, 600 V, cross-linked polyethylene insulated w/PVC jacket. Type "XLP" as manufactured by the Southwire Co., American Insulated Wire Corp., or equal.

    g. Telephone cable shall be #22 AWG, 4-pairs, solid copper PVC insulation and PVC jacket. UL rated Type CMR as manufactured by American Insulated Wire Corp., or equal.

    h. All bare wire for grounding systems shall be tinned copper.

C. Instrumentation Wire

1. Process instrumentation wire shall be twisted pair, 600 V, cross linked polyethylene insulated, aluminum tape shielded, polyvinyl chloride jacketed type "XLP" as manufactured by the Rockbestos Co., or equal.

2. Cable for 4-20 mA instrumentation, potentiometer, RTD and similar analog circuits shall be multi-conductor twisted and shielded.

a. Single pair cable:

1) Conductors: 2 No. 16 AWG stranded and twisted

2) Insulation: XLP

3) Shield: 100 percent tape with drain wire

4) Jacket: PVC with UL and manufacturers identification

b. Three conductor (triad) cable:

1) Conductors: 3 No. 16 AWG stranded and twisted

2) Insulation: XLP

3) Shield: 100 percent tape with drain wire

4) Jacket: PVC with UL and manufacturers identification

c. Multiple pair cables (where shown on the Drawings):

1) Conductor: Multiple 2 No. 16 AWG stranded and twisted

2) Insulation: XLP

3) Shield: Individual pairs and overall shielded with 100 percent tape and drain wire

4) Jacket: PVC with UL manufacturers identification

D. Communication Wire

1. Ethernet cable shall be designed for use with a high-speed (100 Mbps/Gbps) Ethernet communications network. The twisted pair cable shall have nominal impedance of 100 ohms at 1 Mhz and a maximum attenuation of 10 dB per 1000 feet at 1 Mhz. The twisted pair cable shall be non-plenum rated and shall have a minimum of four 24 AWG solid copper conductor pairs with an overall foil shield. Cable shall be Category 5e, *Ethernet/IP* compliant with a voltage insulation rating of 600V. Cable shall be able to be terminated using RJ-45 terminations. Cable shall be Belden 7958A or equal.

2. Profibus PA cable shall be 300 V, 1 pair 18 AWG, stranded tinned copper, 100% foil shield, color blue and orange,

100 ohms at 31.25 kHz, PVC jacket, Belden Type 3076F or equal.

3. Profibus DP cable shall be 300 V, 1 pair 22 AWG, stranded tinned copper, 100% foil shield, color red and green, 150 ohms, PVC jacket, Belden Type 3079E or equal.

4. DeviceNet cable shall be Class 1 (600V), 2 pair, 16 AWG, stranded tinned copper, 100% individually foil shielded, ODVA (Open DeviceNet Vendor Association)Cable V, Belden Type 7896A or equal.

E. Terminations and Splices (Power Conductors)

1. Unless otherwise indicated on the plans, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is approved, then splicing material shall be approved by the Engineer and cable manufacturer. Splicing materials for all 600 volt splices shall be made with long barrel tin plated copper compression (hydraulically pressed) connectors and insulated with heavy wall heat shrinkable tubing. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.

2. 600 volt wire lugs shall be tin plated copper, long barrel compression type (hydraulically pressed) for wire sizes No. 8 AWG and larger. Lugs for No. 10 AWG and smaller wire shall be locking spade type with insulated sleeve. Lugs shall be as manufactured by the Thomas and Betts Co., or equal.

F. Termination and Splices (Control Conductors)

1. Unless otherwise indicated on the plans, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is approved, then splicing material shall be approved by the Engineer and cable manufacturer. Splicing materials and installation shall be as required by the Engineer. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.

2. Termination connectors shall be of the expanded vinyl insulated locking fork-end (upturned leg ends) type as

manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

G. Terminations (Instrumentation Cables)

1. Termination connectors shall be of the expanded vinyl insulated locking fork-end (upturned leg ends) type as manufactured by 3M Co.; Panduit Corp. or equal.

H. Motor Connections

1. For wire sizes #8 AWG and larger, long barrel tin plated copper compression (hydraulically pressed) type connections (Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Bolted connections shall utilize products which are rated for vibration applications (bolt, nut and spring washer). All connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp. or equal).

I. Wire and Cable Markers

1. Wire and cable markers shall be type written, heat shrinkable type as manufactured by the W.H. Brady Co., Thomas & Betts Co., 3M Co., or equal.

2. Wire and cables with diameters exceeding the capacity of the heat shrinkable markers shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co., Panduit Corp., or equal.

J. Wall and Floor Slab Opening Seals

1. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp. or equal.

PART 3 EXECUTION

A. Installation

1. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end with wire and cable markers.

2. Use lubrications to facilitate wire pulling. Pulling compound shall be nontoxic, nonflammable, noncombustible and noncorrosive. The material shall be UL listed and compatible with the cable insulation and jacket.

3. All wire and cable shall be continuous and without splices between points of connection to equipment terminals, except a splice will be permitted by the Engineer if the length required between the points of connection exceeds the greatest standard shipping length available from the manufacturer specified or approved by the Engineer as the manufacturer of the particular item or wire and cable.

4. Seal openings in slabs and walls through which wires and cables pass.

5. Steel fish tapes and/or steel pulling cables shall not be used in PVC conduit runs.

6. Pull cable from direction that requires the least tension.

7. Feed cable into raceway with zero tension and without cable crossover at raceway entrance.

8. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius.

9. Use a dynamometer and constant velocity power pulling. Velocity should not be less than 15-ft./min or more than 50-ft/min. Do not exceed the cable manufacturer's maximum recommended tension.

10. If cable cannot be terminated immediately after installation, install heat shrinkable end caps.

11. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where medium voltage cables of different circuits are present. Use fire-proofing tape and glass tape in accordance with the manufacturer's instructions. Fire-proofing tape shall be with one half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape by 3M Corp. or equal. Tape shall be secured with a two-layer band of Scotch Brand 69 Glass Electrical Tape by 3M Corp. or equal over the last wrap.

12. Uniquely identify all cable at supply and receiving ends and in all manholes, handholes or pullboxes. Use embossed brass tags and tywrap fasteners.

13. Hydraulically or manually operated cable benders shall not be used unless approved in writing by the Engineer.

14. Instrumentation cables shall be installed in conduits as specified. All circuits shall be installed as twisted

pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

15. Install shielded instrumentation wire from terminal to terminal with no splicing at any intermediate point. Shielded instrumentation wire, coaxial, data highway, I/O and fiberoptic cables shall be run without splices between instruments, terminal boxes, or panels.

16. Terminal blocks shall be provided at all instrument cable junctions, and all circuits shall be identified at such junctions.

17. Ground shielding on instrumentation wire at one end only as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own terminal block.

18. Install shielded instrumentation wire in conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from all other (i.e. power, control, etc.) cables in manholes.

19. All shielded cable terminations at each end shall be provided with heat shrinkable tubing placed over the exposed shield and conductors. The tubing shall extend 1" minimum over the jacket end and extend ½" minimum from the jacket end over the exposed conductors.

B. Wire Color Code

1. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.

2. The following coding shall be used:

System	Wire	Color
240/120 Volts Single-Phase, 3 Wire	Neutral	White
	Line 1	Black
	Line 2	Red
208Y/120, Volts 3 Phase, 4 Wire	Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts 3 Phase, 4 Wire delta, center tap ground on phase coil A-C	Neutral	White
	Phase A	Black
	Phase B (High)	Orange
	Phase C	Blue
480Y/277 Volts 3 Phase, 4 Wire	Neutral	Gray
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
Control (Individual Conductors)	AC	Red
	DC	Blue

C. Field Testing

1. Test all 600 volt wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 volts DC. Submit a written test report of the results to the Engineer. Notify Engineer in writing 48 hours prior to testing.

2. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.

3. All service conductors shall be tested as in paragraph 1 above with the Owner’s representative present.

END OF SECTION

SECTION 16121 MEDIUM VOLTAGE CABLES

PART 1 GENERAL

A. Scope of Work

1. Furnish, install and test the medium voltage wire, cable and appurtenances as shown on the Drawings and as specified herein.

2. This Section shall apply to all temporary and permanent feeders used on the project.

B. Submittals

1. Submit to the Engineer, in accordance with Section 01300, samples of proposed wire. Each sample shall have the size, type of insulation and voltage stenciled on the jacket. The submittals shall also include the following:

   a. Product data sheets.

   b. Factory and field test reports.

   c. Pulling tension and sidewall pressure calculation.

2. Approved samples will be sent to the project location for comparison by the Resident Engineer with the wire actually installed.

3. Installed unapproved wire shall be removed and replaced at no additional cost to the Owner.

C. Reference Standards

1. Medium voltage cables shall meet or exceed the specifications and requirements of the latest Insulated Cable Engineers Association (ICEA) and the Association of Edison Illuminating Companies (AEIC) publications, except as modified by this Section.

2. Ethylene-propylene rubber (EPR) insulated cable shall meet or exceed ICEA S-68-516/ NEMA WC-8 and AEIC CS-6.

3. Cables shall comply with Underwriters Laboratories (UL) Standard 1072.

4. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance

Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association unless otherwise modified by this Section.

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

D. Quality Assurance

1. The general construction of the cable and the insulation material used shall be similar to that used for cable of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities.

2. Upon request, the manufacturer shall submit a copy of his Quality Assurance Manual detailing the quality control and quality assurance measures in place at his facility.

3. The manufacturer shall have available for audit detailed descriptions of the method by which his various manufacturing processes and production test are recorded, thus enabling the "traceability" of the completed cable. All steps in the manufacturing process, from receipt of raw material to the final tests, are to be included. Where multiple records are used, the method for cross-referencing shall be noted.

4. Cable shall be UL listed as Type MV-105.

E. Delivery, Storage and Handling

1. Check for reels not completely restrained, reels with interlocking flanges or broken flanges, damaged reel covering or any other indication of damage. Do not drop reels from any height.

2. Unload reels using a sling and spreader bar. Roll reels in the direction of the arrows shown on the reel and on surfaces free of obstructions that could damage the cable.

3. Store cable on a solid, well drained location. Unjacketed armored cable shall be stored indoors. Cover cable reels with plastic sheeting or tarpaulin. Do not lay reels flat.

4. Seal cable ends with heat shrinkable end caps. Do not remove end caps until cables are ready to be terminated.

F. Warranty

1. The manufacturer shall warrant the cable against failures for a period of 40 years from date of installation and shall remove and replace failed cables at their own expense during this warranty period.

PART 2 PRODUCTS

A. General

1. The manufacturer's name, the voltage class, type of insulation, thickness of insulation, conductor size, UL listing and date of manufacture shall be printed on the jacket.

2. Cables shall be suitable for use in submerged wet locations, in non-metallic or metallic conduits, and in underground duct systems.

3. Cables shall be able to operate continuously at 105 degrees C conductor temperature, with an emergency rating of 130 degrees C and a short circuit rating of 250 degrees C. Emergency overloads shall be possible for periods of up to 100 hours. Five 100 hours emergency overload operations within the life time of the cable shall be possible.

4. Medium voltage cable shall be shielded unless specifically noted otherwise on the Drawings.

5. Medium voltage cables shall have the following physical characteristics in accordance with ICEA, AEIC and UL standards:

   a. Conductors: Annealed copper, Class B concentric lay, stranded per ASTM B8.

   b. Insulation: Thermosetting ethylene propylene rubber (EPR) compound over an extruded, semi-conducting high dielectric stress control layer, with a semi-conducting shield applied directly over the primary insulation. The base elastomer shall have a maximum ethylene content of 72 percent by weight and shall contain no polyethylene. The semiconducting layers and insulation shall be applied using a triple extrusion process.

6. All wire of a given type shall be the product of a single manufacturer.

7. To match existing medium voltage cable system,

manufacturer shall be Okonite Company, no exception.

B. Cable Ratings and Type

1. 15 kV Cable

a. Cable type: Single conductor.

b. Insulation level: 15 kV - 133 percent, 110 kV BIL (220 mils).

c. Operating voltage; 12,470 Volts, 3 Phase, 60 Hz, resistance grounded distribution system.

C. Cable Shielding System

1. Insulation Shield

a. The insulation shield shall consist of a layer of black semi-conducting material extruded directly over the insulation.

2. Metallic Shield

a. Longitudinally applied corrugated tin coated copper wires embedded in the insulation shield. Tape shield will not be accepted.

D. Cable Accessories

1. General

a. Cable termination shall be preformed stress cones. All material used in terminating and splicing medium voltage cables shall be as approved by the cable manufacturer. Cables shall be terminated and spliced in accordance with the kit supplier's drawings.

b. Cable terminations shall meet or exceed IEEE Standard 48, Class I requirements.

c. Cable accessories shall be by only one manufacturer to assure adequate installer training and application assistance.

d. The manufacturer shall be able to document a minimum of 5 years successful field experience as well as demonstrating technical life assessment as requested. The manufacturer shall establish and document a Quality Assurance Program implementing suitable

procedures and controls for all activities affecting quality. The program shall provide documentation that verifies the quality of production joint kits and traceability back to inspection records, raw material and the original designs and design prooftested joints.

2. Indoor Cable Terminations

   a. Single conductor shielded cable terminations for indoor applications shall be one piece, track resistant EPDM rubber with top seal and ground strap assemblies.

   b. Termination shall have a current rating equal to, or greater than the cable ampacity.

   c. Termination shall accommodate any form of cable shielding or construction without the need for special adapters.

   d. To match existing medium voltage system, manufacturer shall be Raychem Corp., HVT Series, no alternate.

3. Outdoor Cable Terminations

   a. Single conductor shielded cable terminations for outdoor protected or exposed locations shall be one piece, track resistant silicone rubber with top seal, rain skirt and ground strap assemblies. Cable compartments of outdoor metal clad switchgear shall be considered as outdoor locations.

   b. Termination shall have a current rating equal to, or greater than the cable ampacity.

   c. Termination shall accommodate any form of cable shielding or construction without the need for special adapters.

   d. To match existing medium voltage system, manufacturer shall be Raychem Corp., HVT Series, no alternate.

4. Shielded Inline and Tee Cable Splice

   a. All wire and cable shall be continuous and without splices between points of connection to equipment terminals. Unless otherwise indicated on the plans, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is

approved, then splicing material shall be approved by the Engineer and cable manufacturer. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor. Splicing materials (where splices are approved) are listed below:

1) For all shielded cables rated 15,000 Volts or less, splice in accordance with the instructions provided with the splicing kits, splicing kits shall be HVS Series (15KV minimum rated) as manufactured by Raychem Corp. or 7600 Series as manufactured by 3M Corp.

2) Shielded cable splices shall be capable of normal continuous operations at the rated voltage and current on the cable it is to be used on. The splice kit shall contain all of the necessary materials required to make splices including cable preparation materials, such as solvents, rags and abrasive materials. A comprehensive step-by-step instruction sheet shall be included with each kit.

5. Cable end caps shall be heat shrinkable polyelofin, 3M Corp., Type ICEC or equal.

6. Lugs and Connectors

   a. Copper lugs and connectors shall be tin plated and crimped with standard industry tooling. All connections of copper stranded wire shall be made electrically and mechanically secured. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements. Lugs larger than 4/0 AWG shall be two-hole lugs with NEMA spacing. The lugs and connectors shall be rated for operation through 15 kV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

7. Electrical Grounding Braid

   a. Conducting metal braid shall be woven from 240 strands of 30 AWG tinned copper wires and be capable of carrying fault current comparable to that of 6 AWG copper wire, 3M Corp., Scotchbrand 25 or equal.

8. Cable Marking Systems

a. A 7-mil, flame retardant, cold and weather-resistant vinyl plastic electrical tape shall be used for phase identification, 3M Corp.; Scotch 35 Tape or equal.

b. Cable tags shall be heat stamped nylon secured by polypropylene cable ties, Thomas & Betts No. TC228-TB or equal.

E. Pulling Compounds

1. Pulling compound shall be nontoxic, nonflammable, noncombustible and noncorrosive. The material shall be UL listed and compatible with the cable insulation and jacket.

F. Shop Testing

1. Perform manufacturers standard production testing and inspection in accordance with Section 6 of the referenced ICEA standards. If requested by the Engineer, the manufacturer shall submit certified proof of compliance with ICEA design and test standards.

2. Provide certified test reports indicating that the cable has passed the following tests:

a. Partial Corona Discharge Test in accordance with AEIC CS5/6, Section G.

b. Vertical tray flame test in accordance with IEEE 1202.

3. After completion of the factory tests, individual pulling eyes shall be installed on single or triplexed conductor length of cable. Pulling eyes shall be suitable for maximum allowable pulling tension on the conductors and they shall be sealed against entrance of water.

PART 3 EXECUTION

A. General

1. All cable terminations and splices (if approved) shall be made by a qualified high voltage cable terminator and splicer with at least 80 hours of formal training and a minimum of 10 years experience. The qualifications shall be submitted to the Engineer for approval before any work is done. Any cables terminated without an approved terminator and splicer shall be removed and replaced at no additional cost to the owner.

2. Determine the cutting lengths, reel arrangements and total lengths of cable required and shall furnish this data to the cable manufacturer.

3. Make use of the field engineering services available from the cable manufacturer.

B. Installation

1. Cable Installation

a. When temperature is below 50 degrees F, cable reels shall be stored at 70 degrees F for at least 24 hours before installation.

b. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

c. Pull cables from direction that requires the least tension.

d. Feed cables into raceway with zero tension and without cable crossover at raceway entrance.

e. Use lubrications to facilitate wire pulling. Pulling compound shall be nontoxic, nonflammable, noncombustible and noncorrosive. The material shall be UL listed and compatible with the cable insulation and jacket.

f. Seal openings in slabs and walls through which wires and cables pass.

g. Steel fish tapes and/or steel pulling cables shall not be used in PVC conduit runs.

h. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius

i. Use a dynamometer and constant velocity power pulling. Velocity should not be less than 15-ft./min or more than 50-ft/min. Do not exceed the cable manufacturer's maximum recommended tension.

j. If cable cannot be terminated immediately after installation, install heat shrinkable end caps.

k. Hydraulically or manually operated cable benders shall not be used.

l. Cable ends shall be properly sealed against ingress of moisture and mechanically protected against damage until splices and terminations are completed (time period between cable pull and make-up of splices and terminations).

m. Properly train all cables at termination points with slight curvature to take stress associated with thermal dimensional changes.

n. Cable support intervals shall not exceed 36 inches, unless otherwise shown. Provide adequate slack in the cables and adequate space between circuits.

o. Neatly support cables at all locations and by racks in manholes. Each rack shall have cable support insulators.

p. Assume full responsibility for any damage to existing cables and to electrical system that may occur due to working in existing manholes, cable vault or medium voltage equipment.

q. Unless otherwise specified, use pull ropes, not wire or cable to install cables in conduit.

r. Route circuits within manholes to separate circuits on opposite sides of manholes where possible.

2. Terminating and Splicing

a. All wire and cable shall be continuous and without splices between points of connection to equipment terminals. Unless otherwise indicated on the plans, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is approved, then splicing material shall be approved by the Engineer and cable manufacturer. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.

b. The work area shall be kept warm, dry and ventilated during terminating and splicing of the cables.

c. Prepare cables in accordance with the termination or

splice kit manufacturer’s installation details.

d. Maintain shield continuity around terminations and splices. Bond cable shields at each terminal or splice location.

e. Install a neoprene tape wrap around each splice and bonding jumper to provide a watertight environmental seal.

f. Insulate and seal each cable-to-bus termination with heat shrinkable bus connector kits.

3. Electric Arc and Fire Proofing

a. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where multiple circuits are present. Fireproof each individual cable separately. Use fire-proofing tape and glass tape in accordance with the manufacturer's instructions. Fire-proofing tape shall be with one half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape by 3M Corp. or equal. Tape shall be secured with a two-layer band of Scotch Brand 69 Glass Electrical Tape by 3M Corp. or equal over the last wrap.

4. Marking and Identification

a. Plastic nameplates shall be installed on each cable in every manhole, pull box, handhole, and other accessible intermediate locations as well as at each termination. These nameplates shall show the phase and feeder designations and the date when the cable was installed or termination was made. The feeder designation shall be as indicated on the Drawings. Nameplates shall be tied to each cable with self-locking nylon ties.

b. Each phase shall be identified on each cable termination with red colored electrical tape bands. Each band shall be a minimum of 1-inch wide. One band for phase A, two bands for phase B and three bands for phase C. Apply tape over cable jacket or fireproofing - not on insulation or stress cones.

c. Marking and identification shall be complete prior to energization.

C. Field Testing

1. Engage the services of a recognized independent testing firm to inspect and test the installed cables prior to energization. The testing firm shall provide all material, labor, equipment and technical supervision to perform the tests and inspection. Notify the Engineer in writing at least two weeks prior to scheduling any testing. Provide certified calibration sheets including dates for all equipment to be used for testing with notice of scheduled testing. Calibration sheets shall also indicate that the units have been calibrated within six months of the testing date.

2. Equipment testing and inspection shall be performed in accordance with NETA Standard ATS and shall be witnessed by the Engineer. The testing shall include the following as a minimum:

   a. Visual and mechanical inspection.

   b. Shield continuity test.

   c. Insulation resistance test.

   d. Hot phasing and rotation tests.

   e. Off Line Partial Discharge or Very Low Frequency (VLF) Hipot or Tan Delta (TD) acceptance tests.

3. When new cables are spliced, the shield continuity and insulation resistance test shall be performed in prior to splicing. After the splice is completed, an insulation resistance test, shield continuity test and an engineer approved acceptance test shall be performed on the complete length of cable including the splice.

4. When new cables are spliced into existing cables, an engineer approved acceptance test shall be performed on each old and new cable prior to splicing. After test results are approved and the splice is completed, an insulation resistance test and a shield continuity test shall be performed on the length of new and existing cable including the splice. After a satisfactory insulation resistance test, another acceptance test shall be performed on the cable utilizing a test method and voltage recommended by the testing firm and approved by the Engineer.

5. Submit certified copies of the test results and leakage plots to the Engineer in accordance with Section 01300

within 5 days of completion of the tests.

6. Immediately notify the Engineer and do not energize the cables if any of the following conditions occur:

   a. Cable damage.

   b. Improper installation or grounding.

   c. Shield discontinuity or high resistance.

   d. Dielectric absorption ratio and polarization index below 1.5.

   e. Abnormal leakage current / capacitance.

7. Defective or Damaged Cables

   a. The Engineer shall make sole determination of the acceptability of the cables based on the submitted test reports. Do not energize cables until the test reports have been reviewed and approved by the Engineer.

   b. If, in the opinion of the Engineer, the cables, terminations or splices are determined to be damaged or defective, provide the following remedial actions at no additional cost to the Owner:

      1) Remove splices and terminations and completely re-test the cables to determine whether the cables are damaged or defective.

      2) Remove and replace damaged or defective cables as directed by the Engineer.

      3) Remake terminations and splices with new kits.

      4) Completely re-test cable, splices and terminations in accordance with Paragraph C2 above.

8. Hot Phasing and Rotation Tests

   a. Correct phasing and rotation shall be the responsibility of the Contractor. Verification of same shall be done in the presence of the Engineer. In the event of any improper phasing or rotation, the appropriate circuit will be shutdown and the Contractor will correct the problem at his cost.

b. All medium voltage system switching, shutdown, grounding and re-energization activity will be the responsibility of the Contractor.

c. Contractor shall perform hot phasing and rotation checks at locations specified in contract documents.

d. The electricians performing these duties must be experienced in this type of activity. The qualifications shall be submitted to the Engineer for approval before any work is done.

9. Acceptance Tests

a. In addition to the electrical testing for insulation resistance, shield continuity, hot phasing and rotation, a final acceptance test of the de-energized cable using one or more of the following test methods: off line partial discharge, VLF hipot, or Tan Delta. The intention is to not only prove the cable is acceptable to put into service, but also provide the Owner with baseline information for future cable maintenance testing. As test methods of medium voltage cables have evolved from basic PASS/FAIL of DC hipot tests, the Engineer shall allow any of the test methods listed above, provided the test report includes the information required in paragraph c below.

b. Testing shall be performed by a qualified testing firm with a minimum of 10 years of experience in the test method proposed. The qualifications shall be submitted to the Engineer for approval.

c. Test reports shall provide a summary showing cable length and designation, locations of joints, terminations and defect sites, test voltage levels and associated test results, severity assessment and recommendations for future action.

END OF SECTION

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SECTION 16150 MOTORS

PART 1 GENERAL

A. Scope Of Work

1. All motors shall be furnished as called for in other Sections of these Specifications and shall be in conformance with the requirements of this section.

B. Qualifications

1. Routine tests shall be performed on representative motors, and shall include the information described on NEMA MG1-12.54 "Report of Test Form for Routine Tests on Induction Motors". Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors.

C. Submittals

1. Submittal of motor data for acceptance shall include complete nameplate data and test characteristics in accordance with NEMA Standard MG1-12.54 "Report of Test Form for Routine Tests on Induction Motors" and, in addition, the following for motors typical of the units furnished:

   a. Efficiency at ½, ¾ and full load.

   b. Power factor at ½, ¾ and full load.

   c. Motor outline, dimensions and weight.

   d. Descriptive bulletins, including full description of insulation system.

   e. Bearing design data.

   f. Special features (i.e., space heaters, temperature detectors, etc.).

   g. Power factor correction capacitor rating and type.

   h. Manufacturer’s warranty.

2. The motor manufacturer shall submit to the Engineer as provided in Section 01300, certified dimension prints showing nameplate data and outline dimensions within three

weeks of the date they receive the order.

D. Reference Standards

1. Institute of Electrical and Electronics Engineers (IEEE)

2. National Electrical Manufacturers Association (NEMA)

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

E. Warranty

1. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of three (3) years.

2. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the machine(s) and the unit(s) restored to service at no additional cost to the Owner.

3. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

F. Extended Warranty (Bid Additive Alternate)

1. If authorized by the Owner, Contractor and equipment manufacturer shall extend the initial warranty period listed in the previous paragraph for a period of two (2) years, bringing the total warranty coverage up to five (5) years.

2. The extended warranty shall include all terms and conditions required to be provided by the Owner to maintain the terms of the warranty.

PART 2 PRODUCTS

A. General

1. Unless otherwise noted, all motors ½ through 100 horsepower shall be rated 230/460 volt, 3 phase, 60 Hertz A.C.; motors 125 horsepower and above shall be rated 460 volt, 3-phase, 60 Hertz, and motors below ½ horsepower shall be rated 115/230 volt, 1 phase, 60 Hertz A.C.

2. All motors used with variable frequency drives shall be

rated for inverter duty and shall be in accordance with the latest NEMA MG1, Section IV, Part 31.

3. All motors shall be built in accordance with current NEMA, IEEE, ANSI and AFBMA standards. Motors shall be of the type and quality described by this Section and other Divisions of the Specifications, and/or as shown on the Drawings, fully capable of performing in accordance with Manufacturer's nameplate rating, and free from defective material and workmanship.

B. Ratings

1. All motors shall be sufficient size for the duty to be performed and shall not exceed their full-rated load when the driven equipment is operating at specified capacity and over the operational range. Unless otherwise noted, motors driving pumps, blowers, etc. shall not be overloaded at any head or discharge condition. The motor shall not be required to deliver more than its rated nameplate horsepower, at the 1.0 service factor, under any condition of mechanical or hydraulic loading (i.e. although a 1.15 service factor is required, it may not be used under any condition).

2. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where shown on the Electrical Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.

3. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient unless noted otherwise.

4. Specific motor data such as Hp, rpm, etc., is specified under the detailed specification for the equipment with which the motor is supplied.

C. Nameplates

1. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1-10.38 or MG1-20.60, as applicable.

D. Condensation Heaters

1. Condensation heaters, where specified herein or under the detailed mechanical specifications shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 Volt, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate.

E. Winding Temperature Detectors

1. Winding temperature detectors, unless specified otherwise herein shall be a factory installed, embedded, bi-metallic switch type with leads terminating in the main conduit box. This device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure. The switch shall have normally open contacts. Not less than three detectors shall be furnished with each motor.

2. All motors operating with variable frequency drives shall be equipped with winding temperature detectors.

F. Power Factor Correction Capacitors

1. The operating power factor of the motors shall range from 93 to 95 percent at full load and 95 to 98 percent when partially loaded. The capacitor current shall not exceed the motor no-load magnetizing current.

2. Capacitors shall be oil insulated or dry type (600 volt capacitors shall be of the dry type) with three high interrupting capacity current limiting integral fuse protection, blown fuse indicators, and discharge resistor and shall be hermetically sealed in steel enclosures. The insulating medium shall be nonflammable and meet the U.S. Environmental Protection Agency Standards. Covers shall be gasketed, bolt-on type. Capacitors shall be UL listed and NEMA rated and tested. Oil insulated type shall be non-PCB dielectric, biodegradable and low toxicity.

3. Units shall be designed to provide power factor correction in applications subject to the effects of harmonics as required for each installation. Where required, units shall consist of power factor correction capacitors as specified above and equipped with series inductors. The units shall be tuned to just below the 5th harmonic frequency on systems with predominately 3 Phase loads. Inductors shall have low flux density and distributed

gaps, copper windings, brazed connections, winding varnish impregnated and baked, Class 220 degrees C insulation with 80 degrees C rise.

G. Three Phase Induction Motors

1. Motors 50 horsepower and larger shall have a 120-volt space heater for moisture control.

2. Unless specifically noted in other Sections of these Specifications, all motors shall have minimum efficiencies as listed below:

Horsepower	NEMA Nominal Efficiency, %
1-2	84.0
3-5	88.5
7-1/2	89.5
10	90.2
15	91.0
20	92.0
25	92.2
30	92.4
40-50	94.0
60-100	94.5
Over 100	95.0

3. All motors 100 horsepower and larger shall be furnished with power factor correction capacitors located in the motor starter enclosure as outlined in Section 16480. The motor manufacturer shall provide the kVAR sizing information to the motor control center manufacturer. Power factor correction capacitors shall be provided only for the high-speed winding on a 2-speed motor. Power factor correction capacitors shall not be required for motors operating on variable frequency drives.

H. Construction

1. General:

a. All drip-proof and weather protected Type I and Type II motors shall have epoxy encapsulated windings. Totally enclosed motors shall be provided with an upgraded insulation by additional dips and bakes to increase moisture resistance and shall not be encapsulated. Motors for outdoor service shall have vacuum pressure impregnated (VPI) epoxy insulation for moisture resistance. Two speed motors shall be of the two winding type.

b. Squirrel-cage rotors shall be made from high-grade steel laminations adequately fastened together and to the shaft, or shall be cast aluminum or bar-type construction with brazed end rings.

c. All motors shall be of the premium efficiency and high power factor type. All motors shall be the corrosion resistant type conforming to motors designated as “Corro-Duty” by U.S. Motors or equal.

d. Vertical motors shall be hollow or solid shaft as required by the equipment furnished under other Sections of these Specifications.

e. Totally enclosed non-ventilated (TENV) motors shall include the same ratings and accessories as specified for TEFC motors.

f. Explosion-proof motors shall be UL listed and FM approved for Class 1, Division 1 hazardous areas.

g. Motors installed in Class 1, Division 2 areas shall be rated / listed for this hazardous area.

2. Low Voltage, Three Phase Motors:

a. Motors shall be of the squirrel-cage induction type. Horizontal, vertical solid shaft, vertical hollow shaft, normal thrust and high thrust types shall be furnished as called for on the Drawings and as specified in other Sections of these specifications. Motors shall be of the type and quality described by these Specifications, and/or as shown on the schedule on the Drawings, fully capable of performing in accordance with Manufacturer's nameplate rating, and free from defective material and workmanship.

b. Motors shall have normal or high starting torque (as required), low starting current (not to exceed 650 percent full load current), and low slip.

c. Unless otherwise specified, motors shall be totally enclosed fan-cooled construction with a 1.15 service factor at the Class B Temperature-Rise.

d. The output shaft shall be suitable for direct connection or belt drive as required.

e. Motors shall have a Class F non-hygroscopic insulation

system but shall be limited to Class B Temperature-Rise, at 1.15 service factor.

f. All motors shall have a final coating of chemical resistant corrosion and fungus protective epoxy fortified enamel finish sprayed over red primer over all interior and exterior surfaces. Stator bore and rotor of all motors shall be epoxy coated.

g. All fittings, bolts, nuts, and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.

h. All machine surfaces shall be coated with rust inhibiter for easy disassembly.

i. Conduit box shall be split from top to bottom and shall be capable of being rotated to four 90 degree positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and sealed with a non-wicking, non-hygroscopic insulating material. A frame mounted pad with drilled and tapped hole, not less than 1/4-inch diameter, shall be provided inside the conduit box for motor frame grounding. All motor conduit boxes shall be provided with the correct number of conduit openings sized as indicated on the drawings. Boxes shall be suitably sized for conductor bending and terminations.

j. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.

k. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures shall have stainless steel screens. Motors shall be protected for corrosion, fungus and insects.

l. Low voltage, three phase motors shall be manufactured by Nidec-U.S. Motors, Reliance Electric or Baldor.

m. Fractional Horsepower:

1) Fractional horsepower motors shall be rigid, welded-steel, designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be cast iron or heavy fabricated steel. Windings shall be of varnish-insulated wire with slot insulation of

polyester film, baked-on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses and other hazards.

2) Motor shaft shall be made from high-grade, cold-rolled shaft steel with drive-shaft extensions carefully machined to standard NEMA dimensions for the particular drive connection.

3) For light to moderate loading, bearings shall be quiet all-angle sleeve type with large oil reservoir that prevents leakage and permits motor operation in any position.

4) For heavy loading, bearings shall be carefully selected precision ball bearings with extra quality, long-life grease, and large reservoir providing 10 years normal operation without re-lubrication.

n. Integral Horsepower:

1) Motor frames and end shields shall be cast iron or heavy fabricated steel of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.

2) Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.

3) The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating. Bearing journals shall be ground and polished.

4) Rotors shall be made from high-grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel-cage windings may be cast-aluminum or bar-type construction with brazed end rings.

5) Motors shall be equipped with vacuum-degassed anti-friction bearings made to American Bearing Manufacturers Association (ABMA) Standards, and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold

sufficient lubricant to minimize the need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of lubricant out of the bearing cavity.

6) Bearings of high thrust motors will be locked for momentary upthrust of 30 percent downthrust. All bearings shall have a minimum B10 life rating of 5 years in accordance with ABMA life and thrust values.

7) Vertical motors will have non-reverse ratchets to prevent backspin. Non-reverse ratchets shall be suitable for duty with variable frequency drives.

3. Low Voltage, Single Phase Motors:

a. Single phase motors shall be split-phase and capacitor-start induction types rated for continuous horsepower at the rpm indicated on the drawings or as required by the specifications. Motors shall be rated 115/230 volts, 60 Hertz, single phase, open drip-proof, or totally enclosed fan cooled as indicated on the drawings or as required by the specifications, with temperature rise in accordance with NEMA Standards for Class B insulation.

b. Totally enclosed fan cooled motors shall be designed for severe-duty.

c. Motors shall have corrosion and fungus protective finish on internal and external surfaces. All fittings shall have a corrosion protective plating.

d. Mechanical characteristics shall be the same as specified for polyphase fractional horsepower motors.

PART 3 EXECUTION

A. Installation

1. Motor Connections: All motors shall be connected to the conduit system by means of a short section 18-inch minimum of liquid tight conduit unless otherwise indicated. For all motor connections of No. 4 AWG or larger wire size, the Contractor shall install a grounding conductor in the

conduit and terminate at main conduit box and at the motor control center or variable frequency drive with approved ground lugs and clamps.

2. Low Voltage: For wire sizes #8 AWG and larger, long barrel tin-plated copper compression (hydraulically pressed) type connections (Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Bolted connections shall utilize products which are rated for vibration applications (bolt, nut and spring washer). All connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp. or equal).

B. Tests and Checks

1. The following tests shall be performed on all motors after installation but before putting motors into service.

a. The Contractor shall megger (1000 volts DC) each motor winding before energizing the motor, and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor. The following table gives minimum acceptable insulation resistance in megohms at various temperatures and for various voltages with readings being taken after one (1) minute of megger test run.

Degrees Winding Temperature		Voltage		
F	C	115 V.	230 V.	460V.
37	3.9	60	108	210
50	10	32	60	120
68	20	13	26	50
86	30	5.6	11	21
104	45	2.4	4.5	8.8
122	50	1	2	3.7
140	60	0.50	0.85	1.6

b. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication, and shall lubricate if required in accordance with Manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary. The correction for wrong rotational direction shall be made at the motor.

c. All tests shall meet the requirements of, but not be limited to, IEEE 43, 85 and 112. Efficiency tests for

IEEE 112 shall include Method B.

d. The Contractor shall provide to the Engineer a typed list of all motors 1 HP and larger listing the no load motor current and voltage and the full load current and voltage. Any phase current imbalance greater than 10% shall be reported to the Engineer.

2. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association.

END OF SECTION

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SECTION 16191 MISCELLANEOUS EQUIPMENT

PART 1 GENERAL

A. Scope Of Work

1. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

2. This Section provides the requirements for miscellaneous equipment typically employed in a facility, however, not all components specified in this Section are necessarily utilized on this project.

B. Related Work

1. Surge protective devices are included in Section 16192.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, detailed catalog information or drawings with sufficient detail to determine compliance with the specifications including describing electrical and physical characteristics of all equipment specified.

D. Reference Standards

1. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16000.

PART 2 PRODUCTS

A. Materials

1. Disconnect Switches

   a. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle unless otherwise noted. Enclosure type shall be as noted on the drawings. All current carrying parts shall be copper.

   b. NEMA 4X enclosures shall be stainless steel.

   c. NEMA 7 enclosures shall be cast aluminum.

d. Lugs shall be copper.

e. All exterior hardware shall be stainless steel.

f. Switches shall be as manufactured by Eaton / Cutler Hammer, Schneider Electric / Square D Company, or Siemens.

2. Fused Disconnect Switches

a. Fused disconnect switches shall be NEMA 4X heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle unless otherwise noted. All current carrying parts shall be copper.

b. Fuses shall be rejection type, 600 Volts, 200,000 A.I.C., dual element, time delay, Bussman Fusetron®, Class RK-5 or equal.

c. NEMA 4X enclosures shall be stainless steel.

d. NEMA 7 enclosures shall be cast aluminum.

e. Lugs shall be copper.

f. All exterior hardware shall be stainless steel.

g. Switches shall be as manufactured by Eaton / Cutler Hammer, Schneider Electric / Square D Company, or Siemens.

3. Manual Motor Starters

a. Manual starters shall be furnished and installed for all typed of single-phase motors. Manual starters shall be non-reversing, reversing or two speed type as required. NEMA sizes shall be as required for the actual horsepower of the motor furnished. Manual starters shall have motor overload protection in each phase. Built-in control stations shall be furnished as required or as shown on the Drawings. All manual motor starters shall be provided with provisions to padlock the switch in the OFF position.

b. NEMA 4X enclosures shall be stainless steel.

c. NEMA 7 enclosures shall be cast aluminum.

d. Manual motor starters shall be as manufactured by Eaton / Cutler Hammer, Schneider Electric / Square D Company, or Siemens.

4. Magnetic Motor Starters

a. Motor starters shall be 2 or 3 Pole, single or 3 Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepowers shown on the Drawings.

b. Two speed starters shall be for single or two winding motors as required by the actual motor furnished or as shown on the Drawings.

c. Each motor starter shall have a 120 Volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as required or as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.

d. Overload relays shall be self-powered solid state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test.

e. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses.

f. Built-in control stations and indicating lights shall be furnished as specified herein where shown on the Drawings.

g. NEMA 4X enclosures shall be stainless steel.

h. NEMA Type 7 enclosures shall be cast aluminum.

i. Magnetic motor starters shall be as manufactured by Eaton / Cutler Hammer, Schneider Electric / Square D Company, or Siemens.

5. Combination Magnetic Motor Starters

a. Motor starters shall be a combination motor circuit protector and contactor, 2 or 3 Pole, single or 3

Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepowers shown on the Drawings. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be current limiting type, with additional current limiters if required. Combination motor starters shall be fully rated for 22,000 Amps RMS symmetrical.

b. Two speed starters shall be for single or two winding motors as required by the actual motor furnished or as shown on the Drawings.

c. Each motor starter shall have a 120 Volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as required or as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.

d. Overload relays shall be self-powered solid state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test.

e. Starter solid state overload relays shall also be “smart” to utilize Ethernet control and communication for future use.

f. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses.

g. Built-in control stations and indicating lights shall be furnished as specified herein where shown on the Drawings.

h. NEMA 4X enclosures shall be stainless steel.

i. NEMA Type 7 enclosures shall be cast aluminum.

j. Combination magnetic motor starters shall be as manufactured by Eaton / Cutler Hammer, Schneider Electric / Square D Company, or Siemens.

6. Control Stations and Indicators

   a. Control stations shall be heavy-duty type, with full size (30.5mm) NEMA 4X or 7 operators, indicators, etc.

   b. Indicators shall be full voltage and push-to-test type. Indicators located indoors shall be LED type and indicators located outdoors shall be incandescent lamp type.

   c. NEMA 4X enclosures shall be stainless steel.

   d. NEMA 7 enclosures shall be cast aluminum.

   e. Control stations shall be Square D Company Class 9001, or similar by Eaton / Cutler Hammer or Siemens.

7. Retrofit of Existing Motor Control Center Cubicles

   a. A complete new bucket assembly shall be provided for motor control center cubicles that are substantially changed from the existing cubicle. Insubstantial changes shall be defined as a change-out of an MCP or circuit breaker with the same physical frame size, or a change-out of overloads. All other changes shall be considered substantial.

   b. Components and material requirements shall comply with previous paragraphs regarding combination magnetic motor starters and control stations and indicators.

   c. All components used shall not be required to be from the same manufacturer as the original MCC bucket, but shall be UL listed.

8. General Purpose Dry Type Transformers

   a. Transformers shall be dry type, two-winding with kVA and voltage ratings as shown on the Drawings.

   b. Four full capacity taps shall be furnished, two 2-1/2 percent above and four 2-1/2 percent below rated primary voltage.

   c. Maximum temperature rise shall be 80 degrees C. Windings shall be copper.

   d. Transformers shall be built in accordance with ANSI C89.2 and NEMA ST-20.

e. Transformers shall be provided in NEMA 1 enclosures unless otherwise noted on the Drawings or as required by Section 16000. Where a NEMA 4X and/or stainless steel enclosure is required, the transformer shall be of the TENV type.

f. Transformers shall be furnished with hot dipped galvanized mounting hardware. Where a NEMA 4X and/or stainless steel enclosure is required, the hardware shall be 316 stainless steel.

g. Transformers shall be manufactured by Eaton / Cutler Hammer, Schneider Electric / Square D Company, or Siemens.

9. Transformer-Panel Assembly

a. Each Transformer-Panel Assembly (TPA) shall include a main primary breaker, a dry type transformer and a secondary panelboard with main breaker.

b. Enclosures shall be type NEMA 1 enclosures unless otherwise noted on the Drawings or as required by Section 16000. Main primary, secondary, and feeder breakers shall be enclosed with a padlockable hinged door. Where NEMA 3R stainless steel enclosure is required, the hardware shall be 316 stainless steel.

c. Transformers shall be dry type, two winding with kVA and voltage ratings as shown on the Drawings.

d. Transformer windings shall be copper, 115 degree C rise, epoxy-resin encapsulated with two full capacity taps rated 5 percent below rated primary voltage.

e. Interconnecting wiring between the primary breaker and transformer, transformer and secondary main breaker, and secondary main breaker and distribution section shall be factory installed.

f. Panelboard bus shall be copper.

g. TPA main primary breaker shall have a minimum interrupting rating of 18 kA at 480 volts and shall be sized per manufacturer’s standard for the kVA size.

h. TPA secondary main breaker shall have a minimum interrupting rating of 10 kA at 240 volts and shall be sized per manufacturer’s standard for the kVA size.

i. TPA feeder breakers shall be bolt-on type with a minimum interrupting rating of 10 kA.

j. Panelboard section shall include copper equipment ground bar.

k. TPA shall be Mini Power-Zone as manufactured by Square D, Mini-Power Center as manufactured by Eaton/Cutler-Hammer, or Sentron Power Center as manufactured by Siemens.

10. Wireway

a. NEMA 1 wireway shall be gasketed painted steel with stainless steel screw covers.

b. NEMA 4X wireway shall be 316 stainless steel with gasketed clamped covers.

c. NEMA 1 wireway shall be Square-Duct as manufactured by the Square D Co.; NEMA 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co. or equal.

11. Manual Transfer Switch

a. Manual transfer switches shall be heavy duty, load-break, quick-make, quick-break, visible blades, 3 or 4 Pole, 600 Volt, double throw, with direct manual operation, full cover interlock, interlock defeat and shall be listed under UL 1008. Switch ratings shall be as shown on the Drawings. Enclosure type shall be NEMA 1, unless otherwise noted on the Drawings or as required by Section 16000. All current carrying parts shall be copper.

b. NEMA 4X enclosures shall be stainless steel.

c. NEMA 7 enclosures shall be cast aluminum.

d. Lugs shall be copper.

e. Manual transfer switches shall be as manufactured by Eaton / Cutler Hammer, Schneider Electric / Square D Company, or Siemens.

12. Control Relays

a. Control relays shall be heavy duty machine tool type, with 10 Amp, 300 Volt convertible contacts. Number of contacts and coil voltage shall be as shown on the

Drawings. General use relays shall be Square D Company, Class 8501 Type X, similar by; Eaton / Cutler-Hammer, or Allen-Bradley Company. Latching relays shall be Square D Company, Class 8501 Type X, similar by; Eaton / Cutler-Hammer, or Allen-Bradley Company.

b. Time delay relays shall be pneumatic, 600 Volt, 20 Amp contacts, with calibrated knob operated adjustment and numerical time dial. On delay and off delay types and timing ranges shall be as shown on the Drawings or as required for proper operation of the actual equipment furnished. Relays shall be Agastat Model 7012 or 7022 or equal.

13. Detectable Polyethylene Warning Tape

a. Warning tape shall be 5 mil red polyethylene film, 6-in minimum width. Tape shall be capable of being detected or located by either conductive or inductive location techniques.

b. Warning tape shall be Mutual Industries Part No. 17774 or equal.

14. Terminal Blocks

a. Terminal blocks shall be 600 Volt, channel mounted, with tubular screw and pressure plate.

b. Terminal blocks shall be Bulletin 1492-CA1 as manufactured by the Allen-Bradley Co. or equal.

15. JIC Boxes for GF Receptacles

a. JIC boxes shall be 6-inches x 6-inches x 4-inches aluminum continuous hinge clamp cover boxes, Hoffman Catalog Number A-606 CHAL with Type L23 stainless steel fast operating JIC clamp, or equal.

b. Install 1-1/2-inch bushings in bottom of box for cord and plug to pass through.

16. Corrosion Inhibitors

a. All equipment enclosures, terminal boxes, etc, located in a NEMA 4X rated area (where shown on the Drawings) that contains electrical or electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.

b. The corrosion inhibitor pads shall be as manufactured by Hoffman Engineering Co.; 3M or equal.

17. Equipment Mounting Stands

a. Mounting stands shall be custom fabricated from 1/4-in 316 stainless steel plate and 3-in 316 stainless steel channel, unless otherwise shown on the Drawings.

b. All hardware shall be 316 stainless steel.

18. Terminal Cabinets:

a. Interiors shall be so designed that control relays and terminal blocks can be replaced or added without disturbing adjacent units. Each cabinet shall be furnished with a minimum of 50 spare terminals.

b. All interiors shall be completely factory assembled with control relays, terminal blocks, insulating barriers, etc. All 120 volt AC and DC terminal blocks shall be isolated from each other by insulating barriers or separate enclosures.

c. All wiring within the cabinets shall be grouped together in harnesses and secured to the structure.

d. All shielded cables shall terminate in separate cabinets. A third terminal shall be provided for each twisted shielded pair and the shield for each connected thereto, unless otherwise noted on manufacturer's shop drawings.

e. Terminal blocks shall be tubular screw type with pressure plates and shall be rated 600 volts. Terminal blocks shall be Allen Bradley Catalog Number 1492-CA1 or equal.

f. Boxes shall be made from 14 gauge galvanized steel and shall be of sufficient size to provide a minimum of 4 inches of wiring space on all sides and between adjacent terminal blocks. A minimum 2-inch spare shall be provided between control relays. A minimum of four mounting studs shall be provided on each cabinet. Cabinets shall be furnished without knockouts. Holes for raceways shall be drilled on the job.

g. A single or double hinged door shall cover the front of each terminal cabinet. Doors shall have a neoprene

gasket, vault type handle, three point catch and lock. Two keys shall be supplied for each lock. All locks shall be keyed alike. A terminal block schedule shall be provided with each terminal point numbered and identified (typewritten) as to function.

h. All exterior and interior steel surfaces of the cabinets shall be properly cleaned and finished with ANSI 61 grey over a rust-inhibiting phosphatized coating conforming to ANSI A55.1. The finish paint shall be of a type to which field applied paint will adhere.

i. Cabinets in wet, damp, corrosive and all outdoor locations shall be NEMA 4X 316 stainless steel.

j. Cabinets shall be Hoffman Engineering Company with latch kit hardware or be an equal product.

19. Emergency Shower Alarm Horn and Light

a. Emergency shower alarm horn shall be vibrating type for 120 Volts, 60 Hz and shall be Federal Signal Corp.; Catalog No. 350+WB for surface mounting, Catalog No. 350+FG+FB for flush mounting, similar by Benjamin Co.; Edwards Co. or equal.

b. Emergency shower alarm light shall be a flashing strobe unit with red fresnel globe, for use on a 120 Volts, 60 Hz power supply, and shall be Benjamin Catalog No. KL-4011-120, similar by Federal Signal; Edwards Co. or equal.

20. Intrinsically Safe Relays

a. Intrinsically safe relays shall be solid state type with 5 Amp output contacts, suitable for use on a 120 Volt, 60 Hz power supply and shall be FM approved for pilot devices in Class I, Division 1, Group D hazardous atmospheres.

b. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or equal.

21. Break-Glass Emergency Station

a. Break-Glass Emergency Station shall be of the break glass design with a weatherproof cast metal outer case finished in fire red and have an attached chain hung

"Hammer". A glass panel shall be mounted in front of the push button operator. Switch contacts shall be 1-open, 1-closed, rated 10 Amp, 600 Volts.

22. Lighting Contactor

    a. Lighting contactor shall be of the electrically operated, mechanically held type mounted in NEMA 1, enclosures (except where noted otherwise on the Drawings) with number of poles as noted on the Drawings. Operating coils shall be rated for 120 Volts unless otherwise indicated on the Drawings and shall be for momentary operation. Provide with "Hand Off-Auto" switch on cover where shown on the Drawings.

    b. Contactors shall be rated for 20 Amps, 600 VAC and shall be Automatic Switch Co., Bulletin 917 RC, similar by Square D Co.; Cutler Hammer or Siemens.

23. Digital Lighting Control Time Switches

    a. Time switches for lighting control shall have astronomic ON/Timed OFF and Timed ON/astronomic OFF; pulse switching for mechanically held contactors or low voltage latching relay; LCD digital display for basic setting; manual ON/OFF override and 72 hour rechargeable 9 Volt Nickel Cadmium battery back-up and NEMA III indoor/ outdoor enclosure. Time switches shall be Tork, Catalog No. DZS 200/120 Volt or equal.

24. Beacon Alarm Light

    a. Beacon alarm light for building exterior mounting shall be flush mounted, weatherproof construction and have a 750,000 candlepower xenon strobe tube and red polycarbonate lens. Beacon alarm light shall be Federal Signal, Model 371 DST or equal.

25. Alarm Horn and Light

    a. Alarm horn shall be vibrating type for 120 volts, 60 Hertz and shall be Federal Signal Corp. Cat. No. 350 + WB for surface mounting, Federal Signal Corp. Cat. No. 350+FG+FB for flush mounting, equal by Benjamin Co. or Edwards Co. or equal.

    b. Alarm light shall be a NEMA 4X flashing strobe unit with red glass globe, for use on a 120 volts, 60 Hertz power supply, and shall be Federal Signal Co. Model 191X, or equal.

26. Photocells

    a. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the Drawings. Enclosure shall be NEMA 3R or 4. Contacts shall be rated for 2,000 watts continuous at 120 Volts. The unit shall turn on at 1.5 footcandles and off at 5.5 footcandles.

    b. Photocells shall be Tork, Model 2101 or equal.

27. 24-Hour Programmable Timers

    a. Unless otherwise specified, time switches shall be of the programmable type capable of being programmed at the intervals as noted on the Drawings over a 24-hour day. Program tabs shall be easily set by hand without tools to obtain or to change the desired programming schedule. The switching condition shall be maintained when adjacent tabs are set alike.

    b. The unit shall be powered by a self-starting, enclosed, 120 Volt, synchronous motor capable of continuous accurate operation. A reserve power, precision wound spring and associated escapement device shall be integrally mounted to maintain time settings during power failures of up to 24 hours.

    c. The switch mechanism shall be a self-contained unit rated at not less than 20 Amps, 120 Volts, single pole, double throw and shall be readily replaceable in the field.

    d. An omitting device shall be furnished as an integral part of the time switching operation to be skipped for any preselected day or days of the week.

    e. Unless otherwise specified, time switches shall be as manufactured by Intermatic; Tork; Paragon or equal.

28. Power Monitors

    a. Microprocessor based metering: At each circuit location shown on the Drawings, furnish a digital microprocessor based metering device capable of monitoring and displaying the functions listed below. The device shall provide the status input functions indicated and the capability to communicate data to a centralized monitoring system via Ethernet Cat 6 cable

using Modbus TCP/IP communications protocol. The device shall be UL listed. The device shall be Power Logic type as manufactured by the Square D Company or equal.

b. Metering Functions

1) The Digital AC Instrumentation Package shall be capable of measuring, calculating and directly displaying on the front panel display the following information:

a) Volts on each phase plus average of all three phases

b) Current on each phase plus average of all three phases

c) Neutral or ground current

d) Frequency

e) Power Factor

f) KVA

g) KVAR

h) KW

i) Total KWH as an accumulating total, providing bi-directional (import/export) indication

j) Total KVARH as an accumulating total, providing bi-directional (import/ export) indication

k) Amps Demand.

c. Monitoring and Control Functions

1) Provide eight self-powered digital status inputs to monitor the following points:

a) Circuit breaker OPEN status

b) Circuit breaker CLOSED status

c) Circuit breaker TRIPPED status

d) Circuit breaker OUT OF SERVICE (withdrawn) status.

2) Provide one auxiliary analog input rated 1.0 VAC/VDC nominal full scale input which can be used to measure an external variable such as transformer temperature, air temperature, or battery voltage.

3) Provide one auxiliary analog output (selectable 0-20ma or 4-20ma) proportional to any measure parameter.

4) Provide three Form C dry contact control relay outputs rated 277 VAC or 30 VDC at 10 Amp maximum load current, that can each function as:

a) Setpoint relays that operate as a function of any measured parameter for demand, power factor, or load control. Seventeen programmable setpoints shall each have programmable operate and release limits and time delays on operate and release. Relays shall provide selectable pulse mode or tach mode operation.

b) Remote control relays operated by commands via the communications port.

c) Breaker trip relay (over/under volt, volt unbalance, phase reversal, current unbalance, over/under frequency).

d) KWH or KVARH pulse output relay.

e) Alarm relays.

d. Operational Features

1) Provide the following operating features:

2) True RMS measurements.

3) Connect directly to PT's and CT's for systems over 600 volts.

4) Provision for a fourth current input for measurement of ground or neutral current.

5) 300 amp, one second surge protection on all four current inputs.

6) 3-field, 20 character, high visibility 0.4-in character height vacuum-fluorescent display with a programmable time out feature.

e. Store in non-volatile memory the following:

1) A time-stamped alarm and event log of up to 50 events which records event date, time (to 1 second), event type and value for all over/under limit conditions, all status input activity and all relay operations. Log shall be read via the communications port.

2) A time-stamped minimum/maximum log, which records the value of any parameter exceeding the previous highest or lowest value recorded. Log shall be read from the front panel display or via communication port.

3) A time-stamped snapshot (historical) log, with a 100 snapshot capacity and user-definable snapshot interval from 1 second to 400 days which records snapshot values for Average Volts, Average Amps, KW, KVAR, KW Demand, Power Factor, Frequency, KWH, KWH Reverse, KVARH and Auxiliary Volts Input. Log shall be read via the communications port.

4) All setup data.

f. The device shall be field programmable as follows:

1) Volts scale, volts mode (wye, delta, single phase), amps scale, Vaux scale, baud rate and the relay operation shall be programmable from the front panel.

2) All parameters above, plus additional alarm/event parameters shall be programmable via the communications port using a portable terminal or a computer.

a) The programming shall be password protected.

g. Waveform Capture

1) Provide waveform capture capability allowing any of the eight voltage and current input channels to be digitally sampled at 256 samples/60 Hz cycle. Waveform capture shall be initiated using commands

made via the communications port. Waveform capture data shall be mad accessible via the communications port.

h. Data Communications

1) Provide a serial communication port which has:

a) Switchable RS-232C and RS-485 capability.

b) Addressable polling of multiple units.

c) Packet transmission.

d) Selectable transmission at 300 to 19,200 baud.

2) Provide all communication cables to interconnect monitors within the electrical equipment.

3) All necessary cables, connectors, software, hardware, etc. shall be provided as required to interface with a computer system and/or related PLCs as specified herein or in other Sections and Divisions of the specifications.

29. Enclosed Circuit Breakers

a. Service: 480 volt, 3-phase, 3-wire, 60 Hertz, ampacity as noted on the Drawings.

b. The overall short circuit withstand rating of the equipment and devices shall be 65,000 Amperes R.M.S. symmetrical at 480 volts. Bus shall be tin plated copper.

c. Circuit Breakers

1) Power circuit breakers (400 Amps and larger): 100 percent equipment rated, 600 volt, molded case circuit breakers with integral fully adjustable solid state trip device. Trip device shall be temperature insensitive and have the following characteristics and functions:

a) Independently adjustable long time pick-up and delay.

b) Independently adjustable short time pick-up and delay.

c) Adjustable instantaneous.

d) Independently adjustable ground fault pick-up and delay.

e) Trip mode targets for over load, short circuit, and ground fault.

2) Circuit breakers (Less than 400): Thermal-magnetic trip type, 600 Volt, 2 or 3 Pole as required, labeled in accordance with UL 489. Provide independently adjustable magnetic trips on 225A frame breakers and larger.

d. Breakers shall be housed in NEMA 1 enclosures with padlocking provisions.

e. Each breaker shall be identified with nameplate identification per the Drawings. Signage shall also be provided which reads as follows "DANGER 480 VOLTS - KEEP OUT".

f. Manufacturer shall provide ground fault CT's, metering, lightning arresters, etc. as shown on the drawings.

g. Surge protection shall be as shown on the drawings in accordance with Section 16192.

h. Circuit breakers, enclosures, etc., shall be as manufactured by Cutler-Hammer, Square D or Siemens.

B. Control System

1. The Manufacturer shall provide a complete and fully functional control system to manually or automatically operate the control system as specified herein and in other applicable sections of these specifications. All Manufacturers recommended safety devices shall be furnished to protect operators. All control devices, unless specified otherwise, shall be mounted in the Control Panel.

2. Control Panel Construction

a. The control panel shall consist of a main circuit breaker, a motor circuit protector (MCP) and magnetic starter for each motor, and a 120-volt control power transformer (fused on primary and secondary). All control components shall be mounted in one common

enclosure. Control switches shall provide means to operate each motor manually or automatically.

b. Unless specifically noted otherwise, the electrical control equipment shall be mounted within a NEMA 4X enclosure, constructed of not less than 14 gauge 316 stainless steel. All hardware shall be 316 stainless steel. The door shall be attached via a continuous hinge and shall be provided with a pad-lockable vault type 3-point latch. The enclosure shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Door(s) shall be interlocked with main circuit breaker and provided with pad-locking provision.

c. Outdoor enclosures containing solid state electronics such as soft starters, VFD’s or PLC’s shall be provided with sun shields. Additional temperature control devices such as exhaust of air conditioning shall be provided if required to meet UL listing of internal components. Any outdoor control panel provided with external HMI touch screens shall be appropriately shielded from sunlight.

d. All control panels containing PLC’s shall contain UPS or battery ride-through for the PLC in accordance with Division 13 specifications.

e. All motor branch circuit breakers, motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.

f. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position. A thermal-magnetic air circuit breaker, 65kA AIC, as manufactured by the Square D Company, or equal, shall be furnished for the main breaker. All circuit breakers shall be sealed by the manufacturer after calibration to prevent tampering. Each circuit breaker shall be adequately sized to meet the equipment operating conditions. Motor Circuit Protectors (MCP) shall be molded case with adjustable magnetic trip only, "Mag-Gard" as manufactured by the Square D or equal.

g. An open frame, across-the-line, NEMA-rated magnetic motor/starter, Class 8536 as manufactured by the Square D Company, or equal, shall be furnished for each motor (unless different motor control is specified under another Section). All motor starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Motor starter contacts shall be easily replaceable without removing the motor starter from its mounted position. Overload relays shall be self-powered solid state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test. Class 10 quick trip overloads shall be provided for all submersible motors. Class 20 overloads shall be provided for other motors. Overload reset push-buttons shall be located on the exterior of the door. Normally open and normally closed auxiliary motor overload contacts wired to terminal blocks shall be provided for each motor starter within the control panel.

h. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by Divisions 13, 16 and as shown on the drawings.

i. All operating control and instruments shall be securely mounted on the exterior door. All controls and instruments shall be clearly labeled to indicate function. All exterior mounted equipment shall be NEMA 4X.

j. Mode selector switches shall be Hand-Off-Auto type to permit override of automatic control and manual actuation of shutdown. Switches shall be NEMA 4X (800H) as manufactured by Allen-Bradley, or equal, providing three (3) switch positions, each of which shall be clearly labeled according to function.

k. Indicator lamps shall be LED (indoors) or Incandescent (outdoors) full voltage type and mounted in NEMA 4X (800H) modules, as manufactured by Allen-Bradley or equal. Lamp modules shall be equipped to operate at 120 volt input. Lamps shall be easily replaceable from the front of the control compartment door without removing lamp module from its mounted position.

Indicators shall be provided for individual motor run and an indicator for each failure condition.

l. A six (6) digit, nonreset elapsed time meter shall be connected to each motor starter to indicate the total running time of each motor in "hours" and "tenth of hours". The elapsed time meters shall be Series T50 as manufactured by the ENM Company or equal.

m. A failure alarm with horn and beacon light shall be provided. Silence and reset pushbuttons shall also be furnished. A common failure reset pushbutton shall be provided to reset the alarm conditions (reset shall occur only if fault condition has been cleared). The alarm horn shall be weatherproof rated with gasket (Federal Signal Corporation, Cat. #350 or equal). The alarm beacon shall be NEMA 4X rated, red lense and solid state flasher (Ingam Products Inc. LRX-40 or equal).

n. The control panel shall operate on a power supply of 480 volts, 3-phase, 60 hertz unless otherwise noted.

o. The control diagrams and overload tables shall be laminated to the inside of the door except where door space is limited the laminated documents shall be in the print storage pocket.

p. Print storage pockets shall be provided on the inside of each panel. Pocket shall be of sufficient size as required to hold all prints necessary to service the equipment. A set of reduced drawings shall be provided for each panel, fixed to fit in the storage pocket.

q. A duplex GFCI utility receptacle (circuit breaker protected) providing 120 volts, 60 Hertz, single phase current shall be mounted on the side of the enclosure.

r. The control panel shall include an adjustable time delay relay to prevent any two motors from starting simultaneously. All timing relays shall be solid state, with pin (octal) and bases, relays shall be T-series as manufactured by Diversified Electronics Inc. or equal.

s. Alternators shall be provided to sequence motors, alternators shall be 008-120-13SP or 009-120-23AP as manufactured by Sta-con, or equal.

t. A phase monitor shall be provided for the control panel, monitors shall be Siemens model MSP10G or Square D model MG-24532 or equal.

u. All exterior mounted equipment shall be rated NEMA 4X. Hinged NEMA 4X 316 stainless steel viewing windows will be permitted where such equipment is not available with a NEMA 4X rating.

v. The control panel shall be provided with lightning and surge protection. Protection devices shall be mounted external to the control panel enclosure. Surge current rating shall be 80kA per mode and in compliance with Specification 16192. Approved manufacturers of SPD's are Current Technology; Joslyn (Total Protection Solutions) or Surge Suppression Inc. No substitution will be allowed.

w. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.

x. Wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation.

y. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc.. Nameplates shall be permanently affixed using an epoxy process (inner door nameplates shall be fastened with stainless steel screws). Nameplates shall be laminated plastic, engraved black letters with a white background.

z. All control panels shall be provided with a master nameplate located on the exterior door.

aa. Where applicable provide a nameplate which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Letters shall be black on a high visibility yellow background.

bb. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter that shall protect internal components of control panel from corrosion for up to one year. One spare emitter shall be provided for each control panel.

cc. All control relays shall be have 10 amp rated contacts (minimum), 11 pin with mounting base , 3PDT (minimum),

with LED indicators to show relay status, relays shall be manufactured by Potter Brumfield or equal.

dd. Terminal blocks shall be 600 volt heavy duty rated, tubular clamp type. Terminal strips shall be Allen Bradley catalog #1492-CA-1 or equal. Each terminal shall be individually labeled.

ee. The completed control panel assembly shall be U.L. certified.

ff. Intrinsically safe relays shall be solid state type with 5 amp output contacts, suitable for use on 120 volt, 60 hertz power supply and shall be Factory Mutual approved for devices in Class 1, Division 1 hazardous atmospheres. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or equal.

gg. All electronic control equipment (i.e. controllers, isolators, signal boosters, transmitters, PLC's, etc) shall be as specified in Division 13.

hh. A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.

ii. All signal wiring entering and exiting the control panel shall be provided with surge protection. Surge protection shall be as specified in Division 13.

jj. An 8-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A 4-inch (minimum) clear space within the enclosure shall be provided vertically along the entire sides of the control panel. No devices, terminals, etc. shall be installed within this space, the space shall be provided for field conduit and wiring access only.

kk. Incoming phase conductor terminals shall be clearly identified. All wiring within the control panel shall be color coded or coded using electrical tape in sizes where colored insulation is not available. The following coding shall be used.

System	Wire	Color
Incoming 480 Volts 3 Phase	Phase A	Brown
	Phase B	Orange

	Phase C	Yellow
	Ground	Green
	Neutral (As Required)	White
Control	AC	Red
	DC	Blue
	Foreign	Yellow

3. Spare Parts

a. The following number of spare parts shall be furnished for each control panel.

1) 1 Indicator light assembly

2) 2 control relays for each type furnished

3) 5 fuses for each type/size furnished

4) 1 set thermal overloads for each size furnished

5) 1 selector switch for each type furnished

6) 1 starter coil for each size furnished

PART 3 EXECUTION

A. Installation

1. Mounting Stands

a. Field mounted disconnects, pushbutton control stations, etc, shall be mounted on 316 stainless steel stands as specified herein or as shown on the Drawings. Where clearance requirements for stands may not be maintained, the Engineer may direct equipment to be wall-mounted adjacent to the motor or device, but in no case shall the distance from the motor or device to the control station exceed 3-ft.

B. Cleaning

1. Clean the interior and exterior of electrical equipment in accordance with Section 16000.

END OF SECTION

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SECTION 16192 SURGE PROTECTIVE DEVICES

PART 1 GENERAL

A. Scope Of Work

1. Furnish and install all surge protective devices (SPDs), formerly referred to as transient voltage surge suppressors (TVSSs), for power systems as shown on the Drawings and as specified herein.

B. Related Work

1. Refer to Division 13 for SPDs for instruments, telecommunication systems, antenna systems, or computer systems.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, the following:

    a. Detailed catalog information with sufficient detail to determine compliance with the specifications including the electrical and physical characteristics.

    b. Minimum electrical ratings shall include operating voltage, voltage protection rating (VPR), frequency and phasing.

    c. Minimum performance ratings for type 1 and type 2 SPDs shall include nominal discharge current (In) rating, maximum continuous operating voltage (MCOV), and short circuit current rating (SCCR).

    d. UL 1449, Third Edition (minimum) listing compliance certification.

2. Warranty statement.

D. Reference Standards

1. The materials and installation shall comply with the codes and standards of the following organizations:

    a. American National Standards Institute (ANSI)
    b. Institute of Electrical and Electronic Engineers (IEEE)

c. National Electrical Manufacturers Association (NEMA)

d. National Fire Protection Association (NFPA)

e. Underwriters Laboratories (UL)

2. Specific codes and standards that apply include the following:

a. ANSI/IEEE C62.41 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits

b. ANSI/IEEE C62.45 – Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

c. NEMA LS-1 – (Rescinded August 19, 2009, replacement undetermined)

d. NFPA 70 – National Electrical Code, Article 285

e. NFPA 780 – Standard for the Installation of Lightning Protection Systems

f. UL 1283 – Electromagnetic Interference Filters

g. UL 1449 – Surge Protective Devices

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

E. Warranty

1. All SPD panel units shall be guaranteed by the installing contractor and surge suppression manufacturer to be free of defects in materials and workmanship for a period of not less than 10 years from the date of substantial completion of the system to which the suppressor is installed.

PART 2 PRODUCTS

A. Manufacturers

1. The following manufacturers are acceptable. No substitution will be allowed:

a. Josyln (Total Protection Solutions)

b. Surge Suppression Inc.

c. Current Technologies

B. Products

1. The SPD supplied shall be selected to match the voltage, phasing, and frequency of the power system.

2. The SCCR rating of the SPD shall have at least the same rating of the electrical equipment being protected.

3. The SPD enclosure shall be rated NEMA 12 for indoor dry locations and NEMA 4X for outdoor, wet, damp, chemical, or corrosive areas.

4. The SPD shall protect against surges produced by a 1.2 / 50 µs and 8 / 20 µs combination waveform generator.

5. SPDs at switchgear, switchboards, and motor control centers shall have a nominal discharge current (In) of at least 20 kA 8 / 20 µs per phase.

6. SPDs shall include noise filtration with a 10 kHz to 100 MHz range.

7. The SPD shall be of a parallel design using fast-acting energy protection that will divert and dissipate the surge energy for 480-volt distribution panels, switchgear, switchboards, substations and motor control centers.

8. The SPD shall provide LED indicator lights to provide continuous positive operational status of each protected phase. Indicator lights shall be visible without the need to open any compartments.

9. The SPD shall have a minimum of 10 mode operation for all three phase wye and high leg delta configurations, and six modes of protection for all three phases of delta (no neutral) configurations.

10. The voltage protection ratings (VPRs) shall not exceed the following:

System Voltage	Line-Neutral	Line-Ground	N-Ground	Line-Line
120 (2W+G)	600	600	600	n/a
240 (2W+G)	1000	1000	1000	n/a
120/240 (3W+G)	600	600	600	1200
120/208Y (4W+G)	600	600	600	1200
277/480Y (4W+G)	1200	1200	1200	1200
240Δ (3W+G)	1000	1000	1000	1000

11. SPD shall have a one nanosecond of less response time for any individual component, and shall be self restoring and fully automatic.

12. Minimum surge current ratings per mode shall be as follows:

    a. Distribution panels, switchgear, switchboards and substations (480V): 150 kA
    b. Motor control centers (480V):80 kA
    c. Branch panels and control panels (480V): 80 kA
    d. Branch panels (120/208/240V, single or three phase):40 kA

13. The fusing system shall be capable of allowing the rated maximum single impulse surge current to pass through without fuse operation.

PART 3 EXECUTION

A. Installation

1. Install surge protective devices as shown on the Drawings and in accordance with manufacturer’s instructions.

2. SPDs shall be installed with leads as short as possible (not to exceed 24-inches) and routed to avoid sharp bends or kinks.

3. SPDs may be mounted internally in motor control centers, switchgear or switchboards provided they are in an individual compartment.

4. SPDs may be mounted internally in variable frequency drives.

5. SPDs shall be mounted externally at panelboards and control panels.

END OF SECTION

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SECTION 16265 UNINTERRUPTIBLE POWER SUPPLIES

PART 1 GENERAL

A. Scope Of Work

1. Furnish and install stand alone uninterruptible power supplies (UPSs) for the power system as shown on the Drawings and as specified herein.

B. Related Work

1. Refer to Division 13 for UPSs provided as part of a control panel or other electrical equipment.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, the following:

    a. Detailed catalog information with sufficient detail to determine compliance with the specifications.

    b. Electrical characteristics including: kVA/kW rating, input and output voltage and phasing, frequency, battery run time at half and full load, voltage regulation and tolerances.

    c. Physical characteristics including: heat rejection, weight and dimensions.

    d. Battery specifications and hazardous material information.

    e. Installation instructions including power connections and control schematics. All external connections shall be fully detailed.

    f. Operation manuals.

    g. Field test reports.

2. Warranty statement.

D. Reference Standards

1. The materials and installation shall comply with the codes and standards of the following organizations:

a. American National Standards Institute (ANSI)

b. Federal Communications Commission (FCC)

c. Institute of Electrical and Electronic Engineers (IEEE)

d. National Electrical Manufacturers Association (NEMA)

e. National Fire Protection Association (NFPA)

f. Underwriters Laboratories (UL)

2. Specific codes and standards that apply include the following:

a. ANSI 62.41 / IEEE 587 – Standards for Surge Withstandability

b. FCC Rules and Regulations, Part 15, Subpart B, Class A certified compliance

c. NFPA 70 – National Electrical Code

d. UL 1778 – Standard for Uninterruptible Power Supply Equipment

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

E. System Description

1. Provide a continuous-duty, on-line, solid state, double conversion, uninterruptible power system.

2. The UPS shall provide power conditioning and power backup for critical electronic loads as indicated on the Drawings.

3. The UPS system shall consist of the following major components:

a. Rectifier and battery charger.
b. Inverter.
c. Batteries and battery disconnect switch.
d. Automatic static bypass switch.
e. External maintenance bypass switch.
f. Integral control and monitoring panel.
g. Other features as described in this specification and as indicated on the Drawings.

F. Warranty

1. All UPS units (except the batteries) shall be guaranteed by the installing contractor and the UPS manufacturer to be free of defects in materials and workmanship for a period of not less than three (3) years from the date of substantial completion of the system to which the UPS is installed. Warranty shall afford the Owner a full replacement of the required unit(s) at no additional cost.

PART 2 PRODUCTS

A. Manufacturers

1. The following manufacturers are acceptable. No substitution will be allowed:

   a. Emerson – Liebert GTX3

   b. Eaton PX9

   c. Schneider Electric – APC Symmetra LX

B. General Requirements

1. External Battery Enclosure: A separate enclosure shall be provided for housing additional batteries if required to provide the minimum run time as specified herein. The battery enclosure shall match the main UPS enclosure in style and color.

2. All cabling required to interconnect all components of the UPS system shall be provided by the UPS manufacturer.

3. Battery protection shall be provided an internal circuit breaker disconnect. Battery cabinets shall be protected by an internal circuit breaker.

4. Current limiting circuitry shall protect the inverter output under any load condition. High speed semiconductor fusing shall protect the static bypass in the event of an output short circuit.

5. The AC output neutral shall be electrically isolated from the UPS chassis. The UPS chassis shall have an equipment ground terminal. Provisions for installation of a bonding connector shall be provided.

6. The UPS shall be suitable for continuous use on generator power.

C. Performance Requirements – Ratings

1. Environment: Indoor, 0 to 40 degrees C, up to 3,300 feet, relative humidity up to 95 percent non-condensing.

2. Power: Minimum 5 kVA

3. Input Voltage: 208VAC, single phase

4. Input Voltage Variation: + 15%, -20%, 2 percent imbalance

5. Input Frequency: 60 Hz, +/- 5%

6. Output Voltage: 120/208VAC, single phase

7. Output Voltage Regulation: +/- 3%

8. Output Voltage THD: 5% or less at rated kW load

9. Battery runtime: Full kVA load for 15 minutes. Provide additional batteries in matching separate enclosure as required to meet the runtime requirement.

10. Electrical Connections: Hardwired input and output

D. Modes of Operation

1. Normal Mode: The UPS shall be a continuous online unit. Power to the critical loads shall be continuously generated by the inverter during normal AC line power. In the event of AC line power failure, power to inverter is supplied by the batteries. Under normal operation, the batteries shall be charged in a manner that optimizes battery life.

2. Static Bypass Mode: The internal automatic static bypass shall transfer the critical load to the commercial AC source, bypassing the UPS' inverter/rectifier, in the case of an overload, load fault, or internal failure.

3. Bypass Maintenance Mode: The external manual bypass switch shall be operated to transfer the load to the alternate source when the UPS is taken out of service for maintenance or repair. This transfer shall occur without interruption to the load.

E. Controls

1. Microprocessor-controlled circuitry: Fully automatic operation of the UPS shall be provided through the use of a microprocessor-based controller. All operating and protection parameters shall be firmware-controlled. The logic shall include system test capability to facilitate maintenance and troubleshooting including automatic battery system testing. Startup, battery charging, and transfers shall be automatic functions.

2. Graphical Display: The UPS control panel shall utilize an LED graphical display for all UPS control, monitoring, alarming, configuration and diagnostic functions. The following operational controls and indicators shall be provided on the UPS control panel per the following:

    a. UPS On/Alarm Silence/Manual Battery Test control

    b. Standby/Manual Bypass control

    c. Battery Metering – voltage, current

    d. Battery in operation status

    e. Load on Inverter status

    f. Load on By-Pass status

    g. AC input status

    h. UPS malfunction alarm

    i. AC Input Metering – voltage, current, kW, kVA

    j. AC Output Metering – voltage, current, kW, kVA

    k. Diagnostic Alarms: Specific details for all UPS alarms and status parameters shall be indicated on the graphical panel for diagnosis.

    l. Remote alarm and status indication: Isolated SPDT Form C dry contacts shall be provided to indicate UPS status for remote monitoring. Contacts shall be rated for 250VAC @ 5A or 30VDC @ 5A. Individual contacts shall be provided for separate annunciation of the following alarm and status conditions:

        1) UPS Normal (UPS is using utility power to power the load and detects no faults)
        2) UPS in Static bypass mode

3) UPS using battery to power the load
4) UPS on battery and battery low
5) UPS in Maintenance Bypass mode

F. SCADA Communications

1. Provide hardware and software to communicate UPS status and alarms over Ethernet using Modbus TCP/IP protocol.

G. Rectifier/Charger

1. The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be a solid-state SCR/IGBT power transistor type with constant voltage/current limiting control circuitry.

H. Inverter

1. The inverter shall include all solid-state equipment and controls to convert DC power from the rectifier/charger or battery to a regulated AC power for powering the critical load. The inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.

2. The inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent. The inverter is to provide 150 percent of full load for 30 seconds and 125 percent of full load for 2 minutes. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

3. The output voltage shall be maintained to within plus or minus 4 percent.

4. The output voltage total harmonic distortion (THD) shall not be greater than 5 percent for all loads. For 100 percent rated load of 3:1 crest factor nonlinear loads, the output voltage total harmonic distortion shall not be greater than 4 percent. The output rating shall not be derated in kVA or kW due to the 100 percent nonlinear load with 3:1 crest factor.

5. The inverter shall use software control to adjust the output voltage from plus or minus 5 percent of the nominal value.

I. Batteries

1. The batteries shall be VRLA (valve-regulated lead-acid), sealed, maintenance-free, high-rate discharge, lead-acid cells suitable for use indoors with no offgasing or water addition requirements. Batteries shall not require special ventilation. The battery shall consist of one or more battery banks with the number of cells required to meet the requirements of the rest of these specifications.

2. Battery Design Life: 5 years

3. Run time operation of the UPS shall be accomplished using batteries mounted within the UPS enclosure and supplemented as required with an external battery enclosure to provide the battery runtime specified.

J. Maintenance Bypass

1. Each UPS shall be provided with a "two-position" external bypass switch system to permits the UPS to be removed for repair or maintenance without causing power disruption to the connected power loads. The external bypass switch shall be snap-action type with switching speed approximately 10ms or less independent of operator action. External bypass switch positions shall be labeled UPS and UTILITY.

K. Enclosures

1. All UPS equipment shall be housed in a free standing NEMA 1 enclosure(s). The enclosures shall line up and match in style and appearance.

PART 3 EXECUTION

A. Installation

1. Install UPSs as shown on the Drawings and in accordance with manufacturer’s instructions.

B. Field Testing

1. Perform the following minimum test and checks:

a. Verify that all connections are completed in accordance with shop drawings.

b. Verify supply voltage and phase sequence are correct.

c. Check mechanical interlocks for proper operation.

d. Test ground connections for continuity and resistance.

e. Simulate and verify status and alarm conditions with reporting at SCADA: normal, on battery, on static bypass, on maintenance bypass.

f. Record battery runtime under full load with loss of AC power.

g. With plant generator system supplying the AC input power to the UPS, verify correct operation of UPS. (With frequency fluctuation due to generator operation, UPS should not rely on batteries to power load.)

END OF SECTION

SECTION 16370 VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required to manufacture, assemble, shop-test, and install variable frequency drives with integral isolation/phase shift transformers, as shown on the Drawings and as specified herein. Stand alone variable frequency drives shall be furnished by the equipment manufacturer as specified in Division 11. Other variable frequency drives shall be contained within the motor control centers specified under Section 16480.

2. These specifications are intended to give a general description of what is required, but do not cover all details that will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the variable frequency drives herein specified.

3. The Contractor shall furnish only one manufacturer of variable frequency drives as specified herein. That is, the stand alone VFDs shall be the same manufacturer as the motor control center manufacturer specified under Section 16480.

4. The work shall include the services of factory representatives of the variable frequency drive manufacturers to inspect the final installation, to perform field acceptance tests on the installed equipment and to instruct the regular operating personnel in the care, operation and maintenance of equipment.

B. Related Work

1. Concrete for equipment pad is specified in Division 3.

2. Pumps are specified in Division 11.

3. Motors are specified in Section 16150.

4. Motor Control Centers are specified in Section 16480.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following:

    a. Copy of this specification confirming compliance with each paragraph.

    b. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations. Details to also include front elevations with designation of devices and equipment on door(s) and internal to the enclosure. Internal layout of components including dimensions and space requirements. Standard preprinted sheets or drawings simply marked to indicate applicability to this contract will not be acceptable.

    c. Descriptive literature, bulletins and/or catalogs of the equipment.

    d. Data on the characteristics and performance of the variable frequency drives. Data shall include certification that the variable frequency drives are warranted for use with the motors specified in Division 11 and Section 16150. Data shall include:

        1) Efficiencies and power factor.

        2) Continuous and fault ratings of drive and disconnecting means.

        3) Maximum heat dissipation from enclosure.

    e. Complete drawings shall be furnished for approval before proceeding with manufacture and shall consist of job specific master wiring diagrams, elementary or control schematics including coordination with other electrical control devices operating in conjunction with the variable frequency drive, and suitable outline drawings with sufficient details for locating conduit stub-ups and field wiring. Due to the complexity of the system, it is imperative the above drawings be clear and carefully prepared to facilitate interconnections with other equipment. Standard preprinted sheets or drawings simply marked to indicate applicability to this contract will not be acceptable.

f. The total weight of the equipment including the weight of the single largest item.

g. A complete total bill of materials of all equipment.

h. Manufacturer’s warranty.

i. Field test and inspection reports.

j. Operation and maintenance manuals.

k. A list of the manufacturer's recommended spare parts with the manufacturer’s current price for each item.

D. System Description

1. The stand alone variable frequency drives specified hereinafter will be furnished as a complete system as specified in Division 11. The Contractor shall coordinate with the manufacturer of the Division 11 equipment to ensure the installation compatibility of the equipment.

2. The variable frequency drives integrated within motor control centers shall be coordinated by the Contractor to ensure complete compatibility between the variable frequency drive and the Division 11 equipment.

3. The variable frequency drives will operate motors as specified in Division 11 and Section 16150. The drives furnished herein under shall be totally compatible with the Motors to be supplied.

4. Additional controls shall be provided as required by Division 11 and 13 and as shown on the drawings.

E. Delivery, Storage and Handling

1. 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.

2. All equipment and spare parts must be properly protected against any damage during a prolonged period at the site.

3. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

4. Each box or package shall be properly marked to show its net weight in addition to its contents.

F. Tools and Spare Parts

1. One (1) set of all special tools required for normal operation and maintenance shall be provided.

2. One programming interface cable along with one copy of the manufacturer's software program to allow the Owner to reprogram drive parameters easily.

3. One HMI standard keypad.

4. The manufacturer shall furnish a complete list of recommended spare parts necessary for the first five (5) years of operation.

5. A list of the manufacturer's recommended spare parts with the manufacturer's current price guaranteed for one year for each item.

6. One spray can of enclosure touch-up paint.

G. Qualifications / Manufacturers

1. Variable speed drives shall be of sufficient size for the duty to be performed and shall not exceed their full-rated capacity (horsepower and ampacity) when the driven equipment is operating under full load conditions.

2. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement. The equipment furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

3. All equipment furnished under these Specifications shall be new and unused and shall be the standard cataloged product of a manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of five (5) years.

4. The variable frequency drive manufacturer shall maintain, as part of a national network (United States), engineering service facilities within 250 miles of the project site to

provide start-up service, emergency service, calls, repair work, service contracts, and maintenance and training of customer personnel. When requested by the Engineer, documentation shall be provided showing compliance, capabilities and references for this requirement.

5. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

6. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

7. Approved manufacturers: Eaton/Cutler-Hammer, Square D or ABB. No other manufacturers shall be accepted.

H. Operating Instructions

1. The operating and maintenance manuals shall be furnished in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

2. A manufacturer’s factory trained person, who has complete knowledge of proper operation and maintenance of the specified equipment, shall provide all the instruction and training as specified herein. This shall be done in conjunction with and coordinated with the O&M instructions to be provided for the equipment, motors and motor control centers.

3. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the System being supplied.

4. The manufacturer shall provide classroom training detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project as per Section 01730.

5. The manufacturer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.

6. The training program shall represent a comprehensive program covering all aspects of the VFD and maintenance of the system.

7. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

8. On-site Training: On-site (field) training shall be conducted at the Owner's site and shall provide detailed hands-on instruction to Owner's personnel covering: system debugging, program modification, trouble-shooting, maintenance procedures, calibration procedures, and system operation. The training shall run at times chosen by the Owner. The training shall be conducted for the time period as specified in Section 16000.

9. The Owner may record the training for future training by the Owner.

I. Warranty

1. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of three (3) years.

2. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the machine(s) and the unit(s) restored to service at no additional cost to the Owner.

3. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

J. Extended Warranty (Bid Additive Alternate)

1. If authorized by the Owner, Contractor and equipment manufacturer shall extend the initial warranty period listed in the previous paragraph for a period of two (2) years, bringing the total warranty coverage up to five (5) years.

2. The extended warranty shall include all terms and conditions required to be provided by the Owner to maintain the terms of the warranty.

K. Harmonics Study

1. Not required.

PART 2 PRODUCTS

A. General

1. The Contractor shall furnish and supervise installation of variable frequency drives as described in this specification and as detailed on the applicable Drawings.

2. The Contractor shall be responsible for the erection, installation, and start up of the equipment covered by this specification.

3. The variable frequency drive shall comply with the latest applicable standards of ANSI, NEMA, IEEE, and the National Electrical Code.

4. Variable frequency drives shall operate as specified on existing or new standby generators or normal power sources.

5. Variable frequency drives shall be 6 pulse (or greater) for less than 100 HP. If greater than 6 pulse is provided for less than 100 HP, the variable frequency drives shall utilize a phase shift transformer and cancellation technique. Variable frequency drives shall utilize a phase shift transformer and 18 pulse (or greater) cancellation technique for 100 HP and larger.

6. VFD Service Conditions

   a. Elevation up to 3,300 feet.

   b. Ambient temperature up to 40 degrees Celsius.

   c. Relative humidity less than 95 percent, non-condensing.

   d. Input voltage variation minus 10 percent to plus 10 percent, maximum 2 percent imbalance.

   e. Input frequency variation plus or minus 5 percent.

7. VFD Ratings

   a. The rated input power shall be 480 Volts, 3 Phase, 60 Hz.

   b. VFD input shall be rated for 65 kA short circuit.

   c. The rated output power shall be 480 Volts, 3 Phase, 00 to 60 Hz.

d. Output speed regulation shall be plus or minus 0.5 percent, without encode or tachometer feedback.

e. The power unit rating basis shall be 100% rated current continuous.

8. VFD Performance

a. The VFD shall be capable of 110% overcurrent for 1 minute, every 10 minutes for variable torque loads (centrifugal fans, pumps, etc.). The VFD shall be capable of 150% overcurrent for 1 minute, every 10 minutes for constant torque loads (extruders, mixers, reciprocating compressors and pumps, conveyors, etc.).

b. The minimum VFD system efficiency shall be 96% at 100% speed and 100% torque and exceed 90% at 50% speed and load. Variable frequency drive efficiency shall be defined as drive output power at the motor output terminals divided by the input power at the line side of the main circuit breaker.

c. The variable frequency drives shall maintain the line side displacement power factor no less than 0.95 regardless of speed and load.

d. Motor Compatibility:

1) The VFD shall be capable of operating a motor with variable torque type loads with a minimum speed range of 0-60 Hz.

2) The VFD shall be capable of providing breakaway torque for the pump.

3) VFD system shall provide an output waveform that will allow utilization of standard motors, without need of any special insulation or derating. Motor life expectancy should not be compromised in any way by operation with the VFD system. The system must comply with all elements of the Output Harmonics section of this specification. The VFD must provide motor overload protection in any operating condition.

4) VFD output waveform shall be suitable for operating a standard squirrel cage induction motor without derating or requiring additional service factor.

5) VFD shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. The VFD system shall be designed to produce no standing waves or overvoltage conditions based on a maximum cable length of 1,000 feet. Provide an output filter integral to the VFD if required to meet this requirement.

e. The drive shall be capable of riding through a power outage of up to 5 cycle duration, without causing the drive to shutdown.

f. When the power is restored after a complete power outage, the VFD shall be capable of catching the motor while it is still spinning and restoring it to proper operating speed. The variable frequency drives shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the variable frequency drives shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor in the preset method of starting.

g. The VFD shall be capable of producing a variable AC voltage/frequency output to provide continuous operation over the normal system 30-100% speed range. The VFD must be capable of sustained operation at 1/10 speed to facilitate checkout and maintenance of the driven equipment. As a commissioning and troubleshooting feature, the VFD power circuit shall be capable of operating without a motor connected to the VFD output.

h. Auto-Restart Capability. The VFD system must be capable of automatically restarting in the event of a momentary loss of power, or a clearing of a drive trip. The VFD system shall provide the user with the choice of automatically restarting or not. The user shall be able to selectively apply this feature to some but not all conditions as appropriate for the specific application.

i. Motor Sound Level. All VFDs must be selected for operation at carrier frequencies at or above 8 kHz without de-rating to provide quiet motor operation. Audible motor noise, while operating under VFD control, shall be limited to 3 dB(A) above the amount of noise generated across the line measured at one meter from the motor. Should the motor generate more

audible noise than specified, the VFD manufacturer shall, at no charge, provide sound shielding for the motor such that the installation meets the above performance specification.

B. Construction

1. The variable frequency drives (VFD) shall be rated at 480 VAC input with features and options as specified.

2. The variable frequency drives shall be rated for the HP, full load current and rpm of the motor. The variable frequency drives shall be designed to provide microprocessor-based continuous speed adjustment of three-phase motors. The variable frequency output voltage shall provide constant volts-per-Hertz excitation for the motor up to 60 Hertz. The variable frequency drives shall be optimized for an adjustable or selectable carrier frequency to reduce motor noise. The carrier frequency shall be field adjustable and adjusted by the manufacturer’s field engineer during start up.

3. The variable frequency drives shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency output via a two-step operation. Variable frequency drives utilizing a third power section are not acceptable. Adjustable Voltage and Current Source variable frequency drives are not acceptable. Transistors shall be used in the inverter section. GTOs and SCRs are not acceptable.

4. The variable frequency drives shall be current regulated. Variable frequency drives permitting instantaneous overcurrent trips other than an output short circuit are not acceptable.

5. Stand alone variable frequency drive enclosures shall be NEMA Type 1, gasketed, filtered, freestanding floor-mounted (100 HP and larger), force ventilated (with replaceable air filters) construction requiring front access only. Variable frequency drives up to 75 HP may be wall mounted type meeting all enclosure rating requirements, etc. specified herein. Variable frequency drives requiring rear access for any maintenance are not acceptable. The cooling air required to dissipate heat generated by the power electronics shall be isolated from all drive electronics. Variable frequency drives using liquid-cooled assemblies in conjunction with associated pumps, piping, and separate remote mounted exchangers are not acceptable. The inverters and converters shall have

complete unobstructed front accessibility with easily removable assemblies. The complete enclosure shall maintain a constant height, width and depth. The height for all floor-mounted enclosures shall be 90" high. The enclosures shall include the integral isolation/phase shift transformer (as required) and shall not be more than:

Stand Alone VFDs:

a. WAS Pumps (for Clarifiers 7/8)(5 hp) 20"W x 16"D

b. WAS Pumps (for Clarifier 9) (7.5 hp) 24"W x 20"D

c. RAS Pump (for Clarifiers 10/11) (20 hp) 26”W x 16”D

6. All variable frequency drive programmable parameters shall be adjustable from a digital operator keypad located on the front door of the variable frequency drive. Parameters shall include:

   a. Programmable maximum and minimum frequency.

   b. Programmable acceleration and deceleration times.

   c. Selectable carrier frequencies, V/Hz, and critical frequency avoidance lockout.

   d. Adjustable electronic overload and torque limits.

   e. Multiple attempt restart following utility outage or fault condition.

   f. Jog, thread, and preset speeds.

   g. Keypad lockout and factory default overrides.

   h. Adjustable slip compensation (+/- 5%).

7. The variable frequency drives shall be additionally equipped with a digital operator station mounted on the enclosure front door. Control operator devices and indication lights shall include:

   a. Local digital speed control.

   b. Hand-Off-Remote control selector switch.

   c. LED status lights for each HOR position.

d. Momentary start/stop push buttons utilized with the HOR in “Hand”.

e. Local-Remote speed control selector switch.

f. LED status lights for each Local-Remote position.

g. LED status lights for run, fault, alarm, up-to-speed, power on, and drive ready status.

h. Additional controls as required by Division 11 and 13 and as shown on the drawings. Pump Failure will require pump fail timer (as required). Provide for terminations of remote mounted operator control devices and field devices.

8. The variable frequency drives shall have the following system interfaces:

a. Inputs:

1) Two (2) isolated process control speed reference interfaces to receive and isolate 0-10 Vdc or 4-20 mAdc signals.

2) Dedicated terminal blocks for interface with remote operator and field devices.

3) 120 Vac control to allow variable frequency drives to interface with remote contacts and with two or three-wire control.

4) Additional inputs as required by Division 11 or 13 and as shown on the drawings.

b. Outputs:

1) Two (2) analog output signals 0-10 Vdc or 4-20 mAdc for external metering.

2) Run relay with an isolated set of form C contacts.

3) Dry contact output (N.O.) to indicate protective function trip.

4) Dry contact output (N.O.) to indicate common alarm.

5) Additional outputs as required by Division 11 or 13 and as shown on the drawings.

9. System Communication

a. VFD’s shall be provided with interfacing hardware, software, etc. as required for control and monitoring from the plant computer system. The VFD’s shall include external communications link to the plant computer system via Ethernet cable using Modbus TCP/IP communication protocol as shown on the Instrumentation drawings. Communications between individual VFDs and the SCADA network shall be in a star configuration. The manufacturer shall be responsible for complete coordination and compatibility with the plant computer system specified under Division 13 and the VFD’s. Proof of coordination with Division 13 shall be included with the VFD submittals.

b. 24VDC power supplies associated with communication system shall be provided with UPS / battery backup to allow for ride-through for plant generator start and transfer.

10. Monitoring and Displays:

a. The variable frequency drives shall have a vacuum fluorescent display indicating monitored functions as described in the following paragraph.

b. The following parameters shall be monitored:

1) Input current (3 phases)

2) Input voltage (3 phases)

3) Output current (3 phases)

4) Output voltage (3 phases)

5) Output frequency

6) Kilowatts

7) Drive temperature

8) Time

9) Date

10) Motor rpm

11) Eight (8) most recent trips/faults

11. Protection Functions:

a. The variable frequency drives shall have the following protective features, with indication for **1)** through **9)**:

1) Speed compensated electronic motor overload current.

2) Undervoltage.

3) Overfrequency.

4) Overtemperature.

5) Ground Fault.

6) DC bus protection.

7) Inrush current limit (adjustable 50 to 150%).

8) Input and output phase loss.

9) Emergency stop pushbutton (Red mushroom head and maintained).

10) Current limiting fuses shall be provided on the input side of the VFDs to protect against fault currents up to 200,000 A sym.

11) The output side of the VFDs shall be equipped with a current limiting reactor to reduce the dv/dt.

12) Phase insensitive to input power.

13) Surge protection from input AC line transients at line side of main circuit breaker.

14) Electrical isolation between the power, control and logic circuits.

15) Drive to be capable of withstanding output terminal line short or open circuits without component failure.

12. Additional Features shall be provided as follows:

    a. The variable frequency drives shall be equipped with a flange mounted molded case input circuit breaker (65,000 AIC minimum). The breaker shall be interlocked with the enclosure doors to prevent access to the variable frequency drive unless the breaker is in the open position and to prevent moving the breaker to the ON position while the unit door is open. The circuit breaker shall have provisions for padlocking in the open position. Provide mechanical interlocks on doors of auxiliary sections of multi-bay or multi-cubical cabinets. Handle height shall not exceed NEC requirements when VFD is located on 4-inch high housekeeping pad.

    b. Fused space heaters with thermostat to minimize condensation potential upon drive shutdown.

    c. The variable frequency drives shall be variable torque design. Provide constant torque design as required by Division 11.

    d. Variable frequency drives shall be capable of unidirectional operation.

    e. Variable frequency drives shall have 115 VAC control power for operator devices.

    f. Control relays shall be machine tool type, heavy duty type, industrial grade, 600 volt, 10 amp rating, Square D, Class 8501, Type X or equal.

    g. A copper ground bus.

    h. A separate door-mounted elapsed time meter.

    i. All bus and exposed copper shall be tin plated.

    j. All stand alone floor mounted enclosures shall have complete 18" (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All stand alone wall mounted enclosures shall have complete 12" (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.

    k. A switchable fluorescent light within each floor mounted section of the enclosure for stand alone VFDs.

l. Barriers on terminals that are energized with the power disconnect OFF.

m. All circuit boards shall be conformal coated to help protect them from hydrogen sulfide gases.

13. Identification

a. All wiring shall be numbered at each end with typed sleeved type labels at each termination. Labels shall correspond to the wiring diagrams. Wiring less than 6 inches may be numbered at only one end.

b. Provide warning signs on terminals that are energized with the power disconnect OFF.

c. Provide 2-inch by 5-inch, nominal, engraved three-layer laminated plastic master nameplates on each VFD fastened with stainless steel screws or rivets. Nameplates shall be black letters with white background core, 3/8-inch high lettering and shall indicate equipment designation as shown on the Drawings.

d. Provide legend plates or 1-inch by 3-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.

e. Provide permanent warning signs as follows:

1) "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.

2) "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT".

14. The isolation/phase shift transformers shall be provided as follows:

a. Transformers shall be dry type, self ventilated, with insulation for 100 degrees C average temperature rise above 30 degrees C ambient at full continuous operation and shall be suitable for site ambient and altitude. Each shall be equipped with 120 volt single phase space heater(s) for moisture control.

b. Transformer windings shall be copper and exposed copper and bussing shall be tin plated.

c. Impedance shall be selected by the drive system designer.

d. Transformer shall be designed for Inverter duty service with three phase, twelve-pulse or greater static power converter connected to the secondary windings. The increased eddy and stray losses due to harmonic currents shall be minimized and shall be included in the specified temperature rise.

e. A high temperature alarm and indication shall be provided.

f. Standards: The transformer shall meet the general requirements of ANSI C57.12.00 plus the applicable requirements of ANSI C57.18 (since it is for rectifier service). Tests shall be per ANSI C57.12.90. Additional dry type transformer construction requirements:

1) Noise Level: The maximum sound level shall not be excessive and shall conform to NEMA Standard TR27-5.09.

2) Nameplates: Nameplates, warnings, connection diagrams, etc., shall be in accordance with ANSI C57.12.00.

3) Factory Tests: The routine tests listed in ANSI C57.12.00 shall be conducted on all transformers.

4) Outline Drawings: To include weight, center of gravity, losses at rated load, DC resistance at 25 degrees C. and nameplate data.

g. Transformer shall be integral to VFD enclosure.

C. Shop Testing

1. The manufacturer shall perform factory tests in accordance with manufacturer’s standards.

2. All printed circuit boards shall be heat run tested at 50 degrees C for a minimum of 16 hours, or per manufacturer’s standard test procedure to minimize infant mortality failures. Boards that exhibit drift during the heat run test shall be replaced with boards that have completed the heat run without drift.

3. All electronic components, i.e. power transitors, diodes, insulated gate bipolar transistor (IGBT), and micro chips shall be functionally tested to insure reliability.

4. Upon Engineer’s request, the variable frequency drive manufacturer shall submit the actual test data.

D. Shop Painting

1. Prior to shop painting, all surfaces shall be thoroughly cleaned, dry, and free from all mill/scale, rust, grease, dirt, and other foreign matter.

2. Variable frequency drive enclosures shall be shop painted.

PART 3 EXECUTION

A. Installation

1. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Field wiring shall be in accordance with manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

B. Contractor Field Testing

1. Make the following minimum tests and checks before the Manufacturer’s representative is called in for start-up and adjustment.

   a. Verify that all connections are completed in accordance with shop drawings.

   b. Verify supply voltage and phase sequence are correct.

   c. Verify nameplate data in field of both driven equipment and VFD for conformance with approved submittals and compatability.

   d. Check mechanical and electrical interlocks for proper operation.

   e. Test ground connections for continuity and resistance.

   f. Verify room air conditioning system is in operation.

2. The Manufacturer’s service technician shall perform start-up and adjustment of the VFD system.

C. Start-Up and Adjustment

1. The Contractor shall notify the Engineer two weeks prior to all field tests. The Engineer shall have the option to witness all tests in the field.

2. Field Tests:

   a. Field tests of the drive shall be made by the manufacturer who will furnish all equipment and record all data. The Contractor shall be present during testing.

   b. Field tests are the basis of demonstrating equipment proficiency and correct operation.

   c. If the drive performance does not meet the Specifications, corrective measures shall be taken or the drive shall be removed and replaced with a drive which satisfies the conditions specified. A seven (7) day 24 hour (actual operation) operating period as specified herein of the drive will be required before acceptance. The Contractor shall provide for seven (7) day 24 hour (minimum) on-site supervision of the field acceptance tests. If a drive fails to perform and must be replaced, the rejected drive shall not be removed until the replacement drive has been delivered to the site. If corrective measures are to be taken, such measures shall be done on-site at such times as convenient to the Owner. The Owner shall be allowed to use any drive supplied immediately following installation and testing whether or not the equipment meets the conditions specified.

   d. Factory representatives of the manufacturer who are competent and experienced and who have complete knowledge in the proper operation and maintenance of the equipment shall be provided to inspect and supervise the installation of the equipment and supervise the initial test run. The first visit will be for checking and inspecting the equipment during installation. The second visit will be to operate and supervise the initial field test. If problems are encountered in operation of the equipment additional service shall be provided at no additional cost to the Owner. These services are in addition to the services required for training.

e. Training will not be permitted until all equipment is fully operational. In the event that the equipment becomes inoperable under warranty provisions, additional training will be provided at no additional cost to the Owner as follows:

Inoperable Period	Additional Training
0-2 weeks	None
2-6 weeks	2 days
More than 6 weeks	5 days

f. All training shall be coordinated and conducted concurrently with training to be supplied by the equipment and motor manufacturers.

g. Functional Test: Prior to plant start-up, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Submit test procedure for review and approval by the Engineer.

h. Vibration Test: Vibration analyses shall be performed on the equipment when operating the variable frequency drive through its entire speed range. Where loads and drives are separated by intermediate flexible shafting, vibration shall be measured both at the top motor bearing and at two points on the equipment bearing, 90 degrees apart.

i. Performance Testing: Demonstrate system performance by operating the system for a seven (7) day continuous period while varying the application load, as the input conditions allow, to verify system performance. Record all data necessary to document the successful performance of the system. Provide all instruments, equipment, and labor required to accomplish this test. If a unit fails the performance test, the supplier will be allowed to readjust and retest the system. If the unit fails the second test, the unit will be rejected and the Contractor shall furnish a unit that will perform as specified.

j. Check each alarm and detection device for proper operation.

k. The drive manufacturer shall provide all necessary personnel and equipment necessary to properly start-up and pass all tests at no additional cost to Owner.

l. A copy of all tests and checks performed in the field complete with meter readings and recordings, where applicable, shall be submitted to the Engineer.

D. Cleaning

1. Clean the interior and exterior of electrical equipment in accordance with Section 16000.

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SECTION 16410 UNIT SUBSTATIONS

PART 1 GENERAL

A. Scope of Work

1. Furnish and install outdoor unit substations as hereinafter specified and as shown on the Drawings.

2. All units shall be complete from the incoming primary switch to the secondary distribution.

3. The unit substations shall be front aligned and arranged as indicated on the Drawings.

4. The primary switch operating handle and the transformer nameplate shall be the front of the unit substation.

5. All exposed current carrying parts shall be tin plated copper. All cable terminations shall be insulated.

6. The unit substations shall not exceed the physical size shown on the Drawings.

7. The outdoor enclosure, including the primary switch, transformer, and secondary compartments, shall be phosphate cleaned to remove oxide film and painted with electrostatic dry power polyester base paint to 4 mils thick. The enclosures shall be rated NEMA, Type 3R. Unit substations paint color shall be ANSI-61 or ANSI-49 light grey.

8. Substation shall be provided with pulling eyes, jacking facilities and lifting lugs on each shipping section to set the substation in place.

B. Related Work

1. Concrete for equipment pad is specified in Division 3.

2. Power System Study is specified in Section 16000. The preliminary short circuit study shall be approved by the Engineer before the substation submittal will be reviewed.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, the following:

a. Copy of this specification confirming compliance with each paragraph.

b. Construction Details

1) Complete construction details shall be furnished for approval before manufacture. Details shall include front, plan and sectional views of the substation, incoming line equipment, transformer, secondary distribution, elementary and wiring schematic diagrams.

c. Manufacturer’s warranty.

2. Each bidder shall also submit to the Engineer for his approval a complete listing of all full-size transformers of his manufacture within the category covered by these specifications that have been short-circuit tested. This list shall designate complete ratings and shall also point out whether these tests were performed on developmental units or on customer units. In the case of units tested for or by the ultimate customer, indication shall be given on each unit as to whether the test was successful or unsuccessful and, if tested more than once, each subsequent test shall be so listed and appropriate comments given as to design changes made, if any. Shop drawing submittals shall clearly show proof that the transformers are in compliance with "Distribution and Power Transformer Short-Circuit Test Code in ANSI C57.12.91".

D. Reference Standards

1. American National Standards Institute (ANSI)

2. Institute of Electrical and Electronics Engineers (IEEE)

3. National Electrical Manufacturers Association (NEMA)

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

E. Maintenance

1. Provide the following spare parts in the quantities specified:

a. For each primary switch, provide three (3) spare primary fuses.

b. Three dozen each of cover bolts, cage nuts and door fasteners.

c. One quart of touch-up paint.

d. Ten (10) replacement lens caps.

e. Ten (10) pilot lamps of each size and voltage.

f. Ten (10) control power fuses of each size.

2. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of the package. Identify each item with manufacturer's name, description and part number.

F. Qualifications

1. The unit substation shall be the product of a manufacturer who shall also be the manufacturer of the primary switch and secondary distribution equipment. Manufacturer shall take complete responsibility for transformers purchased from third parties.

2. Each unit substation shall consist of a primary switch, a transformer, and secondary power distribution section combined as an integral unit.

3. The unit substations shall be Eaton/Cutler-Hammer, Schneider Electric/Square D Company, or ABB.

G. Warranty

1. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of three (3) years.

2. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the machine(s) and the unit(s) restored to service at no additional cost to the Owner.

3. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

H. Extended Warranty (Bid Additive Alternate)

1. If authorized by the Owner, Contractor and equipment

manufacturer shall extend the initial warranty period listed in the previous paragraph for a period of two (2) years, bringing the total warranty coverage up to five (5) years.

2. The extended warranty shall include all terms and conditions required to be provided by the Owner to maintain the terms of the warranty.

PART 2 PRODUCTS

A. Primary Switch

1. Rating:

a. Each primary switch shall be designed for 12,470-volt, 3-phase, 3-wire, resistance grounded, 60-Hertz service.

2. Switch:

a. The switch shall be fused.

b. The switch shall be 3-pole, load break, air interrupter, front operable, gang operated, stored energy closing and opening.

c. The switch shall be equipped with arc chutes and barriers between poles and the rear cable compartment.

d. The switch shall have the following rating:

1) Continuous and interrupting ratings shall be 600 Amps.

2) Momentary and fault-close ratings shall be 40,000 Amps asymmetrical.

3. Buses:

a. Buses shall be tin plated copper rated not less than 600 Amps.

b. Each bus bar shall be totally-enclosed with insulating material.

c. A ground bar with grounding lugs for the incoming cable and connection to the ground grid system shall be furnished.

4. Construction:

   a. The primary switch shall consist of one or more metal enclosed cubicles and one termination cubicle. One cubicle shall contain a two-position switch with stored energy mechanism for both closing and opening. The cable termination cubicle shall house the incoming line lugs (refer to Drawings for quantity and size).

   b. Three low sparkover 15 kV distribution type lightning arresters shall be mounted in the switch compartment.

   c. The cubicle shall have a separate compartment below the switch suitable for a set of self-contained power fuses.

   d. All switch and fuse enclosures shall include internal barriers to fully isolate switches from each other, from the lightning arresters and the fuses, and from the rear cable termination compartments. Barriers between devices shall be of rigid non-tracking, flame resisting, self extinguishing, non-hygroscopic insulating material. When it is necessary to take bus or cable connections through barriers, close fitting insulating sleeves or bushings shall be provided. Provide insulating interphase barriers between the current limiting fuses and different phases of high voltage primary.

   e. Viewing windows of not less than 1/4-inch safety glass shall be furnished.

   f. The fuse compartment door shall be interlocked so that the door may not be opened unless the switch is opened. The fuse compartment shall be at the bottom of the enclosure.

   g. The switch cubicle shall have a thermostatically controlled 120V heater, unswitched, to prevent condensation, with control power generated from the unit substation.

   h. Conduits shall enter the terminal compartment from above or below.

5. Key Interlocks

   a. Provide Kirk® key interlock (no substitution) to prevent opening of lightning arrester section unless switch is open.

b. Provide Kirk® key interlock (no substitution) to prevent opening of switch unless secondary main breaker is open.

6. Fuses

a. Fuse holders for current limiting primary fuses shall be provided to accommodate power fuses similar to or equal to General Electric Co. Type EJ-1, 15 kV class. Each fuse holder shall be fitted with a fuse of the current rating required for the specified transformer.

b. Current limiting fuses shall have a minimum short circuit rating of 40,000 amperes rms symmetrical and shall be of a size to provide proper protection of the transformer and coordination with secondary main and up-stream feeder breakers.

7. Accessories:

a. Provide engraved, laminated phenolic nameplates (black letters on a white background) attached with stainless steel screws. Nameplate to identify each primary switch compartment. Nameplates shall be approximately 2" x 3". Lettering on the switch shall identify system loop and fed from switch, i.e.

LOOP 1
FED FROM SW 09

B. Transformer Section

1. The transformer shall be liquid filled with biodegradable food grade oil, dual rated 55°/65°C rise over 40°C ambient at full load continuous operation.

2. The primary winding shall be rated for 12,470 volts, 110 kV BIL, with four approximately 2-1/2 percent rated KVA taps, two above and two below rated primary voltage. Taps shall be accessible from a terminal board from front of unit. The secondary shall be rated (480Y/277V), 3-phase, 4 wire with the mid-point (wye) connection insulated for grounding. Each low voltage connection shall be provided with a flexible section for minimizing transmission of noise to switchgear. Impedance shall be 5.75 percent minimum on the self-cooled KVA base.

3. Transformer accessories shall include sound isolating pads of neoprene rubber under each core/coil mounting point,

ground pad, on low-voltage end, provisions for rolling and skidding in any direction, diagrammatic nameplate, thermometer (one in each winding) and high winding temperature alarm switch for a remote alarm and fan operation, fan control and monitoring shall be Life Guard-85 as manufactured by Square D Co. or equal. An indicator shall be provided to display each windings temperature. Fans for forced air cooling shall be provided. Forced air-cooled capacity shall not be less than 115 percent of self-cooled rating at 55°/65°-rise. Fans shall operate on 120-volt power supplied a 480-volt to 120-volt control power transformer located in the secondary section of the substation. A fused disconnecting means shall be provided for the fan power.

4. Buswork for the high-voltage delta connection shall be bolted to connectors on the face of the coils. Low-voltage buswork shall be assembled and supported by the core clamping structure.

5. Transformer core shall be of grain-oriented silicon steel which has been slit, sheared, and annealed at the transformer manufacturer's plant, to relieve stress and to be burr-free. Boltless core construction shall be employed to provide rigidity and strength, to reduce stress on the laminations and flux concentration in the core. The outer surfaces of the core steel shall be coated with a moisture-resisting material to prevent atmospheric corrosion.

6. Windings shall be copper and shall closely match the expansion and contraction properties of the insulation system.

7. Enclosures shall be constructed of heavy gauge sheet metal with flanges to mate with incoming and outgoing sections.

8. The following standard factory tests shall be run on each unit manufactured and shall be made in accordance with the latest revision of ANSI Test Code for Transformers, C57.12.91.

    a. Resistance measurements of all windings on the rated voltage connection.

    b. Ratio test on the rated voltage connection and on all panel connections.

    c. Polarity and phase relation tests on the rated voltage connection.

d. No load loss at rated voltage on the rated voltage connection.

e. Exciting current at rated voltage on the rated voltage connection.

f. Impedance and load loss at rated current on the rated voltage connection of each unit.

g. Applied potential tests.

h. Induced potential test.

9. Certified test reports shall be furnished (on request) for the above standard test of each unit.

10. Transformer shall have a paint finish same as the low-voltage section.

11. The transformer shall meet the general requirements of ANSI C57.12.01 plus the applicable requirements of ANSI C57.110. Tests shall be per ANSI C57.12.91. Additional transformer construction requirements:

    a. Noise Level: The maximum sound level shall not be excessive and shall conform to NEMA Standard TR1.

    b. Nameplates: Nameplates, warnings, connection diagrams, etc., shall be in accordance with ANSI C57.12.01.

    c. Factory Tests: The routine tests listed in ANSI C57.12.01 shall be conducted on all transformers.

    d. Outline Drawings: To include weight, center of gravity, losses at rated load, DC resistance at 25 degrees C. and nameplate data.

12. Accessories:

    a. Diagrammatic stainless steel nameplate mounted on the front enclosure panel.

    b. Provide engraved, laminated phenolic nameplate (black letters on a white background) attached with stainless steel screws. Nameplate to identify unit substation. Nameplate shall be approximately 2" x 3". (i.e. SUB No. 01).

C. Secondary Distribution

1. Rating:

   a. Service: 480/277 Volt, 3 Phase, 3 or 4 Wire, 60 Hz as shown on the Drawings.

   b. The distribution section and protective devices shall have a fully rated, short circuit rms symmetrical amp withstand rating as noted on the drawings.

   c. The continuous current rating of the bus shall be equivalent to the frame size of the main circuit protective devices as shown on the Drawings. The bus shall be designed to carry its rated continuous current in the specified ambient temperature without exceeding the temperature rise limits specified in ANSI Standard C37.20.1. Bus bracing shall exceed the specified equipment short circuit rating. Line and load bus connections to feeder devices shall be rated to carry the full continuous current of the device frame.

   d. The distribution section, including devices shall be designed for continuous operation at its rated current in a 40 degree C ambient temperature.

2. Buses:

   a. All buswork shall be tin plated copper, with bolted connections. All bus bars shall be 98 percent conductivity copper with a current density of 1,000 amperes per square inch. Surfaces shall be tin-plated by the Alstan 70 (or comparable) process to have a uniform appearance, free of blisters. The bus structure shall be mounted on supports of high impact non-tracking insulating material. Bus bars shall be uniformly arranged to provide A-B-C sequence left to right (from front), front to rear and top to bottom.

   b. Bus bars shall not be tapered. Bolted connections shall be made with high strength bolts and locking hardware. Individual horizontal and vertical phase bus bars shall be insulated where industry standard 600 Volt clearances cannot be met. Breaker runbacks shall be insulated.

   c. Provide a continuous, 1/4-inch by 2-inch (minimum), tin plated copper ground bus extending throughout the entire length of the switchgear, bolted to each vertical section, equipped with lugs for external

ground connections, sized for cables shown on the Drawings.

d. All hardware used on conductors shall be zinc or cadmium plated, have a tensile strength of 120 psi.

e. Provide compression type lugs as required to connect size and quantity of cables as shown on the Drawings.

f. Provide a fully rated, isolated neutral bus for 4-wire systems shown on the Drawings. Bus material and construction shall be similar to the phase bus.

3. Construction:

a. The secondary switchgear distribution section shall be bus-connected to the transformer through a metal-enclosed transition section with orientation to transformer as shown on the Drawings.

b. The loading cabling compartment in the rear shall be completely barriered from the main bus compartment and shall have full height hinged doors. Cable termination compartment at the rear of each circuit breaker shall be completely isolated from the circuit breaker compartment with only the load side bus extensions protruding. Any main or line side tap busses accessible in the cable termination compartment must be fully insulated.

c. The secondary distribution cubicle(s) shall have a 120-volt thermostatically controlled heater, unswitched, to prevent condensation, with control power generated from the unit substation.

d. Enclosure shall be rated NEMA 3R, non-walk-in.

e. The distribution section shall be provided with adequate means for lifting, and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

f. Protective devices shall be arranged so they are individually removable and readily interchangeable from the front of the switchgear. Rotary operating handles for all protective devices shall be of the same design and shall be prominently labeled to indicate device ampere ratings, and color coded for device type. ON/OFF and other indication shall be

clearly shown by prominent markings and handle position. The protective devices shall be individually mounted with front hinged cover plates and all necessary buses and straps shall be provided.

g. Access doors shall be gasketed with external padlockable door latch. Full height, hinged and gasketed, padlockable rear section doors with captive knurled type knob screws shall be provided. Shielded ventilation louvers shall provide air circulation within the structure while excluding insects, vermin, moisture and dust. Provide removable filter elements on all louvered exterior openings. Provide a structural steel base with lifting lugs and jacking plates to support the switchgear and floor plates. Provide removable steel cover plates over conduit entrance areas. A bituminous undercoating shall be applied to the base and to the underside of the floor. The following accessories shall be provided:

4. Low Voltage Power Circuit Breakers:

a. Circuit breakers shall be low voltage, fixed mount type, manually or electrically operated with stored energy closing mechanism. Circuit breakers shall be Eaton / Cutler Hammer, “Magnum DS" Type; Schneider Electric / Square D Company, Type "Masterpact"; or ABB Emax Type. Circuit breakers shall conform to ANSI standards C37.13 and C37.16 and NEMA SG-3.

b. Where required to meet the specified equipment short circuit rating, breakers shall be equipped with integrally mounted current limiting fuses, coordinated with the trip devices. Each breaker shall be equipped with an open fuse tripping device and blown fuse indicator.

c. Circuit breakers shall be equipped with a temperature insensitive, adjustable, microprocessor overcurrent trip device with true three phase RMS sensing of sinusoidal and non-sinusoidal currents. Trip units shall be Eaton / Cutler Hammer, "Digitrip RMS"; Schneider Electric / Square D Company, "Micrologic or ABB “PR122”.

d. Trip devices shall have as a minimum the following independent trip adjustments and functions:

1) Interchangeable rating plugs.

2) Adjustable long time pick-up.

3) Adjustable long time delay.

4) Adjustable short time pick-up.

5) Adjustable short time delay.

6) Adjustable ground fault pick-up.

7) Adjustable ground fault delay.

8) Trip mode targets for ground fault, overload and short circuit.

9) Adjustable instantaneous that can be set to OFF.

10) Ammeter readout.

e. Manually operated circuit breakers shall be charged by a fixed operating handle. Tripping and closing shall be initiated by pushbutton or levers mounted on the front of the breaker. Racking position indicators shall be provided.

f. Electrically operated circuit breakers shall be charged by an electric motor. Electrically operated breakers shall also be provided with a mechanically operated manual trip pushbutton or lever mounted on the front of the breaker, a manual charging handle and racking position indicator.

g. Circuit breaker frame sizes and trip ratings shall be as shown on the Drawings.

h. Provisions shall be provided for padlocking of the breaker in the open and/or withdrawn position.

i. Fused breakers shall be equipped with open fuse lockout device and indicator to protect against single phasing and prevent breaker from reclosing until fuse is replaced and lockout is reset. Fused breakers shall be coordinated with the trip devices so that faults within the rating of the circuit breaker shall be interrupting by the breaker in order to avoid nuisance tripping of the fuses.

5. Key Interlocks:

a. As referred to in the Primary Switch Section, the main secondary circuit breaker shall include a Kirk® key interlock (no substitution) to prevent the operation of the primary switches unless the secondary main circuit breaker is open.

6. Secondary Wiring and Control Devices:

a. Provide control power transformer for transformer fan control. Control power transformer shall be sized for additional station loads as specified herein and as shown on the Drawings.

b. Each breaker shall be electrically operated at 120 Volts from a 480-120V control power transformer power supply as shown on the Drawings. Breaker operating mechanism shall be electrically charged, stored-energy type. Charging motor shall include a limit switch feature and an anti-pump relay. Make provisions for manual charging of the mechanism and for slow closing of the contacts for inspection and adjustment.

c. Wiring: 600 Volt, stranded tinned copper, type SIS, flameproof switchboard wire, minimum size No. 14 AWG for control, No. 12 AWG for power and instrument transformer secondaries. Wiring shall be grouped together with harnesses or in ducts and shall be secured to the structure. Pull out type fuse holders shall be used for control circuits.

d. Identification and termination: All wiring shall be numbered at each end with type-written heat shrinkable or sleeve type markers. Terminal blocks shall be rated 20 amps minimum, 600 volt, screw type with white marking area. Current transformer secondaries shall be wired to shorting type terminal blocks.

e. Instrument and control switches: 600 Volt switchboard rotary type, rated 20 Amps continuous, with black molded phenolic escutcheon plates, white characters, General Electric Type SB-1 or equal.

1) Circuit breaker control switches shall be of the momentary contact, spring return type having mechanical target or flag (target position shall not prohibit operation in any cases) and a black, fixed, pistol grip handle.

2) Ammeter and voltmeter switches shall be maintained contact, non-spring return type with black, fixed, knurled handle.

f. Indicator lights: Provide green, red and amber pilot lights for each circuit breaker OPEN, CLOSED and TRIP indication. Indicators shall be full size, LED type.

g. Potential transformers: Two-winding, encapsulated type with primary and secondary fuses. Voltage ratings shall be as required for the application. Thermal rating and metering accuracy per ANSI standards.

h. Current transformers: Toroidal type suitable for mounting on breaker stabs. Continuous thermal current rating, relaying and metering accuracy shall conform to ANSI standards.

i. Control power transformers: Two-winding dry type with primary fuses, secondary circuit breaker, NEMA sized for the application.

j. Provide four self-powered digital status inputs to monitor the following points:

1) Circuit breaker OPEN status

2) Circuit breaker CLOSED status

3) Circuit breaker TRIPPED status

4) Circuit breaker OUT OF SERVICE (withdrawn) status

k. Provide one auxiliary analog input rated 1.0 VAC/VDC nominal full scale input which can be used to measure an external variable such as transformer temperature, air temperature, or battery voltage.

l. Provide one auxiliary analog output (selectable 0-20ma or 4-20ma) proportional to any measured parameter.

7. Accessories:

a. Provide Surge Protective Device in accordance with Section 16192.

b. Provide nameplates at each breaker and for each control or indicating device. Nameplates shall be engraved as specified on the Drawing or as directed, using lettering approximately 3/8-in high for unit

identification nameplates and 1/4-in high elsewhere. The nameplates shall be black and white laminated phenolic material. The engraving shall extend through the white exterior lamination to the black core. Nameplates shall be screw fastened.

c. Provide permanent master nameplate for switchgear designation, manufacturer's name, model number, order number and voltage, current and interrupting ratings.

d. Provide warning signs marked "DANGER - 480 VOLTS KEEP OUT" on each rear compartment door. Signs shall be adhesive backed mylar, OSHA approved.

e. Provide one GFCI protected weatherproof convenience outlet powered from control power transformer.

PART 3 EXECUTION

A. Installation

1. The substation shall be mounted on steel channels furnished under this Section, set flush with the concrete pad and level in all directions. Provide galvanized hardware for installation. Grout and caulk all voids beneath the equipment base. The substation shall be bolted to the pad with anchor bolts not less than 1/2-inch galvanized steel, minimum sized and installed in accordance with the manufacturer’s recommendation.

2. Install the equipment in accordance with the manufacturers' instructions.

3. Remove temporary lifting angles, lugs, and shipping braces. Touch-up damaged paint finishes.

4. Make wiring interconnections as required.

5. Caulk seams, cracks, and openings in outdoor enclosures.

B. Field Testing

1. Engage the services of a recognized independent testing firm to inspect and test the installed equipment prior to energization. The testing firm shall provide all material, labor, equipment and technical supervision to perform the tests and inspection. Notify the Engineer at least 2 weeks prior to scheduling any testing.

2. Equipment testing and inspection shall be performed before energizing the unit substation in accordance with NETA Standard ATS and shall include the following.

   a. Visual and mechanical inspection.

   b. Ratio and polarity tests on current and voltage transformers.

   c. Ground resistance test.

   d. Insulation resistance tests (phase-to-phase and phase-to-ground).

   e. Meter calibration

   f. Circuit breaker contact resistance test.

   g. Insulation power factor and resistance test for surge arresters.

   h. Phasing check.

   i. Current injection tests on each circuit.

3. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, Engineer, Owner and the equipment manufacturer’s factory service technician. Repair or replace the equipment as directed by the Engineer and Owner prior to placing the equipment back into service.

C. Adjustment

1. The manufacturer shall provide the services of a factory trained service technician for the time period specified in Section 16000. The first trip shall be coordinated with the field testing. The second trip shall include any necessary follow-up or punch list work and technical instruction for the Owner's designated personnel. The manufacturer's service technician shall demonstrate all operational features of the installed equipment.

2. The manufacturers factory service technician shall make the following test and adjustments:

a. Calibrate and test all circuit breaker trip devices, protective relays and controls per the final version of the Coordination Study specified in Section 16000.

b. Adjust and lubricate switch and circuit breaker operating mechanisms and contacts.

D. Cleaning

1. Clean the interior and exterior of electrical equipment in accordance with Section 16000.

END OF SECTION

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SECTION 16450 480 VOLT SWITCHGEAR

PART 1 GENERAL

A. Scope Of Work

1. Furnish and install the 480 Volt switchgear as shown on the Drawings and as specified herein.

B. Related Work

1. Concrete for equipment pad is specified in Division 3.

2. Power system studies are included in Section 16000. The preliminary short circuit study shall be approved by the Engineer before the switchgear submittal will be reviewed.

3. Centralized power monitoring system is in Section 16191.

4. Surge protective devices are included in Section 16192.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data to establish compliance with this Section. Submittals shall include at least the following:

    a. Copy of this specification confirming compliance with each paragraph.

    b. Equipment shop drawings showing elevation and plan views, conduit entrance spaces, nameplate data, bus arrangement, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from this Section.

    c. Point-to-point compartment wiring diagrams for metering, relay, and control circuits. Show wire and terminal numbers.

    d. Product data sheets and catalog numbers for circuit breakers, trip devices and protective relays. List all options, trip adjustments and accessories furnished specifically for this project.

    e. Itemized bill of materials for metering, protective relays, accessories and control equipment.

f. Manufacturer’s warranty.

g. Instruction and renewal parts books.

h. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.

i. Certified shop test reports.

j. Field test and inspection reports.

D. Reference Standards

1. Switchgear and components shall be designed, built and tested in accordance with the latest revision of the following standards:

a. UL1558 - UL Standard for Safety Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

b. NEMA SG.5 - Power Switchgear Assemblies.

c. NEMA SG.3 - Low voltage power circuit breakers.

d. ANSI C37-20.1 and related standards.

e. National Electrical Code (NEC)

2. Solid-state circuitry shall meet or exceed the Transient Overvoltage Withstand Test per NEMA ISCI-109 and the Surge Withstand Capability Tests (SWC) per IEEE Standard 472 (ANSI C37.90A). In addition, where UL Standards exist for components, devices and/or assemblies, such standards shall apply.

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

E. Quality Assurance

1. The equipment furnished under this Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years.

2. Switchgear shall be designed, assembled and tested by the manufacturer of the circuit breakers used in the switchgear.

3. All sections and devices shall be UL listed and labeled. Service equipment shall be UL labeled as suitable for use as service entrance equipment.

F. Delivery, Storage and Handling

1. Package the equipment for maximum protection during delivery and storage.

2. Store the equipment indoors in a clean, dry, heated storage facility until ready for installation. Do not install the equipment in its final location until the facilities are permanently weather tight. Furnish, install and wire temporary electric space heaters in the equipment until the permanent heating equipment is operational. Protect the equipment at all times from exposure to moisture, chemicals, hydrogen sulfide and chlorine gas.

G. Maintenance

1. Furnish the following maintenance accessories for the switchgear.

   a. Two cranks for racking breakers.

   b. Overhead breaker traveling lifting device at each switchgear lineup.

   c. One portable full function trip device test set and cables for secondary injection testing of trip units.

   d. Remote racking and closing device.

2. Provide the following spare parts in the quantities specified:

   a. Three dozen each of cover bolts, cage nuts and door fasteners.

   b. One quart of touch-up paint.

   c. 100 percent replacement of lens caps.

   d. 10 pilot lamps of each size and voltage.

e. 10 control power fuses of each size.

3. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of the package. Identify each item with manufacturers name, description and part number.

H. Warranty

1. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of three (3) years.

2. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the machine(s) and the unit(s) restored to service at no additional cost to the Owner.

3. The manufacturer’s warranty period shall run concurrently with the Contractor’s warranty period. No exception to this provision shall be allowed.

I. Extended Warranty (Bid Additive Alternate)

1. If authorized by the Owner, Contractor and equipment manufacturer shall extend the initial warranty period listed in the previous paragraph for a period of two (2) years, bringing the total warranty coverage up to five (5) years.

2. The extended warranty shall include all terms and conditions required to be provided by the Owner to maintain the terms of the warranty.

PART 2 PRODUCTS

A. Ratings

1. Service: 480/277 Volt, 3 Phase, 3 or 4 Wire, 60 Hz as shown on the Drawings.

2. The switchgear and protective devices shall have a fully rated, short circuit rms symmetrical Amps withstand rating as noted on the drawings. Systems employing series connected ratings shall not be used. Main and feeder devices shall be coordinated for selective tripping using zone selective interlocking.

3. The continuous current rating of the bus shall be equivalent to the frame size of the main circuit protective devices as shown on the Drawings. The bus shall be designed to carry its rated continuous current in the specified ambient temperature without exceeding the temperature rise limits specified in ANSI Standard C37.20.1. Bus bracing shall exceed the specified equipment short circuit rating. Line and load bus connections to feeder devices shall be rated to carry the full continuous current of the device frame.

4. The switchgear, including devices shall be designed for continuous operation at its rated current in a 40 degree C ambient temperature.

B. Construction

1. General

a. The general arrangement of the Switchgear is shown on the Drawings. Switchgear shall be Magnum DS Type as manufactured by Eaton/Cutler Hammer; Type PZ-IV by Schneider Electric / Square D Company; or Type MaxSG as manufactured by ABB.

2. Structure

a. Switchgear shall be indoor NEMA 1 gasketed as shown on the Drawings, completely metal enclosed and sectionalized to isolate and minimize the effects of internal short circuit currents. The structure shall consist of a framework of preformed steel channels or angles covered with bolted steel sheets. Each individual breaker/metering cell shall be completely segregated from adjacent compartments and sections by steel barriers at top, bottom, rear and sides.

b. Breaker compartments shall be equipped with shutters to protect against contact with the energized primary disconnects when the breaker is removed from its compartment. Each individual breaker cell, metering and auxiliary compartment shall be provided with a hinged front panel door.

c. Provide side barriers between adjacent vertical structures in cable and bus compartments. The vertical bus shall be so arranged as to have insulating barriers interposed between phases to inhibit

phase-to-phase faults. In addition, protective devices shall be completely compartmentalized by the addition of barriers above and below each device to minimize fault communication.

d. Line and/or load terminals of each circuit breaker shall be extended to the rear so that it will be unnecessary to reach across or beyond a line bus to make connections. Removable insulation boots shall be provided to insulate the cable connections after the feeder cables have been installed. Rear cable compartments shall be isolated from the main and riser bus by insulated or grounded steel barriers. Provide cable supports in each vertical section. Cable compartments shall be standard depth with bending space in accordance with the NEC.

e. Provide hinged padlockable covers on the rear of each vertical section. Cover shall utilize 3-point latch system to allow for easy opening when padlock is removed.

f. All live buses shall be phase-isolated in the rear to help prevent accidental contact with buses when making upload terminations. The vertical buses shall be isolated from the main buses with full length glass polyester barriers. The main buses shall be phase-isolated from each other and from the device load/line lugs by means of isolating barriers. Joint bolts in the isolated bus system shall be insulated yet, maintainable without removal of the barriers. Insulation and isolation shall be designed to reduce entrance of foreign objects and contaminants, serving as a deterrent to fault initiation, yet designed to facilitate inspection and maintenance.

g. The switchgear shall be provided with adequate means for lifting, and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

h. Protective devices shall be arranged so they are individually removable and readily interchangeable from the front of the switchgear. Rotary operating handles for all protective devices shall be of the same design and shall be prominently labeled to indicate device ampere ratings, and color coded for device type. ON/OFF and other indication shall be clearly shown by prominent markings and handle

position. The protective devices shall be individually mounted with front hinged cover plates and all necessary buses and straps shall be provided.

3. Auxiliary Sections

   a. The switchgear shall include an auxiliary cable pull section if required for transition from underground or overhead cable feeds. Provide bus extensions and compression lugs for number and size of incoming cables as shown on the Drawings.

4. Buses

   a. Main bus, riser bus, and circuit breaker connections shall be tin plated copper, with bolted connections. All bus bars shall be 98 percent conductivity copper with a current density of 1,000 amperes per square inch. Surfaces shall be tin-plated by the Alstan 70 (or comparable) process to have a uniform appearance, free of blisters. The bus structure shall be mounted on supports of high impact non-tracking insulating material. Bus bars shall be uniformly arranged to provide A-B-C sequence left to right (from front), front to rear and top to bottom.

   b. Bus bars shall not be tapered. Bolted connections shall be made with high strength bolts and locking hardware. Individual horizontal and vertical phase bus bars shall be insulated where industry standard 600 Volt clearances cannot be met. Breaker runbacks shall be insulated.

   c. Provide a continuous, 1/4-inch by 2-inch (minimum), tin plated copper ground bus extending throughout the entire length of the switchgear, bolted to each vertical section, equipped with lugs for external ground connections, sized for cables shown on the Drawings.

   d. All hardware used on conductors shall be zinc or cadmium plated, have a tensile strength of 120 psi.

5. Provide compression type lugs as required to connect size and quantity of cables as shown on the Drawings.

6. Bus extensions from the load side of each feeder breaker into the rear cable compartment shall be the same size as the line side bus taps. Provide neutral bus runbacks for

each branch circuit compartment if neutral bus is not accessible without removing barriers. Runbacks shall be tin plated copper.

7. Provide a fully rated, isolated neutral bus for 4-wire systems shown on the Drawings. Bus material and construction shall be similar to the phase bus.

8. Low Voltage Power Circuit Breakers

   a. Circuit breakers shall be low voltage, drawout type, manually or electrically operated with stored energy closing mechanism. Circuit breakers shall be Eaton/Cutler Hammer, “Magnum DS" Type; Schneider Electric/Square D Company, Type "Masterpact"; or ABB “Emax” Type. Circuit breakers shall conform to ANSI standards C37.13 and C37.16 and NEMA SG-3.

   b. Where required to meet the specified equipment short circuit rating, breakers shall be equipped with integrally mounted current limiting fuses, coordinated with the trip devices. Each breaker shall be equipped with an open fuse tripping device and blown fuse indicator.

   c. Circuit breakers shall be equipped with a temperature insensitive, adjustable, microprocessor overcurrent trip device with true three phase RMS sensing of sinusoidal and non-sinusoidal currents. Trip units shall be Eaton/Cutler-Hammer, "Digitrip RMS"; Schneider Electric / Square D Company, "Micrologic"; or ABB “PR122”.

   d. Trip devices shall have as a minimum the following independent trip adjustments and functions:

      1) Interchangeable rating plugs.

      2) Adjustable long time pick-up.

      3) Adjustable long time delay.

      4) Adjustable short time pick-up.

      5) Adjustable short time delay.

      6) Adjustable ground fault pick-up.

      7) Adjustable ground fault delay.

8) Trip mode targets for ground fault, overload and short circuit.

9) Adjustable instantaneous that can be set to OFF.

10) Ammeter readout.

e. Manually operated circuit breakers shall be charged by a fixed operating handle. Tripping and closing shall be initiated by pushbutton or levers mounted on the front of the breaker. Racking position indicators shall be provided.

f. Electrically operated circuit breakers shall be charged by an electric motor. Electrically operated breakers shall also be provided with a mechanically operated manual trip pushbutton or lever mounted on the front of the breaker, a manual charging handle and racking position indicator.

g. Circuit breakers shall be equipped with a shunt trip and provisions for remote closing when automatic control is required.

h. Circuit breakers shall be capable of being racked out without exposing the operator to live parts. Interlocks shall be provided to prevent the following operations:

1) Racking a closed breaker into or out of the CONNECTED position.

2) Closing a circuit breaker until it is fully racked into the TEST or CONNECTED position.

3) Withdrawing a circuit breaker from the cubicle while the closing springs are charged.

4) Insertion of a breaker of incorrect frame size or inadequate interrupting capacity.

i. Provide a mechanical Kirk Key interlocking system to allow the following manual breaker operations:

1) With the bus tie breaker open, opening either main breaker shall release a key to allow manual closing of the tie breaker.

2) With the bus tie breaker closed, the key shall remain captive to prevent parallel operation of the main sources. Opening the tie shall release the key to allow the open main to be restored.

9. Each breaker shall have a secondary control power plug which automatically engages a cell mounted mating receptacle in the CONNECTED position and disengages as the circuit breaker is racked out to the TEST/DISCONNECT position. Provide a means to manually engage the control power plug in the TEST/DISCONNECT position.

10. Breaker contacts on the removable element (TOC) auxiliary switch shall be wired to terminal blocks. Provide 6 normally open and 6 normally closed spare auxiliary contacts in addition to the auxiliary contacts required for breaker operation. Normally closed auxiliary contacts shall break before the normally open auxiliary contacts make.

11. Circuit breakers shall be equipped with mechanism operated (MOC) auxiliary switch contacts for remote status indication. Provide 6 spare "a" and 6 spare "b" contacts wired to terminal blocks.

12. Circuit breaker frame sizes and trip ratings shall be as shown on the Drawings.

13. Cells for future breakers shall be fully equipped with drawout carriage, racking mechanism, primary and secondary contacts, and current transformers. Unless otherwise shown on the Drawings, future breakers shall be for up to 1600 Amp ratings.

14. Circuit breakers shall have additional auxiliary contacts for the controls and interlocks as required and as shown on the Drawings. The circuit breakers shall be provided with a key interlock and bell alarm switches. The following but not limited to shall be provided, in addition to the trip devices; power supply, trip coil, close coil, interpole phase barriers with manual trip button and position indicator. The trip button shall also permit mechanical simulation of overcurrent tripping for test purposes.

15. Provisions shall be provided for padlocking of the breaker in the open and/or withdrawn position.

16. Fused breakers shall be equipped with open fuse lockout device and indicator to protect against single phasing and prevent breaker from reclosing until fuse is replaced and lockout is reset. Fused breakers shall be coordinated with the trip devices so that faults within the rating of the circuit breaker shall be interrupting by the breaker in order to avoid nuisance tripping of the fuses.

17. Secondary Wiring and Control Devices

    a. Wiring: 600 Volt, stranded tinned copper, type SIS, flameproof switchboard wire, minimum size No. 14 AWG for control, No. 12 AWG for power and instrument transformer secondaries. Wiring shall be grouped together with harnesses or in ducts and shall be secured to the structure. Pull out type fuse holders shall be used for control circuits.

    b. Identification and termination: All wiring shall be numbered at each end with type-written heat shrinkable or sleeve type markers. Terminal blocks shall be rated 20 amps minimum, 600 volt, screw type with white marking area. Current transformer secondaries shall be wired to shorting type terminal blocks.

    c. Instrument and control switches: 600 Volt switchboard rotary type, rated 20 Amps continuous, with black molded phenolic escutcheon plates, white characters, General Electric Type SB-1 or equal.

        1) Circuit breaker control switches shall be of the momentary contact, spring return type having mechanical target or flag (target position shall not prohibit operation in any cases) and a black, fixed, pistol grip handle.

        2) Ammeter and voltmeter switches shall be maintained contact, non-spring return type with black, fixed, knurled handle.

    d. Indicator lights: Provide green, red and amber pilot lights for each circuit breaker OPEN, CLOSED and TRIP indication. Indicators shall be full size, LED type.

18. Control and Metering Transformers

    a. Potential transformers: Two-winding, encapsulated type with primary and secondary fuses. Voltage ratings

shall be as required for the application. Thermal rating and metering accuracy per ANSI standards.

b. Current transformers: Toroidal type suitable for mounting on breaker stabs. Continuous thermal current rating, relaying and metering accuracy shall conform to ANSI standards.

c. Control power transformers: Two-winding dry type with primary fuses, secondary circuit breaker, NEMA sized for the application.

19. Instrumentation and Metering

a. All trip units shall have amp readout.

b. Power circuit monitors shall be provided on the circuit breakers as indicated in the single line diagrams. The circuit breaker monitor shall have the system display and shall be capable of monitoring up to 16 remotes on a standard RS-485 communications link, 10,000 feet (maximum). The power circuit monitors shall be per Section 16191 with all features.

20. Uninterruptible Power Supply (UPS) shall be provided for operating all Power Monitors within the switchgear. UPS shall be provided with overcurrent protection.

21. Monitoring and Control Functions

a. Provide four self-powered digital status inputs to monitor the following points:

1) Circuit breaker OPEN status

2) Circuit breaker CLOSED status

3) Circuit breaker TRIPPED status

4) Circuit breaker OUT OF SERVICE (withdrawn) status

b. Provide one auxiliary analog input rated 1.0 VAC/VDC nominal full scale input which can be used to measure an external variable such as transformer temperature, air temperature, or battery voltage.

c. Provide one auxiliary analog output (selectable 0-20ma or 4-20ma) proportional to any measured parameter.

d. Provide three Form C dry contact control relay outputs rated 277 VAC or 30 VDC at 10 Amp maximum load current, that can each function as:

1) Setpoint relays that operate as a function of any measured parameter for demand, power factor, or load control. Seventeen programmable setpoints shall each have programmable operate and release limits and time delays on operate and release. Relays shall provide selectable pulse mode or latch mode operation.

2) Remote control relays operated by commands via the communications port.

3) Breaker trip relay (over/under volt, volt unbalance, phase reversal, current unbalance, over/under frequency).

4) KWH or KVARH pulse output relay

5) Alarm relays

e. Operational Features

1) Provide the following operating features:

2) True RMS measurements.

3) Connect directly to PT's and CT's for systems over 600 volts.

4) Provision for a fourth current input for measurement of ground or neutral current.

5) 300 amp, one second surge protection on all four current inputs.

6) 3-field, 20 character, high visibility 0.4-in character height vacuum-fluorescent display with a programmable time out feature.

22. Communication

a. Provide interfacing hardware, software, etc., as required to connect power circuit monitor(s) outputs and all breaker status to plant SCADA system via Ethernet cable using Modbus TCP/IP communications protocol. The manufacturer shall be responsible for

complete coordination and compatibility with the plant computer system specified under Division 13 and the switchgear. Proof of coordination with Division 13 shall be included with the switchgear submittals.

23. Lightning and Surge Protection

    a. Provide Surge Protective Devices in accordance with Section 16192.

24. Marking and Identification

    a. Provide nameplates on each breaker cell door and for each control or indicating device. Nameplates shall be engraved as specified on the Drawing or as directed, using lettering approximately 3/8-in high for unit identification nameplates and 1/4-in high elsewhere. The nameplates shall be black and white laminated phenolic material. The engraving shall extend through the white exterior lamination to the black core. Nameplates shall be screw fastened.

    b. Provide permanent master nameplate for switchgear designation, manufacturer's name, model number, order number and voltage, current and interrupting ratings.

    c. Provide warning signs marked "DANGER - 480 VOLTS KEEP OUT" on each rear compartment door. Signs shall be adhesive backed mylar, OSHA approved.

    d. Identify each phase of bus runouts in cable compartments

    e. Label hoist with maximum allowable weight.

C. Surface Preparation And Shop Coatings

1. All non-current carrying metal parts of the switchgear assembly shall be cleaned of all weld spatter and other foreign material and given a hot iron-phosphate chemical treatment. A zinc rich, heat cured, epoxy primer shall be applied to inhibit rust.

2. Indoor equipment shall be painted with one finish coat of manufacturer’s standard air dried enamel. Color shall be light grey ANSI 61 or ANSI 49.

3. Outdoor equipment shall be painted with two finish coats of polyurethane or epoxy enamel, 1 to 2 mil thickness. Exterior color shall be light grey ANSI 61 or ANSI 49.

4. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion. Printed circuit boards shall be coated with a protective conformal epoxy. All device contacts shall be gold or silver plated.

D. Shop Testing

1. Perform manufacturers standard production testing and inspection in accordance with ANSI standards. If requested by the Engineer, the manufacturer shall submit certified copies of test results to indicate proof of compliance with ANSI C37.50 and C37.51.

PART 3 EXECUTION

A. Installation

1. The equipment shall be leveled and anchored directly to a concrete equipment pad or finished floor as shown on the Drawings. Provide hardware and metal shims for installation. Grout and caulk all voids beneath the equipment base. Anchor bolts shall be 5/8-in galvanized steel, minimum sized and installed in accordance with the manufacturer’s recommendation.

2. Install the equipment in accordance with the manufacturers' instructions.

3. Remove temporary lifting angles, lugs, and shipping braces. Touch-up damaged paint finishes.

4. Make wiring interconnections between shipping splits.

5. Install bus splice plates and torque the connections.

6. Caulk seams, cracks, and openings in outdoor enclosures.

B. Field Testing

1. Engage the services of a recognized independent testing firm to inspect and test the installed equipment prior to energization. The testing firm shall provide all material, labor, equipment and technical supervision to perform the tests and inspection. Notify the Engineer at least 2 weeks prior to scheduling any testing.

2. Equipment testing and inspection shall be performed before energizing the switchgear in accordance with NETA Standard ATS and shall include the following.

   a. Visual and mechanical inspection.

   b. Ratio and polarity tests on current and voltage transformers.

   c. Ground resistance test.

   d. Insulation resistance tests (phase-to-phase and phase-to-ground).

   e. Meter calibration

   f. Circuit breaker contact resistance test.

   g. Insulation power factor and resistance test for surge arresters.

   h. Phasing check.

   i. Primary current injection tests on each circuit breaker.

3. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, Engineer, Owner and the equipment manufacturer’s factory service technician. Repair or replace the equipment as directed by the Engineer and Owner prior to placing the equipment back into service.

C. Adjustment

1. The switchgear manufacturer shall provide the services of a factory trained service technician for the time period specified in Section 16000. The first trip shall be coordinated with the field testing. The second trip shall include any necessary follow-up or punch list work and technical instruction for the Owner's designated personnel. The manufacturer's service technician shall demonstrate all operational features of the installed switchgear.

2. The switchgear manufacturers factory service technician shall make the following test and adjustments:

   a. Calibrate and test all circuit breaker trip devices, protective relays and controls per the final version of the Coordination Study specified in Section 16000.

   b. Adjust and lubricate circuit breaker operating mechanisms and contacts.

D. Cleaning

1. Clean the interior and exterior of electrical equipment in accordance with Section 16000.

END OF SECTION

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SECTION 16470 PANELBOARDS

PART 1 GENERAL

A. Scope of Work

1. Furnish all labor, materials, equipment and incidentals required and install all panelboards as shown on the Drawings and as specified herein.

2. All panelboard wiring shall include wiring numbers and terminal point numbers cross referenced to shop drawing and subsequent record drawing submittals.

B. Submittals

1. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data, for the following as a minimum:

a. Equipment outline drawings showing elevation and plan views, dimensions and weight. Indicate all options, special features, ratings and deviations from this Section.

b. Bus arrangement drawings.

c. Product data sheets and catalog numbers for circuit breakers, etc. List all options, trip adjustments and accessories furnished specifically for this project.

d. Instruction and renewal parts books.

e. Test and inspection reports.

f. Complete bill of materials list.

g. The equipment drawings, summary tables, and bill of materials list shall be computer generated (i.e. no hand-drawn drawings, sketches, lists will be accepted).

C. Reference Standards

1. Panelboards shall be in accordance with the Underwriter Laboratories (UL) "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA

Standard for Panelboards and the National Electrical Code (NEC).

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

D. Manufacturers

1. 120/240 Volt, single phase, 3 Wire and 120/208 Volt, 3 Phase, 4 Wire panelboards shall be Type Pow-R-Line by Eaton/Cutler-Hammer; Type NQ by Schneider Electric /Square D; or P Series by Siemens.

2. 277/480 Volt, 3 Phase, 4 Wire panelboards shall be Type Pow-R-Line by Eaton/Cutler-Hammer; Type NF by Schneider Electric/Square D; or P Series by Siemens.

3. 480 Volt, 3 Phase, 3 Wire panelboards shall be Type Pow-R-Line by Eaton/Cutler-Hammer; I-Line series by Schneider Electric/Square D; or P Series by Siemens.

4. NEMA 3R and 4X panelboards shall be as specified herein, provided in 316 stainless steel enclosures as manufactured by the Hoffman or equal and completely assembled by the panelboard manufacturer.

5. Refer to additional requirements for manufacturers in Section 16000.

PART 2 PRODUCTS

A. General

1. Rating

a. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.

b. Circuit breaker panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

B. Materials (NEMA 1)

1. Interiors

a. All interiors shall be completely factory assembled

with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper wire of the sizes indicated.

b. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.

c. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.

d. A nameplate shall be provided listing manufacturer's name, panel type and rating.

2. Buses

a. Bus bars for the mains shall be of tin plated copper. Full size tin plated copper neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Cross connectors shall be tin plated copper. Each panel shall be provided with a ground bus bar, with removable link/jumper between neutral and ground bus. The ground bus shall be sized to the maximum number of circuit breakers that can be installed in the panelboard.

b. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

c. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.

d. Tin plated copper equipment ground bars shall be furnished.

3. Boxes

a. Recessed or flush mounted boxes shall be made from galvanized code gauge steel having multiple knockouts,

unless otherwise noted. Boxes shall be of sufficient size to provide a minimum gutter space of 4-in on all sides.

b. Surface mounted boxes and trims shall have an internal and external finish as specified in Paragraph 4d below.

c. At least four studs for mounting the panelboard interior shall be furnished.

d. All conduit entrances shall be field punched.

4. Trim

a. Hinged doors covering all circuit breaker handles shall be included in all panel trims.

b. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door. All trims shall be door-in-door type construction.

c. The trims shall be fabricated from code gauge sheet steel.

d. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 49 or 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.

e. Trims for flush panels shall overlap the box by at least 3/4-in all around. Surface mounted panel trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

f. Door-in-door type construction shall be provided so that trim may be opened to access wireways without removing the trim from the panel.

C. Materials (NEMA 3R and 4X)

1. Interiors and Buses

   a. Interiors and buses shall be as hereinbefore specified for NEMA 1 construction.

2. Boxes and Covers

   a. Boxes, covers and hardware shall be made from 316 stainless steel with natural finish.

   b. Boxes and covers shall have continuous welded seams and shall be hinged (piano type) together and gasketed.

   c. Exterior door shall be secured using a 3-point latch with door handle.

   d. Conduit openings shall be tapped.

D. Circuit Breakers

1. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.

2. Circuit breakers shall be molded case, bolt-in type.

3. Each circuit breaker used in 120/208 Volt panelboards shall have an interrupting capacity as noted on the Drawings.

4. Each circuit breaker used in 120/240 Volt and 120/208 Volt panelboards shall have an interrupting capacity as noted on the Drawings.

5. Each circuit breaker used in 277/480 Volt and 480 Volt panelboards shall have an interrupting capacity of not less than 65,000 Amps, RMS symmetrical.

6. GFCI (ground fault circuit interrupter) shall be provided for circuits as required and where indicated the Drawings. GFCI units shall be 1 Pole, 120 Volt, molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and an interrupting capacity as noted on the Drawings.

7. Circuit breakers shall be manufactured by the panelboard

manufacturer.

PART 3 EXECUTION

A. General Installation

1. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.

2. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses. Record normal base load phase voltages and currents for each phase and the total neutral current and submit to the Engineer for review.

3. Unless otherwise noted on the Drawings, top of cabinets shall be mounted 6 feet-0-inch above the floor, properly aligned and adequately supported independently of the connecting raceways.

4. All wiring in panelboards shall be neatly formed, grouped, and identified to provide a neat and orderly appearance.

5. All panelboards shall be protected from physical damage, water damage, moisture, corrosion, dirt and dust during construction. Any panelboard judged to be unacceptable by the Engineer shall be replaced by the Contractor at no additional cost to the Owner.

6. Standard factory testing shall be performed for the equipment furnished under this section and these tests shall be in accordance with the latest version of NEMA and UL standards. Certified copies of these tests shall be provided to the Engineer upon request.

7. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association (NETA Standard ATS) unless otherwise modified by this Section.

B. Identification

1. Branch circuit wires shall be labeled with the corresponding pole number for both phase and neutral wires using vinyl cloth wrap around labels.

2. A typewritten directory card giving location and nature of load served shall be placed in the card holder inside the front cover.

3. Install a 1-in by 3-in nominal laminated plastic nameplate with 1/2-in black letters on a white background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.

C. Cleaning

1. Clean the interior and exterior of new and modified electrical equipment in accordance with Section 16000.

END OF SECTION

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SECTION 16480 480 VOLT MOTOR CONTROL CENTERS

PART 1 GENERAL

A. Scope Of Work

1. Furnish, install and test the motor control centers as shown on the Drawings and as specified herein.

2. Power factor correction capacitors shall be factory installed by the motor control center manufacturer as specified herein or as shown on the Drawings.

3. Motor control centers shall be sized to include all equipment, spares and spaces shown on the Drawings.

B. Related Work

1. Concrete for equipment pad is included in Division 3.

2. Power Factor Correction Capacitors are included in Section 16150.

3. Power Monitors are included in Section 16191.

4. Surge Protective Devices are included in Section 16192.

5. Variable Frequency Drives are included in Section 16370.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data, for the following as a minimum:

   a. Copy of this specification confirming compliance with each paragraph.

   b. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from this Section.

   c. Conduit entrance drawings.

   d. Bus arrangement drawings.

   e. Unit summary tables showing detailed equipment

description and nameplate data for each compartment.

f. Product data sheets and catalog numbers for overcurrent protective devices, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this project.

g. Provide control systems engineering to produce custom unit elementary and compartment wiring diagrams for metering, relay, power and control circuits in accordance with the NEMA wiring class specified. Elementary drawings shall show interwiring and interlocking between units and to remotely mounted devices. Show all field devices, switches, lights, wire, terminal numbers, etc. and indicate special identifications for electrical devices per the Drawings.

h. Instruction and renewal parts books.

i. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.

j. Complete bill of materials list.

k. Certification that manufacturer and SCADA system integrator have coordinated regarding network device identification and SCADA communication protocols. (Division 13 coordination).

l. The equipment drawings, summary tables, elementary drawings/diagrams, spare parts list and bill of materials list shall be computer generated (i.e. no hand-drawn drawings, sketches, lists will be accepted).

m. Manufacturer’s warranty.

n. Operation and maintenance manuals.

o. Test and inspection reports.

p. Digital file of network device information.

q. Digital file of drive and electronic overload settings.

D. Reference Standards

1. Motor control centers shall be designed, built and tested in accordance with the latest editions and revisions of NEMA Standard ICS-2 and Underwriters Laboratories (UL) Standard No. UL-845. Equipment shall conform to ANSI C19.3 test standards and the requirements of the National Electrical Code (NEC).

E. Quality Assurance

1. The motor control centers shall be the product of a manufacturer who shall also be the manufacturer of all the circuit breakers, fused switches and motor starters included in the motor control center.

2. Motor control centers shall be designed, assembled and tested by the manufacturer of the motor control equipment included in the control center assembly.

3. All units and sections shall be UL labeled. Motor control centers containing service entrance equipment shall be UL labeled "Suitable For Use As Service Equipment."

F. Operating And Maintenance Manuals

1. Operating and maintenance manuals shall be furnished in accordance with Division 01 and Section 16000.

2. The manuals shall be bound and shall also include:

   a. A list of "as left" settings for all motor circuit protectors and circuit breakers.

   b. A table listing cubicle number, load description, installed overload heater size and motor horsepower, Amps, service factor and starting code letter.

G. Manufacturers

1. The general arrangement of the motor control centers is shown on the Drawings. Motor control centers shall be one of the following products:

   a. Eaton/Cutler-Hammer "Freedom 2100 Series".

   b. Schneider Electric/Square D Corp. "Model 6 iMCC".

   c. ABB “MNS-MCC”.

H. Tools and Spare Parts

1. Provide the following spare parts in the quantities specified:

   a. Two dozen each size of cover bolts, cage nuts and door fasteners.

   b. 1 can of aerosol touch-up paint.

   c. 50 percent replacement fuses, all types and sizes.

   d. 6 replacement lamps for pilot lights.

   e. 6 of each color replacement lens caps for pilot lights.

   f. 2 starter coils for each size furnished.

   g. 2 replacement overload devices of each size/type used.

   h. 2 motor circuit protectors for each size used.

   i. 2 circuit breaker rating plugs for each size used.

2. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturers name, description and part number on the exterior of the package.

3. Provide a hand-held programming unit to set/change the network communication address for each device, adjust network parameters, display device information, and display monitored values. Require password protection for programming time / current set points and to perform functional testing of phase and ground trip characteristics. The programmer shall be self-powered by an internal battery. Provide as a minimum one (1) hand-held programming unit.

I. Software

1. Provide all software required for Owner to utilize electronic files turned over to communicate with the SCADA network and allow Owner to program and adjust drives and electronic overloads.

J. Warranty

1. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of three (3) years.

2. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the machine(s) and the unit(s) restored to service at no additional cost to the Owner.

3. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

K. Extended Warranty (Bid Additive Alternate)

1. If authorized by the Owner, Contractor and equipment manufacturer shall extend the initial warranty period listed in the previous paragraph for a period of two (2) years, bringing the total warranty coverage up to five (5) years.

2. The extended warranty shall include all terms and conditions required to be provided by the Owner to maintain the terms of the warranty.

PART 2 PRODUCTS

A. Rating

1. Service: 480 Volt, 3 Phase, 3 Wire, 60 Hz.

2. The overall short circuit withstand and interrupt rating of the equipment and devices shall be not less than 65,000 Amps, RMS symmetrical at 480 Volts unless otherwise shown on the Drawings. Main and feeder circuit protective devices shall be fully rated for the specified short circuit duty. Systems employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL labeled for the specified short circuit duty in combination with the motor branch circuit protective device.

3. The continuous current rating of the main horizontal bus shall be as shown on the Drawings. Vertical busses shall be sized for the structure load and shall have a minimum rating of 300 Amps. Bus bracing shall equal or exceed the

specified equipment short circuit rating.

4. Motor control centers, including devices, shall be designed for continuous operation at rated current in a 40 degree C ambient temperature.

B. Construction

1. Enclosure

a. Enclosure type shall be NEMA Type 1A unless otherwise noted on the drawings.

2. Structure

a. Motor control centers shall consist of a series of metal enclosed, free-standing, dead front vertical sections bolted together to form double wall construction between sections. Individual vertical sections shall be nominally 90-in high, 20-in wide and 20-in deep unless otherwise shown on the Drawings. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full width of each shipping split. Top of each section shall have removable plates with lifting angle. Make provisions for field installation of additional sections to each end and provide full depth cover plates (rodent barriers) at each end of the motor control center channel sills.

b. Provide continuous top and bottom horizontal wireways extending the full width of the line-up, isolated from the horizontal bus. Provide a 4-in wide, full height, vertical wireway in each section, equipped with a hinged door and cable supports. Vertical wireway shall be isolated from the bus and device compartments. Wireways openings shall have rolled edges or protective grommets.

c. Provide individual, flange formed, pan type door with concealed hinges and quarter turn latches for each device compartment and future space. Doors shall be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.

d. Motor control centers shall be designed for against-the-wall or back-to-back mounting. All wiring, bus joints and other mechanical parts requiring tightening or other maintenance shall be accessible

from the front or top.

3. Unit Compartments

a. Provide individual compartments for each removable combination starter and feeder tap device unit. Each vertical section shall accommodate a maximum of six compartments. Each size 1 or 2 combination starter shall be a minimum of 18 inches high. Steel barriers shall isolate the top, bottom and sides of each compartment from adjacent units and wireways. Removable units shall connect to the vertical bus in each section with tin plated, self aligning, pressure type copper plug connectors. Size 5 and larger starter units may be wired directly to the bus. Removable units shall be aligned in the structure on guide rails or shelves and secured with a cam latch mechanism or racking screw.

b. Provide individual, isolated compartments for all fixed mounted devices including circuit breakers, cable lugs, metering, relaying and control devices. Main and bus tie circuit breakers shall be wired directly to the main horizontal bus. All bus connections shall be fully rated.

c. Provide the following features:

1) Provision to padlock removable units in a partially withdrawn TEST position, with the bus stabs disengaged.

2) Provision to padlock unit disconnect handles in the OFF position with up to three padlocks.

3) Mechanical interlock with bypass to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.

4) Mechanical split-type terminal blocks for disconnecting external control wiring.

5) Auxiliary contact on unit disconnect to isolate control power when fed from an external source.

6) Disconnect operating handles and control devices mounted on the removable units.

7) All compartments shall have laminated wiring diagrams fastened to the inside of each compartment door or print pockets with these diagrams. Compartments containing motor starters shall have laminated wiring diagrams and overload tables fastened to the inside of the compartment door. Compartments containing panelboards shall have circuit directories consisting of two ply laminated plastic, with black face and white core fastened to the inside of the compartment door.

4. Bus Systems

a. Main horizontal bus: Tin plated copper, bolted joints, accessible from the front of the structure, fully rated throughout the lineup.

b. Vertical section bus: Tin plated copper, full height, totally insulated and isolated by glass polyester barriers with shutters to cover stab openings when units are withdrawn. Provide fishtape barriers to isolate bottom wireways from lower ends of vertical bus.

c. Vertical buses used for a tie circuit breaker or tie feeder lugs shall be rated for a continuous capacity equivalent to the main horizontal bus rating.

d. Horizontal ground bus: Provide a 1/4-inch by 2-inch (minimum) tin plated copper uninsulated ground bus in each section equipped with lugs for termination of feeder and branch circuit ground conductors. Connect to ground bus in adjacent sections with splice plates.

e. The buses shall be sized for a maximum current density of 1200 Amps per square inch.

5. Wiring

a. Wiring: Stranded copper, minimum size No. 14 AWG, with 600 Volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation, NEMA Class II-S, Type B. Line side power wiring shall be sized for the full rating or frame size of the connected device.

b. Identification: All wiring shall be numbered with type written heat shrinkable or sleeve type wire markers at each termination point, color coding per NEMA Standards and the NEC. Foreign voltage control wiring

shall be yellow.

6. Signage

   a. Each motor control center shall be furnished with a sign marked "DANGER - 480 VOLTS - KEEP OUT". Letters shall not be less than 1-in high, 1/4-in stroke. Signs shall be laminated plastic, engraved white letters with a red background.

   b. Compartments with voltages from sources outside of the compartment shall have a sign mounted inside the compartment door marked "CAUTION - THIS UNIT CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE". Letters shall be black on a high visibility yellow background.

   c. Provide a 2-in by 6-in nominal engraved master nameplate, of two ply laminated plastic, white face, 3/8-in high by 1/8-in stroke black letters, screw fastened to the top wireway of each lineup with stainless steel screws. Include MCC designation and service ratings.

   d. Provide 1-in by 3-in nominal engraved unit nameplates of two ply laminated plastic, white face, 3/8-in high by 1/16-in stroke black letters, screw fastened to each door with stainless steel screws. Equipment names shall be as shown on the drawings.

7. Internal Communication

   a. It is the intention for the MCC to be “intelligent” or “smart” to provide the maximum amount of control and communication via the plant SCADA system.

   b. The Ethernet cabling system using Cat 5 Ethernet cable shall be configured in a star topology connecting to a central managed switch.

   c. The central managed switch shall be located in a separate prepared space.

   d. The method of control shall utilize Ethernet cable with Modbus TCP/IP protocol rather than hardwire.

   e. Each motor starter, VFD and soft starter unit in the MCC shall be supplied with means to control and communicate via Ethernet and be capable of monitoring at least two input points.

f. Ethernet cable insulation rating shall be 600V, be incorporated throughout the vertical sections and barried from the unit spaces and field wireway spaces.

g. 24VDC power supplies associated with communication system shall be provided with UPS / battery backup to allow for ride-through for plant generator start and transfer.

h. Motor starter units shall have an electronic overload relay that includes monitoring of motor current and voltage.

i. VFD units shall include monitoring of drive parameters such as current, voltage, and kW in addition to the control required as shown on the Drawings and in Section 16370.

j. Provide an external RJ45 port for local interface to allow for local set-up with a hand held device.

C. Components

1. General

a. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the NEMA size starter, circuit breaker trip ratings, control power transformers and overload ratings matched to the motors and control equipment actually supplied, in compliance with the NEC and the manufacturers overload selection tables. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.

2. Circuit Breakers

a. Power circuit breakers (400 Amps and larger): 100 percent equipment rated, 600 Volt, molded case circuit breakers with integral fully adjustable solid state trip device. Trip device shall be temperature insensitive and have the following characteristics and functions:

1) Independently adjustable long time pick-up and delay.

2) Independently adjustable short time pick-up and delay with i^2t in and out switch.

3) Adjustable instantaneous.

4) Independently adjustable ground fault pick-up and delay.

5) Trip mode targets for over load, short circuit and ground fault.

6) Long time pick-up light.

b. Circuit breakers (Less than 400 Amps): Thermal-magnetic trip type, 600 Volt, 2 or 3 Pole as required, labeled in accordance with UL 489. Provide integral current limiting fuses as required to meet the specified equipment short circuit rating. Provide independently adjustable magnetic trips on 225A frame breakers and larger.

c. Provide a full function portable solid state circuit breaker test set by the same Manufacturer as the circuit breakers.

3. Combination Starter Units

a. Combination starters shall include a motor circuit protector (MCP) in series with a motor controller and an overload protective device. The MCP shall have an adjustable magnetic trip range up to 1000 percent of rated continuous current and a trip test feature. MCP's shall be labeled in accordance with UL489.

b. Motor starters: 3 Pole, 600 Volt, electrically operated, of the types shown on the Drawings. Provide NEMA sizes as required for the horsepowers shown on the Drawings. Minimum size shall be NEMA Size 1. Fractional size starters are not acceptable. IEC rated starters shall not be acceptable. Starters shall have 120 Volt encapsulated operating coils; individual control power transformers with primary and secondary fuses and renewable line contacts.

c. Multi-speed and reversing starters shall include two motor rated contactors mechanically and electrically interlocked so that only one device may be energized at any time.

d. Reduced voltage starters: Solid state, six SCR, full wave type with adjustable current limit and voltage ramp to control starting torque, automatic load sensing circuit to minimize energy consumption, line and load side surge protection and noise suppression and controlled deceleration adjustment to reduce the effects of surges caused by centrifugal pump loads. Provide heat sinks and ventilation to remove heat from the structure. Each starter shall include a motor horsepower rated isolation contactor to positively disconnect the line voltage when the SCR control is off.

e. Contactors: Electrically held, 120 VAC coil operator, suitable for tungsten, ballast, or resistive non-motor loads, with over current protection, control transformer and contact ratings and poles as shown on the Drawings.

f. Motor overload protection: Overload relays shall be self-powered solid state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test. Overload relays for submersible pump motors shall be Class 10 trip. All other overload relays shall be Class 20 trip. Overload relays shall be manually reset from outside the enclosure by means of an insulated pushbutton. Provide auxiliary alarm contacts where shown on the Drawings.

g. Auxiliary contacts: Form C, NEMA A600 rating, as required by the control schemes on the Drawings. Provide 1-normally open and 1-normally closed spare contacts on each starter. Additional auxiliary contacts shall be furnished as shown on the Drawings or as required by the control schematic and this Section.

h. Control power transformers: Two winding type, 120 VAC secondary, fused on primary and secondary, secondary grounded. Provide extra capacity as required or where shown on the Drawings.

4. Instrumentation and Metering

a. Instrumentation transformers: Indoor, 600 Volt, butyl-rubber molded, metering class designed in

accordance with ANSI and NEMA standards. Window type current transformers, with burden capacity as low as 50 VA, may be used where such capacity is sufficient. Current transformer accuracy ratings shall be at least equal to NEMA standard requirements for the particular application.

b. Elapsed time hour meters: Five digit, non-reset type, with 120 Volt synchronous motor.

c. Power circuit monitors shall be provided on the units as indicated in the single line diagrams. The circuit breaker monitor shall have the system display and shall be capable of monitoring up to 16 remotes on a standard RS-485 communications link, 10,000 feet (maximum). The power circuit monitors shall be Square D Company's "Power Logic", or equal, with all features listed in Section 16191 except for waveform capture.

5. External SCADA Control and Communications

a. Provide interfacing hardware, software, etc. as required for control and monitoring from the plant computer system. Include communications link to the plant computer system. External cable connection shall be via Ethernet cable using Modbus TCP/IP communication protocol as shown on the Instrumentation drawings. Communications shall allow for the MCC to be placed in a daisy chain of SCADA network connectivity. The manufacturer shall be responsible for complete coordination and compatibility with the plant computer system specified under Division 13 and the MCC’s. Proof of coordination with Division 13 shall be included with the MCC submittals.

6. Relays and Timers

a. Control relays: Heavy duty machine tool type, with 10 Amps, 600 Volt convertible contacts, General Electric Co., CR120 Series; Cutler-Hammer, Type M-600; Square D, Type X or equal.

b. Timing relays: Provide programmable timers with 10A, 240VAC rated contacts, Time Mark Corp.; Model 380. Timing ranges shall be set by the control schemes shown on the Drawings. Timing relays shall include a minimum 5-year unconditional warranty.

c. Panel mounted timers: Provide as noted on the

drawings, flush mounted, plug-in type, Eagle Signal, Bulletin 125 Cycle-Flex or equal, with ranges as shown on the Drawings.

7. Pilot Devices

   a. Control operators: Heavy duty, full size, oiltight, with NEMA A600 contact rating. Types and quantities as shown on the Drawings.

   b. Indicator lights: Full size (30.5mm), oiltight, low voltage, LED type, with push-to-test feature. Colors and quantities as shown on the Drawings.

8. Miscellaneous Units

   a. Surge protective devices: Per Section 16192.

   b. Power factor correction capacitors: Sizing per motor manufacturer, provided by motor control center manufacturer in accordance with Section 16150.

   c. General purpose transformers: Open, dry-type, with primary and secondary overcurrent protection in accordance with the NEC, size and voltage ratings as shown on the Drawings. Refer to Section 16191 for additional requirements.

   d. Lighting and Distribution Panelboards: Factory wired to transformer, bolt-on branch circuit breakers, size and voltage rating as shown on the Drawings. Refer to Section 16470 for additional requirements.

   e. Variable frequency drives: Per Section 16370.

D. Surface Preparation and Shop Coatings

1. All non-current carrying metal parts of the control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.

2. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion.

3. Indoor equipment shall be finish painted with one coat of manufacturers standard electrocoated, heat cured enamel. Color shall be ANSI-49 or 61 light grey.

E. Shop Testing

1. Perform manufacturers standard production testing and inspection in accordance with NEMA and ANSI standards. If requested by the Engineer, the manufacturer shall submit certified copies of the test results and reports.

2. Manufacturer shall preload the network device addresses as coordinated with the Contractor and test the communication system of the MCC prior to shipment.

PART 3 EXECUTION

A. Installation

1. Motor control center floor sills shall be bolted directly to the finished floor or equipment pad. Structure shall be leveled and plumb. Anchor bolts shall be ½-inch (minimum). Provide hardware and shims for installation.

2. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed.

3. In general, all conduit entering or leaving a motor control center shall be stubbed up into the bottom horizontal wireway directly below the vertical section in which the conductors are to be terminated, or shall enter the motor control center from the top. Conduits shall not enter the motor control center from the side unless approved in writing by the Engineer.

4. Housekeeping pads shall be included for the motor control centers as detailed on the Drawings with the exception of motor control centers which are to be installed adjacent to an existing unit. Housekeeping pads for these (if used) should match the existing installation.

5. Where motor control centers are to be installed on existing floor slabs, concrete anchor bolts sized and installed per the requirements of this Section shall be used.

6. Install the equipment in accordance with the manufacturers instructions.

7. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.

8. Make wiring interconnections between shipping splits.

9. Install bus splice plates and torque connections.

10. No operator devices shall be located over 6 ft. 6 in. above the operating floor. Circuit breaker operating handles located more than 6 ft. 6 in. above the operating floor shall have operating arm extensions.

B. Field Testing

1. Make the following minimum tests and checks before the manufacturer's representative is called in for testing and adjustment.

   a. Megger incoming line terminals and buses, phase-to-phase and phase-to-ground after disconnecting devices sensitive to megger voltage.

   b. Remove current transformer shunts after completing secondary circuit. Check polarity and continuity of metering and relaying circuits.

   c. Check mechanical interlocks for proper operation.

   d. Test ground connections for continuity and resistance.

   e. Adjust unit compartment doors.

   f. Check control circuit interlocking and continuity with starters in the TEST position. Provide external source of control power for this test.

   g. Adjust motor circuit protectors and overloads to their correct settings for actual motor nameplate currents.

   h. Verify internal communication system and SCADA network communication system to the MCC is operational.

2. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, Engineer, Owner and the equipment manufacturer’s factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

C. Adjustment

1. The motor control center manufacturer shall provide the services of a factory trained service technician for start-up and training of the Owner's personnel. The first trip shall be coordinated with the equipment start-up. The second trip shall include any necessary follow-up or punch list work and shall also include instructions to the Owner or to his/her designated personnel. The manufacturer's service technician shall demonstrate and test all operational features of the installed equipment to the satisfaction of the Owner. Submit a certified copy of the field inspection to the Engineer. No equipment shall be energized without the written approval of the Engineer.

2. The motor control center manufacturer's factory service technician shall make the following inspection, tests and adjustments:

   a. Calibrate and test main and feeder circuit breaker trip devices and protective relays per the approved Coordination Study specified in Section 16000.

   b. Inspect the installation for compliance with the manufacturers recommended installation practices and report all deviations to the Engineer.

D. Cleaning

1. Clean the interior and exterior of electrical equipment in accordance with Section 16000.

END OF SECTION

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SECTION 16500 LIGHTING SYSTEM

PART 1 GENERAL

A. Scope of Work

1. Furnish and install complete lighting systems including panelboards, transformers, lighting fixtures, receptacles, switches, contactors, and all necessary accessories and appurtenances required as hereinafter specified and shown on the Drawings.

B. Related Work

1. All concrete and reinforcing steel required for exterior lighting pole bases shall be as specified under Division 3, but the responsibility of furnishing and installing the material shall be that of Division 16.

2. Conduit is included in Section 16110.

3. Wire is included in Section 16120.

4. Transformers are included in Section 16191.

5. Panelboards are included in Section 16470.

C. Submittals

1. Submit, in accordance with Section 01300. Submittals shall include those set forth in Section 16000, Paragraph 1.03.

2. Wiring Devices

3. Lighting Fixtures

4. Spare parts list for this project.

D. Reference Standards

1. All lighting fixtures shall be in accordance with the National Electrical Code (NEC) and shall be constructed in accordance with the latest edition of the Underwriters Laboratories (UL) "Standards for Safety, Electric Lighting Fixtures." All lighting fixtures shall be UL labeled.

E. Spare Parts

1. Provide the following spare parts:

a. Five (5) spare single pole switches

b. One (1) spare three-way switch

c. Five (5) weatherproof covers for light switches

d. Ten (10) spare lamps for each type of lamp

PART 2 PRODUCTS

A. Materials

1. Lighting Fixtures

a. Lighting fixture types shall be furnished as required by the "Lighting Fixture Schedule" on the Drawings. The catalog numbers are given as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers will be acceptable upon approval by the Engineer.

2. Lamps

a. Fluorescent lamps shall be medium bi-pin, recessed, double contact, with color temperature as shown on the "Fixture Schedule".

b. HID lamps shall be clear and of the size and type as shown on the "Lighting Fixture Schedule."

c. All lamps shall be of one manufacturer and shall be as manufactured by Osram/Sylvania Electric Products, Inc.; General Electric Co.; North American Philips Lighting Corp. or equal.

3. Ballasts

a. Fluorescent ballasts shall be electronic, high-frequency, full-output rapid start or instant start type for use on 265 mA, T8 lamps as shown on the “Fixture Schedule”.

1) All ballasts shall be UL listed, ETL certified, Class "P", high power factor (minimum 0.90).

2) Ballasts shall have a "A" sound rating or better.

3) All ballasts used in exterior applications shall have a minimum starting temperature of 0 degrees F unless otherwise specified.

4) All interior ballasts shall have a minimum starting temperature of 50 degrees F.

5) Ballasts shall be series wired type and designed to operate the number and length of lamps specified.

6) The total harmonic distortion (THD) of each ballast shall be in accordance with the requirements of the utility company and in no case shall it be more than 10 percent THD.

7) Ballasts shall have a minimum ballast factor of 0.88.

8) Ballasts shall have nominal power factor 0.90 or higher.

9) Ballasts shall have a maximum lamp current crest factor of 1.7.

10) Ballast shall provide normal rated life for the lamp specified.

11) All electronic ballasts shall be warranted for parts and replacement for 1 full year from the date of installation.

12) Electronic ballasts shall be as manufactured by Advance, Model Mark V, similar by Valmont; Osram/Sylvania; MagneTek or equal.

b. HID ballasts shall be of the constant voltage auto-transformer type of the correct size and voltage for the fixture it is to serve as shown on the "Lighting Fixture Schedule". All ballasts shall be as manufactured by Holophone Lighting; MagneTek Universal Manufacturing; Advance Transformer Co. or equal.

4. Flexible Fixture Hangers

a. Flexible fixture hangers used in non-hazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be Type ECHF as manufactured

by the Crouse-Hinds Co., similar by Appleton Electric Co.; Killark Electrical Mfg. Co. or equal.

b. Where required in Section 16000 all pendent mounted and recessed in suspended ceilings, recessed lighting fixtures shall be provided with four anti-sway supports to meet Type II seismic requirements.

5. Emergency Lighting Battery Units

a. Emergency lighting units and remote lighting heads shall be as specified in the "Lighting Fixture Schedule" shown on the Drawings.

b. Battery units shall be of the self-contained, fully automatic type with sealed lead acid batteries.

c. Unit enclosures shall be compatible to their environment and units shall comply with the requirements of NFPA 70 (NEC).

d. All necessary mounting hardware shall be provided.

6. Photo Electric Controls

a. Photo electric control with time delay for outdoor lighting shall be completely self-contained and not affected by moisture, vibration or temperature changes.

b. ON/OFF adjustments are to be made by movement of a light level selector without the use of tools in a range from 2 to 50 foot candles.

c. Photo electric control device shall be SPST, and have 2000 watt tungsten capacity and be Tork Catalog Number 2101 (120V); 2104 (208-277V) or equal by Intermatic Inc., Carlon, or other approved equal.

7. Device Color

a. In administrative office areas, conference rooms, breakrooms, restrooms, and control rooms, switches, receptacles and other devices shall be white.

b. In all other areas (electrical, mechanical, process, etc.), switches, receptacles and other devices shall be gray.

c. In existing rooms, devices shall match color of existing devices.

8. Switches

a. Wall switches shall be of the indicating, toggle action, flush mounting quiet type. All switches shall conform to Federal Specification WS896-E.

b. Wall switches shall be the manufacturer's "industrial specification grade". Wall switches shall be the following types and manufacturer or approved equal.

1) Single pole - Arrow-Hart, Catalog Number 1991, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

2) Double pole - Arrow-Hart, Catalog Number 1992, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

3) Three way - Arrow-Hart, Catalog Number 1993, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

4) Four way - Arrow-Hart, Catalog Number 1994, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

5) Single pole, key operated - Arrow-Hart Catalog Number 1991-L, or approved equal.

6) Single pole, pilot indicating, Bryant Catalog Number 4901-PLR120, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

7) Momentary contact, 2 circuit, center off - Arrow-Hart, Catalog Number 1895, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc.,or approved equal.

8) Weatherproof cover for standard toggle switches - Crouse-Hinds Catalog Number DS181, or approved equal by Appleton Electric Co., L.E. Mason Co., or approved equal.

9) Explosion-proof single pole switches shall be for 20 amperes, 120/277 volts, mounted in cast boxes

and be similar and equal to Crouse-Hinds EDS Series, or approved equal by Appleton Electric Co., L.E. Mason Co., or approved equal.

9. Receptacles

a. Receptacles shall be the manufacturer's "industrial specification grade". Receptacles shall be of the following types and manufacturer or approved equal. Receptacles shall conform to Federal Specification WC596-F.

1) Duplex, 20A, 125V, 2P, 3W; Arrow-Hart, Catalog Number 5362, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

2) Weatherproof or corrosion resistant single, 20A, 125V, 2P, 3W; by Harvey Hubbell, Inc., Pass & Seymour, Inc., with TayMac Corp., #30310G cover, or approved equal.

3) Weatherproof or corrosion resistant duplex, 20A, 125V, 2P, 3W; by Harvey Hubbell, Inc., Pass & Seymour, Inc., with TayMac Corp., #10310G cover, or approved equal.

4) Ground fault interrupter, duplex, 20A, 125V, 2P, 3W; Arrow-Hart Catalog Number GF 5342, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

5) Duplex, 20A, 125V, 2P, 3W with transient voltage surge suppressor and indicator light; Pass & Seymour Catalog 6362-5P, approved equal by Harvey Hubbell Inc., Bryant Electric Co., or approved equal.

6) Stainless steel indoor mounting plate for G.F.I. receptacle; Arrow-Hart Catalog Number 97061, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc. or approved equal.

7) Weatherproof cover for G.F.I. receptacle shall be TayMac Corp., #20310G, or approved equal.

8) Explosion-proof, 20A, 125V, 2P, 3W; Appleton Electric Co. Catalog Number EFS175-2023 or EFSC175-2023 or approved equal by Crouse-Hinds Co., Killark Electric Manufacturing Co., or

approved equal. Furnish one Appleton Electric Co. Catalog Number ECP-1523 cap or approved equal by Crouse-Hinds Co., Killark Electric Manufacturing Co., or approved equal for every two receptacles (minimum of one).

9) Single, 20A, 250V, 2P, 3W; Arrow-Hart Catalog Number 5861, or approved equal by Harvey Hubbell, Inc., Pass & Seymour, Inc., or approved equal.

10) Single, 30A, 125V, 2P, 3W; Arrow-Hart Catalog Number 5716; cap: Arrow-Hart Catalog Number 5717 or approved equal.

11) Single, 30A, 250V, (3 phase) 3P, 4W; Arrow Hart Catalog Number 8430N; Cap: Arrow-Hart Catalog Number 8432AN or approved equal.

10. Device Plates

a. Plates for flush mounted devices shall be of the required number of gangs for the application involved and shall be:

1) Smooth high strength thermoplastic or nylon of the same manufacturer as the device for all administrative office type areas. Color to match device.

2) Type 302 (18-8) high nickel stainless steel of the same manufacturer as the device.

b. Plates for surface mounted device boxes shall be of the same material as the box.

PART 3 EXECUTION

A. Installation

1. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.

2. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.

3. Fixtures noted to be installed flush in suspended ceilings shall be of mounting types suited for the type ceiling involved. It shall be the responsibility of the electrical contractor to verify the ceiling types prior to ordering fixtures.

4. Flexible fixture hangers shall be used for all pendant mounted fixtures. Fixtures 2-ft long and larger shall be supported with a minimum of two fixture hangers.

5. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.

6. Exterior lighting poles shall be mounted plumb.

7. Fixture locations are shown on the Drawings in approximate locations; however exact locations shall be coordinated so as to avoid conflicts with HVAC ducts, equipment and other obstacles.

8. Switch and receptacle outlets shall be installed flush with the finished floor or wall when raceways are shown as "concealed" on the Drawings.

9. Device Mounting Height

    a. Light switches shall be mounted 48″ AFF (above finished floor) to center of box, located on the strike side of the door.

    b. Wall mounted receptacles shall be vertically mounted, AFF to the center of the box as follows, unless otherwise noted on the Drawings.

        1) Process areas and shops – 36″

        2) Administration office areas – 18″

        3) Corridors and hallways – 18″

        4) Electrical and mechanical rooms – 18″

        5) Restrooms – 18″

        6) Exterior walls – 18″

    c. Where the wall and partitions are of unplastered brick

or masonry, the height of wall outlets as given above shall be adjusted so that one horizontal edge of the box lines up with a horizontal joint in the masonry.

10. Identification labels of light switches and receptacles shall be per Section 16000.

B. Replacement

1. Lamps (except for H.I.D.) used during the building construction, prior to 2 weeks from completion of the work, shall be removed and replaced with new lamps.

C. Cleaning Up

1. Plastic dust cover bags to be provided with new parabolic reflector lighting fixtures shall be removed after all construction activity that may cause dust formation on reflector surfaces has been completed.

2. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

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SECTION 16502 LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

A. Scope of Work

1. Provide a complete lightning protection system (LPS) for existing and new buildings and structures at Orange County's Eastern Water Reclamation Facility under the Phase V Improvements Construction as described herein and shown on the Contract Documents.

   a. LPS shall be provided for the following existing buildings and structures:
      1) North Control Building 155
      2) Phase I/II BNR Basins for 1st Anoxic (Process 215), Aeration (Process 220), and 2nd Anoxic (Process 230). Fermentation structure (Process 210) is not included.
      3) Phase III BNR Basins for Fermentation (Process 310), 1st Anoxic (Process 315), Aeration (Process 320), and 2nd Anoxic (Process 330).
      4) Phase III Effluent and In-Plant Reuse Pumping Station (Process 390).
      5) Phase IVC Biological Basin 7 (Process 420).

   b. LPS shall be provided for all new Phase V buildings and structures, including:
      1) Pretreatment Structure, Odor Control and Influent Metering Stations (Process 500).
      2) Supplemental Carbon Feed Canopy (Process 520).
      3) Clarifier No. 11 (Process 540).
      4) Secondary Effluent Reject Pumping Station, Metering Station and Diversion Structures (Process 560).
      5) West electric building (Process 575)
      6) Chlorine Contact Tank (Process 580).

2. The system shall be UL Master Labeled and shall be designed and installed in compliance with provisions of UL 96A and NFPA 780.

3. The Contractor shall employ the services of a licensed lightning protective systems engineering company to design and install the lightning protection system and prepare detailed installation drawings and material specifications. These drawings and specifications shall be submitted for review in accordance with Section 01300.

4. The lightning protection system shall be checked by a UL field inspector upon completion of the installation. The Contractor shall assume full responsibility for the correctness of the installation and shall make any and all corrections and additions deemed necessary by the UL inspector. The Contractor shall pay for all costs of the UL inspection and any subsequent reinspections as required.

5. The lightning protection system for the buildings shall consist of conductors, air terminals and accessories which shall be grounded to the building structural steel or ground grid at regular intervals. The contractor may submit alternate methods of lightning protection with his proposal, provided the alternate provides equal or greater lightning protection than specified.

6. The lightning protection system contractor shall coordinate his work with the electrical contractor.

7. Each bidder or his authorized representatives shall, before preparing his proposal, visit all area of the existing buildings and structures in which work under this section is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that he or his representative has visited the buildings and noted the locations and conditions under which the work will be performed and that he takes full responsibility for a complete knowledge of all factors governing his work.

B. Related Work

1. Refer to Section 16660 for Grounding Systems.

C. Submittals

1. Contractor shall submit to the Engineer/Owner for review the facility lightning protection system. The submittal data shall contain the following minimum information.

   a. Plan view of site showing buildings and structures, locations of air terminals, and associated zone of protection for each air terminal; show all equipment on roofs which require protection.

   b. Schematic diagram of lightning protection system showing air terminals, conductors, and other connectors or fittings required for the complete

system. Provide details showing bonding requirements to structural steel, water piping, etc.

c. Locations of connection points of lightning protection system to facility grounding system.

d. Bill-of-materials

e. Final test results and certifications

D. Reference Standards

1. Underwriters Laboratories (UL)

a. UL 96 – Standard for Lightning Protection Components

b. UL 96A – Standard for Installation Requirements for Lightning Protection Systems

2. National Fire Protection Association (NFPA)

a. NFPA 780 – Standard for the Installation of Lightning Protection Systems

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

PART 2 PRODUCTS

A. Materials

1. All materials shall be new and shall comply in weight, size, and composition with the requirements of UL and NFPA.

2. Grounding materials and methods shall be equal to those specified under Section 16660.

3. The following is a brief description of the various items of material.

a. Air Terminals

1) Buildings 75 feet and less in height shall use Class I air terminals. Aluminum air terminals shall be solid aluminum, ½″ minimum diameter. Copper air terminals shall be nickel plated solid copper, 3/8″ minimum diameter. Length 18″.

2) Buildings over 75 feet tall shall use Class II air terminals. Aluminum air terminals shall be solid aluminum, 5/8″ minimum diameter. Copper air terminals shall be nickel plated solid copper, ½″ minimum diameter. Length 18″.

3) Air terminal type shall be copper unless the following applies. Copper lightning protection materials shall not be installed on aluminum roofing, siding or other aluminum surfaces.

4) Air terminal base supports shall be specifically designed for the surface where used. All air terminal bases shall be cast bronze with stainless steel bolt pressure cable connectors. Air terminal bases for flat roof areas shall be of the adhesive type.

b. Conductors

1) Buildings 75 feet and less in height shall use Class I conductors. Main conductors shall be either aluminum 14 AWG, 28 strand (weighing 105 lbs. per 1,000 feet) or tinned copper 17 AWG, 32 strand (weighing 220 lbs. per 1,000 feet).

2) Buildings over 75 feet tall shall use Class II conductors. Main conductors shall be either aluminum 13 AWG, 37 strand (weighing 200 lbs. per 1,000 feet) or tinned copper 14 AWG, 28 strand (weighing 380 lbs. per 1,000 feet).

3) Conductor type shall be copper unless the following applies. Copper lightning protection materials shall not be installed on aluminum roofing, siding or other aluminum surfaces. Aluminum lightning protection materials shall not be embedded in concrete, masonry, or on or below copper surfaces.

c. Fasteners

1) Conductor fasteners shall be an approved type of non-corrosive metal and have ample strength to support conductors.

d. Cable Connectors

1) All cable connectors shall be per NFPA standards, cast bronze with screw pressure type stainless steel bolts and nuts. For buried and non-accessible connections, exothermic weld process shall be used.

PART 3 EXECUTION

A. Installation

1. All materials shall be installed by a UL listed lightning protection contractor. The lightning protection system shall be installed per approved shop drawings and UL and NFPA recommended practices.

2. The lightning protection system engineering company shall provide jobsite assistance and supervision of the installation as required, and shall be present during the UL inspection.

3. Lightning Protection System shall be installed in a neat and inconspicuous manner.

4. All mounting and penetration of roof surface shall be coordinated with roofing contractor to assure maximum roofing guarantee. All through-roof penetration flashings shall be furnished, sealed and guaranteed by a licensed roofing contractor.

5. Excavate and backfill as required. Finish grade and restore to original condition.

6. All metal bodies within 6 feet of the conductor shall be bonded to the system with approved fittings and conductors. Connections between dissimilar metals shall be made with approved bimetallic connections.

7. As the work progresses, legibly record all field changes on a set of project contract drawings. When the project is complete, furnish a complete set of reproducible "As-built" drawings for the Project Record Documents per Section 01720.

8. Air Terminals:

a. Air terminals shall be spaced so as not to exceed 20 feet apart around the outside perimeter of the roof or ridge and not over 50 feet apart through the

center of flat roof areas.

b. Air terminals shall not project more than 24 inches nor less than 10 inches above the protected object.

9. Conductor Routing:

a. All main conductors shall maintain a downward or horizontal course, free from "U" or "V" pockets.

b. Conductors shall not form an angle of less than 90 degrees nor less than an 8-inch radius bend.

c. Metal roofing and siding, eave downspouts or other metal parts subject to displacement will not be permitted as substituted parts of the lightning conductor system.

d. Fasteners shall be spaced not more than 3 feet horizontally or vertically and shall be the same material as the conductor.

e. Bimetallic fittings shall be used for all connections between dissimilar metals.

10. Down Conductors:

a. Down conductors shall follow the most direct patch possible between roof conductors and ground terminals.

b. All buildings, with a ground perimeter less than 250 feet shall have a minimum of two down conductors installed at the diagonally opposed corners of the building.

c. Any building with a ground perimeter in excess of 250 feet shall have down conductors installed so that the distance between the conductors does not exceed 100 feet.

d. Within the building, the down conductors shall be placed in Schedule 80 PVC conduit in the wall. Care shall be taken not to damage the conductors. Connections through roof shall be made with through-roof connectors.

e. Splices will not be permitted on conductors embedded in concrete.

f. Down conductors shall be installed concealed. When conductors cannot be concealed they shall be substantially guarded to prevent mechanical injury or displacement. The guards shall protect the conductor from grade level to a height of at least 6 feet. All conduit used for physical protection of down conductors shall be Schedule 80 PVC.

11. Roof Conductors:

a. Roof conductors shall interconnect and provide a two-way path from all air terminals.

b. Roof conductors shall bond together all air terminals and shall be installed exposed except that where connections are made to equipment located under roof.

c. Conductors on perimeters of flat roofs shall form closed loops.

d. Dead end air terminals shall not be permitted.

e. All interconnecting cables from air terminals to roof conductors or metal roof decks shall be similar to roof conductor.

12. Pitch Pockets:

a. Contractor shall subcontract all pitch pocket work to a qualified roofing contractor.

13. Grounding System:

a. Ground rods shall be provided at each down conductor and they shall be installed a minimum of 3 feet away from the foundation walls.

b. The ground rods shall be in addition to the ground rods provided for the system grounding grid.

c. Connectors used to connect ground rods to the down conductors shall make contact with the ground rods for a distance of 1-1/2" measured parallel to the ground rod. In addition, ground terminals shall be interconnected with the grounding grid, and all grounding mediums. This shall include electric and telephone service grounds and underground metallic piping systems.

d. Bonding of down conductors to the system grounding grid and splicing of conductors in concealed work shall be made by an exothermic weld process.

e. Where conductors are bonded to structural steel or metal roof decks, a bolted-on bonding plate shall be used. All other bonding of the lightning protection system shall be made with pressure clamps.

f. Contractor shall notify design Engineer prior to concealment for Engineer's inspection.

B. Testing

1. General:

a. Notify the Engineer in writing at least two weeks prior to scheduling any testing. Testing shall be witnessed by the Engineer.

b. The Lightning Protection System shall be tested for continuity of all conductors and air terminals.

c. Maximum resistance of system shall not exceed five (5) ohms unless otherwise specified or scheduled. If such resistance cannot be obtained with the system, provide additional grounding as directed by the Engineer, at no additional cost to the Owner.

d. Contractor shall submit written test results to the Engineer.

2. Indicators:

a. Stamped metal tags shall be attached to, or adjacent to, each down conductor indicating in feet the exact vertical depth in the ground of each ground terminal.

1) Down leads connected to water pipes shall also be indicated.

2) Tags shall be of a corrosion resistant metal and shall be placed at a height of 5 feet above finish grade.

END OF SECTION

SECTION 16600 UNDERGROUND SYSTEM

PART 1 GENERAL

A. Scope Of Work

1. Furnish and install a complete underground system of raceways, manholes and handholes as shown on the Drawings and as specified herein. This work includes all underground raceways which are direct buried or concrete encased. All conduits on this project shall be concrete encased or below a building slab.

B. Related Work

1. All concrete and reinforcing steel shall be as specified in Division 3, but the responsibility of furnishing and installing the material shall be that of this Section.

2. All trenching, excavation and backfilling, including gravel and sand bedding and surface restoration shall be as specified in Division 2, but the responsibility of furnishing and installing the material shall be that of this Section.

3. Conduit, fittings, installation, etc. shall be as specified in Section 16110.

4. Polyethene warning tape shall be as specified in Section 16191.

5. Ground rods and other grounding materials and methods shall be as specified in Section 16660.

6. Precast electrical concrete manholes and handholes shall be furnished under Division 16 and shall be in compliance with precast concrete structures as specified in Division 3.

7. Concrete encasement for electrical ductbanks shall be as specified in Section 16900.

C. Submittals

1. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data, for the following:

    a. Manholes and handholes along with associated buoyancy calculations.

b. Plastic duct spacers

c. Manhole and handhole frames and covers

d. Underground raceway routing in accordance with Section 16000, PART 1, paragraph C,4.

PART 2 PRODUCTS

A. Materials

1. Cable racks, supports, pulling-in irons, manhole steps and hardware shall be hot dipped galvanized steel as manufactured by Line Materials Co. or equal.

2. Precast concrete manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load. Precast manholes and handholes shall be as manufactured by Brooks Products Co. or equal.

3. Manhole frames and covers shall be cast iron heavy duty type for class H-20 wheel loading, and shall be as manufactured by Neenah, or equal. Manhole covers shall be marked “ELECTRIC”.

4. Handhole covers and frames shall be hot dipped galvanized and designed for a Class H-20 wheel load. Handhole covers and hatches shall have 316 stainless steel security bolts. Handhole covers shall be marked “ELECTRIC”.

5. Bell ends and plastic duct spacers shall be as manufactured by Carlon or equal.

PART 3 EXECUTION

A. Installation

1. Install raceways to drain away from buildings. Raceways between manholes or handholes shall drain toward the manholes or handholes. Raceway slopes shall not be less than 3-in per 100-ft.

2. Reinforce raceway banks as shown on the Drawings.

3. Lay raceway lines in trenches on a clean sand backfill bedding (not gravel or rock) not less than 6 inches thick and well graded and compacted.

4. Use plastic spacers located not more than 4-ft apart to hold raceways in place. Spacers shall provide not less than 2-in clearance between raceways.

5. The minimum cover for raceway banks shall be 24-in unless otherwise permitted by the Engineer.

6. Make raceway entrances to buildings and vaults with rigid aluminum conduit not less than 10-ft long. Conduits which are not concrete encased for runs below floor slabs in slab-on-grade construction shall be rigid aluminum conduit. Conduits which are concrete encased for runs below floor slabs in slab-on-grade construction shall be encased under the slab to their respective equipment.

7. Raceway terminations at manholes shall be with end bells for PVC conduit and insulated throat grounding bushings with lay-in type lugs for metal conduit.

8. For bends in 2 inch and larger raceways, long radius elbows, sweeps and offsets shall be used.

9. All 2 inch and larger raceways shall have a mandrel drawn through followed by a swab to clean out any obstructions which may cause cable abrasions. The mandrel shall be 12 inches in length and the diameter 1/2 inch less than the inside diameter of the raceway. All 1-1/2 inch and smaller raceways shall be swabbed clean before installing cables.

10. Plug spare raceways and seal them watertight at all buildings and structures.

11. Raceways in use shall be sealed watertight at all buildings and structures.

12. Install pulling-in irons opposite all raceway entrances to manholes.

13. Cables shall be trained in manholes and supported on racks and hooks at intervals not greater than 3 feet-0 inches and supports shall be installed on each side of all splices. Furnish inserts on all manhole walls for mounting future racks as well as racks required for present installation. Branch circuit conductors shall not be run in manholes.

14. All joints shall be made so as to prevent the passage of concrete inside the conduit to form obstructions or cause cable abrasions.

15. Manhole covers in streets shall finish flush with finished paving and in other areas shall finish 3 inches above crown of adjacent roadway. Floor elevations of manholes shall be so set that the center line of the lowest conduit entering will be not less than 1-foot above the floor and center line of the highest conduit entering will be not less than 1 foot below the roof slab.

16. Concrete monuments shall be provided at each stubbed conduit location. Monuments shall be as shown on the Drawings and shall be installed in the same manner outlined for manhole covers.

17. A #6 bare copper wire (stranded) shall be installed in each 4-inch PVC conduit containing control cable unless otherwise noted.

18. A 3/4-inch by 20-foot copperclad ground rod shall be driven in the bottom of each manhole. All bond wires, galvanized conduits and metal cable racks shall be bonded to the ground rod.

19. Polyethylene warning tape shall be provided for all underground raceways, duct banks etc. Tape shall be placed along the raceways entire length and shall be installed 18" above the raceways on compacted backfill material.

20. Spare and empty conduits shall have a pull wire (3/16 inch polypropylene) installed.

21. As-built drawings shall be furnished showing each conduit terminations, elevations, locations, manholes, handholes, etc.

END OF SECTION

SECTION 16660 GROUNDING SYSTEM

PART 1 GENERAL

A. Scope Of Work

1. Furnish all labor, materials, equipment and incidentals required and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code (NEC), as shown on the Drawings and as specified herein.

2. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the NEC. Minimum size shall be No. 12 AWG.

B. Submittals

1. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data, for the following:

   a. Manufacturer's name and catalog data for ground rods, test stations, materials and exothermic welding methods and materials.

   b. Test results

PART 2 PRODUCTS

A. Materials

1. Conduit shall be as specified under Section 16110.

2. Wire shall be as specified under Section 16120.

3. Ground rods shall be 3/4-in diameter by 20-ft copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be 0.25 mm. Ground rods shall be Copperweld or equal.

4. Grounding conduit hubs shall be malleable iron type, manufactured by Thomas & Betts Co.; Catalog No. 3940 (3/4-in conduit size), similar to Burndy; O.Z./Gedney Co. or equal, and of the correct size for the conduit.

5. Waterpipe ground clamps shall be cast bronze saddle type, manufactured by Thomas & Betts Co. Cat. No. 2 (1/2-in, 3/4-in, or 1-in size), similar by Burndy; O.Z./Gedney Co. or equal, and of the correct size for the pipe.

6. Buried grounding connections shall be by Cadweld

process, or equal exothermic welding system.

7. Direct buried bare copper wire shall be tinned.

PART 3 EXECUTION

A. Installation

1. The service entrance equipment ground bus shall be grounded to a ¾-inch cold water pipe and to the ground as indicated on the Drawings. Run grounding electrode conductors in Schedule 80 PVC conduits and seal conduits watertight. Do not allow water pipe connections to be painted. If the connections are painted, disassemble them and re-make them with new fittings.

2. Install equipment grounding conductors with all feeders and branch circuits.

3. Bond all steel building columns in new structures together with ground wire in rigid conduit and connect to the distribution equipment ground bus, as shown on the Drawings.

4. Ground wire connections to structural steel columns shall be made by exothermic welding.

5. Metal conduits stubbed into a motor control center shall be terminated with insulated grounding bushings and connect to the motor control center ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with NEC Table 250.122, except that a minimum No. 12 AWG shall be used.

6. Ground bus in all motor control centers and unit substations shall be connected to the service entrance equipment ground bus with a No. 1/0 conductor or as noted on the Drawings.

7. Ground transformer neutrals to the nearest available grounding electrode with a minimum conductor sized in accordance with NEC Article 250 or as shown on the drawings.

8. Drive grounding electrodes (where rock is encountered, grounding plates may be used in lieu of grounding rods) and install ground grids as shown on the Drawings.

9. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in

accordance with the NEC.

10. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.

11. Lay all underground grounding conductors slack and, where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified herein.

12. Care shall be taken to ensure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

13. All grounding type receptacles shall be grounded to the outlet boxes with a No. 12 XHHW-2 green conductor connected to the ground terminal of the receptacle and fastened to the outlet box by means of a grounding screw.

B. Inspection And Testing

1. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.

2. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance to ground of the system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method. Notify the Engineer in writing at least two weeks prior to scheduling any testing. Testing shall be witnessed by the Engineer. Provide certified calibration sheets including dates for all equipment to be used for testing with notice of scheduled testing. Calibration sheets shall also indicate that the units have been calibrated within six months of the testing date.

3. All test equipment shall be provided under this Section and approved by the Engineer.

4. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

5. Testing shall be performed before energizing the distribution system.

6. A separate test shall be conducted for each building or

system.

7. Dry season resistance of the system at each testing location shall not exceed five ohms. If such resistance cannot be obtained with the system, provide additional grounding, as directed by the Engineer, at no additional cost to the Owner.

8. Contractor shall submit written test results to the Engineer.

END OF SECTION

SECTION 16720 FIRE ALARM SYSTEM

PART 1 GENERAL

A. Scope Of Work

1. The Contractor shall employ the services of a licensed fire alarm protection systems engineering company to design and install the fire alarm protection system and prepare detailed installation drawings and material specifications for the West Electrical Building (Bldg 575), Preliminary Treatment Structure (Process 500), and the North Control Building (Bldg 155) at the Orange County Eastern Water Reclamation Facility, Orlando, Florida, to be signed and sealed by a professional engineer registered in the state where the project is located. The existing Main Electrical / Blower Building fire alarm control panel has capacity for six additional detection zones, four manual pull stations and six audio-visual strobe lights for the associated Preliminary Treatment Structure. This existing panel may be modified if desired or the new fire alarm panel in the Preliminary Treatment Structure may be made a sub-panel to this existing panel. These Contract Documents shall be submitted for review in accordance with Section 01300.

2. The fire alarm protection system shall be checked by the local fire authority having jurisdiction (AHJ) during design and upon completion of the installation. The Contractor shall assume full responsibility for the correctness of the installation and make any and all corrections and additions deemed necessary by the fire authority. The Contractor shall pay for all costs of the inspection and any subsequent reinspections as required. Provide additional upgrades to existing site fire alarm systems if required by the AHJ.

3. Design, furnish, install, test and place in operating condition an electronically-operated, double-supervised, closed-circuit fire alarm system. All units of equipment shall be listed by UL for fire alarm signaling use and shall consist of a control unit, manual fire boxes, alarm indicating appliances, automatic smoke and heat detectors, door release appliances, standby battery and charger and supervisory switches, all located as required by the system designer and applicable codes and wired in accordance with the manufacturer's instructions to make a complete and workable system.

4. System designer shall coordinate with the local Fire Department to assure that all local, state, and federal requirements are met.

5. The fire alarm system design shall provide total coverage for all the facilities and shall be in accordance with the applicable local building codes and the Americans with Disabilities Act (ADA). Where the local codes are silent on an issue, the design shall be in accordance with NFPA 101. The application, installation, performance and maintenance of the fire alarm system and its components shall be in accordance with NFPA 72.

6. The design and installation of all wiring, cable and equipment shall be in accordance with NFPA 70, and specifically with Article 760, Article 770 and Article 800.

7. Provide all the documentation indicated in NFPA 72, Sections 1-7 and 7-5.2. The documentation and permanent records shall include but not be limited to written statement by the Contractor indicating the system has been installed and tested in accordance with applicable documents; certificate of completion; installation instructions and after successful completion of acceptable test satisfactory to the Authority having jurisdiction; a set of reproducible as-built installation drawings; operation and maintenance manuals and a written sequence of operation.

8. The fire system coverage in the Preliminary Treatment Structure shall comply with NFPA 820.

9. There are additional fire alarm systems located on the site. These fire alarm systems are located at the Operations and Control Building (Bldg 170), the Maintenance Building (Bldg 175), the Main Electrical / Blower Building (Bldg 185), and Clarifier No. 10 Electrical Building (Bldg 190). Design shall take this into account when designing for the new fire alarm systems for communication with the Fire Department.

B. Related Work

1. Conduit, boxes, fittings, and supports shall be furnished for all wiring to meet the requirements of the system design and be provided and installed under this Section as specified in Section 16110.

2. Wire shall be furnished to meet the requirements of the system design and be provided and installed under this Section as specified in Section 16120.

3. Fire suppression systems, sprinkler system alarm valves, flow and supervisory switches, and HVAC duct smoke detectors shall be furnished under Division 15.

C. Submittals

1. Submit, in accordance with Section 01300, the following:

a. Shop drawings for each Fire Alarm Control Panel and its associated detectors, alarms, inputs and outputs. Each set of Fire Alarm Control Panel shop drawings shall include:

1) Manufacturers equipment data sheets including sufficient data to indicate compliance with the specifications and component identification tag number, when applicable. Show physical dimensions, mounting and installation details and wiring connections. Indicate all options, special features and deviations from this Section.

2) Bill of material for each fire alarm panel listing all modules by quantity and part number.

3) Listing of every input/output point address for each panel.

4) Standby battery calculations.

5) Internal point-to-point wiring diagram for each panel showing interconnections between modules.

6) External loop interconnection wiring diagram for each initiating and notification circuit, including interlock wiring to HVAC. Loop diagrams shall indicate the origin of the loop at the control panel and include all external devices connected to the loop. Identify external devices by room number or location and type. Show all terminal numbers and color coding for wiring.

7) Fire Department acceptance paperwork.

8) Manufacturer’s warranty.

D. Sequence Of Operation

1. Upon activation of any manual pull station, automatic detector, the system shall:

    a. Automatically notify local Fire Department (or other agency as directed by the fire authority) via a dedicated telephone line and transmitting/receiving equipment provided, installed and coordinated by the Contractor. All costs for this work shall be borne by this Contractor.

    b. Automatically start the audible and visual alarm indicating appliances throughout the building under alarm (if more than one) as specified herein.

    c. The audible alarm appliances shall sound the standard evacuation tone temporal pattern 3 and visual alarms flash until alarm initiating devices have been restored to normal and the reset switch located at the control panel actuated.

2. When any of the building's alarm initiating devices are activated, its building exterior mounted beacons shall operate.

3. The local Fire Department shall be hereinafter referred to as the Fire Department.

4. Communication between the fire alarm control panels and the plant’s main telephone backboard for autodial out to the fire department may be done utilizing the existing fiber loop system, if approved by the AHJ. The main telephone backboard is located in the North Electrical Building 150. Provide additional components as required to make system operational and comply with the Fire Department requirements.

E. Reference Standards

1. National Fire Protection Association (NFPA)

    a. NFPA 70 - National Electrical Code.

    b. NFPA 72 - National Fire Alarm Code.

    c. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.

    d. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

2. Underwriters Laboratories (UL)

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

F. Spare Parts

1. Provide five (5) keys for each control panel door.

G. Manufacturers

1. To provide consistency with the preferred fire alarm systems on site, the manufacturer of the fire alarm control panel shall be Edwards Systems Technology, product line EST, no exception. References within this specification to other manufacturers are for technical equivalency only.

H. Warranty

1. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of three (3) years.

2. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the machine(s) and the unit(s) restored to service at no additional cost to the Owner.

3. The manufacturer’s warranty period shall run concurrently with the Contractor’s warranty period. No exception to this provision shall be allowed.

I. Extended Warranty (Bid Additive Alternate)

1. If authorized by the Owner, Contractor and equipment manufacturer shall extend the initial warranty period listed in the previous paragraph for a period of two (2) years, bringing the total warranty coverage up to five (5) years.

2. The extended warranty shall include all terms and conditions required to be provided by the Owner to maintain the terms of the warranty.

PART 2 PRODUCTS

A. Materials

1. The control panel shall be surface mounted, modular, of dead-front construction with key lock door, using solid-state components to operate the system. Alarm initiating circuits shall meet National Electrical Code (NEC) requirements for limited energy applications and function with up to 100 ohms resistance in the alarm initiating device and its associating wiring. The control unit shall contain an internal audible signal with audible acknowledge switch, system reset switch, lamp test switch, audible silence switch and auxiliary master box disconnect switch. Control unit shall be double-supervised so that a trouble signal shall sound in the event of loss of either operating or supervising power. Two light-emitting diodes (LEDS) shall be installed and shall remain illuminated to indicate both operating and supervisory power are energized. Trouble audible acknowledge switches shall be furnished with its associated LED so that indication of trouble on alarm initiating circuits, alarm indicating circuits and supervisory circuits shall initiate a control panel audible and be silenced independent of each other. The silencing of a trouble condition in any zone shall not prevent the resounding of the control panel audible in the event of a subsequent trouble conditions in other circuits. When trouble conditions are restored to normal, the audible acknowledge switch shall not require restoration to normal.

    a. Each circuit shall be supervised to provide a trouble condition in the event of an open or short in either circuit. A means shall be provided so that alarm indicating appliances may be discontinued before the actuated initiating device has been restored to normal; but shall not prevent the resounding of subsequent alarms received from another zone. A visual indicator shall be provided so that operating personnel can readily determine that the signals have been discontinued.

    b. The initiating device circuits and the notification appliance circuits shall be Class "A". They shall allow the receipt of and notification of alarms even in the event of a single open or a single ground in the circuits.

    c. Each of the zones shall have a separate zone trouble and alarm indicator. All field wires connected to alarm initiating devices necessary to activate an alarm shall be electrically supervised and a single open or ground on such wires shall not cause an alarm

condition. An open in any alarm initiating circuit shall cause the associated visual trouble indicator to flash and the control panel audible to sound steady, until the audible acknowledge switch is actuated at which time the trouble indicator shall go steady and the control panel silenced. On alarm condition in any alarm initiating circuit, its associated visual alarm indicator shall flash and the control panel audible shall pulsate and the alarm indicating appliances shall sound. When a zone audible acknowledge switch is activated, the indicator shall be lit steady and the control panel audible silenced. The silencing of a trouble or alarm condition in any zone shall not prevent the resounding of the control panel audible in the event of a subsequent alarm or trouble condition in other circuits, or loss of either operating or supervising power. Each alarm initiating circuit shall have associated dry, fused, Form "C" alarm contacts for its associated zone. This contact shall transfer upon alarm condition in its associated zone. Each initiating circuit containing four wire smoke detectors shall incorporate an end of line relay to supervise the smoke detector power circuit.

d. The horn/strobe light units shall be wired on dual circuits to permit silencing of the horns and allow the strobe lights to flash during alarm conditions.

e. Means shall be provided to sound the control panel audible upon a ground fault between any supervised circuit and ground. This ground fault shall also light a visual indicator on the control unit for rapid identification of the trouble cause.

f. All visual indicators on the control panel shall be supervised so that an open or short in any visual indicator shall provide a trouble indication.

g. The batteries used with the fire alarm control panel shall be capable of operating the panel for 60 hours with a 5 minute ring-down at the end of a 60 hour period. The calculation used to determine battery capacity shall be submitted to the Engineer and presented to the Fire Department at the time of inspection. Control unit shall be Autocall, Type MDK or equal.

2. Manual fire boxes shall be non-coded and shall be semi-flush mounted in finished areas and surface-mounted in unfinished and existing areas. Stations shall be double-

action with "LIFT TO BREAK" plastic shield. When operated, fire boxes shall remain mechanically locked until manually reset. Construction shall be of rigid metal with raised lettering and clear plastic shield with lettering "LIFT TO BREAK - PULL LEVER DOWN". Manual fire boxes shall be Autocall, double-action 4051 or equal. Double-action stations requiring external hammer to break glass to gain access to actuating lever shall not be acceptable.

3. Manual fire boxes for "WP" weatherproof applications shall be non-coded, surface mounted type. Stations shall be slide action type with internal glass rod. Construction shall be die-cast aluminum finished in red with raised natural aluminum lettering, gasketed with back box. Stations shall be Autocall, Catalog No. 5 DW or equal. Double-action stations requiring external hammer to break glass to gain access to actuating lever will not be acceptable.

4. Manual fire boxes for Class 1, Division 1, Group D hazardous area applications shall be non-coded surface mounting type. Stations shall be double-action type with a hinged cover which holds a sliding actuator plate in place. Activation of the stations is made by lifting the hinged cover and pulling down on the ring. Stations may be reset after activation without need for replacement parts. Stations shall be Killark, XAD Series or equal. Double-action stations requiring a hammer to break glass to gain access to actuating lever will be acceptable.

5. Automatic ionization type smoke detectors shall be of the dual-chamber, locking type. The dual-chamber shall be highly sensitive to products of combustion and shall allow for compensation for pressure and humidity changes. The detectors shall be equipped with a solid-state regulator to maintain detection sensitivity over a wide range of input voltages. A visual indication of an alarm shall be given by a LED on the detector grille. Automatic ionization type detectors shall be four-wire Autocall, Type 1451-B402B or equal.

6. Automatic photo-electronic type smoke detectors shall operate on the forward light scattering principle using a pulsed infra-red light emitting diode light source and a photo diode sensor. The detectors shall be of the locking type and have an alarm verification circuit requiring several successive signals exceeding the alarm threshold value prior to transmitting an alarm. A visible LED indicator shall blink to indicate power on and normal operation. On alarm the indicator shall turn on and remain

on until the detector is reset. Automatic photo-electronic detector shall be four wire type, Autocall, Model 2451-B402B or equal.

7. Heat Detectors

a. Heat detectors shall be combination fixed temperature and rate of rise of fixed temperature only. Rate of rise element shall comprise of calibrated, moisture proof, trouble free vented chamber with flexible metal diaphragm to close contact when temperature rise exceeds 15 degrees F per minute. Contact shall be rated 3 Amps, 28 VDC. Fixed temperature element shall comprise nonrestorable fusible alloy element with external heat collector that drops for view when alloy fuses for visual indication of operation. Units shall be enclosed in white low profile dome shell with matching base.

b. Units shall be color-coded to indicate one of the following types:

1) 135 degrees F fixed temperature and rate of rise (Autocall 601)

2) 200 degrees F fixed temperature and rate of rise (Autocall 602)

3) 135 degrees F fixed temperature only (Autocall 603)

4) 200 degrees F fixed temperature only (Autocall 604)

c. Heat detectors for Class 1, Division 1, Group D hazardous areas shall have, in addition to their rated enclosures, electrical features similar to those above.

1) 136 degrees F fixed temperature and rate of rise (Autocall EPB-501)

2) 190 degrees F fixed temperature and rate of rise (Autocall EPB-502)

3) 136 degrees F fixed temperature only (Autocall EPB-503)

4) 190 degrees F fixed temperature only (Autocall EPB-504)

8. Combination audio-visual horn/strobe light units meeting current ADA requirements and shall be installed on supervised circuits. Visual portion shall flash on alarm condition. Audio-visual units shall be Autocall, Types SM-24D/H or equal.

9. Horn for Class 1, Division 1, Group D hazardous area applications shall have a sound rating of 100 dB at 10-ft and be Federal Signal, 41x or equal.

10. Strobe light for Class 1, Division 1, Group D hazardous area applications shall be for wall mounting, provide 72 high intensity flashes per minute, be furnished with a red polycarbonate lens and be Crouse-Hinds, EVBS101R/024 or equal.

11. Remote trouble station shall consist of buzzer and silencing with switch. Autocall, Type SC-3 or equal.

12. Remote zone annunciator shall be of the non-graphic type with red bulls-eye lamps mounted on a stainless steel plate.

13. Door hold and release units for the closing of doors when the threat of fire exists to prevent the spread of fire and smoke shall each consist of two elements: an electromagnetic portion to be wall or floor mounted and an armature section to be mounted on the door. The electromagnetic portion is continuously energized by 120 VAC input power. Wall-to-door mounted assembly shall be Autocall, Model 7392-3 or equal. Floor-to-door mounting assembly shall be Autocall, Model 7392-1 or equal.

14. Beacon alarm lights for building exterior mounting shall be weatherproof construction and have a 750,000 candle power xenon strobe tube and red polycarbonate lens. Beacon alarm lights shall be similar and equal to Federal Signal, Model 371 DST.

15. Master box shall be of the local energy, weatherproof enclosure type for surface mounting. Gamewell, Model M3456 or equal.

16. Grounding assembly consisting of ground rod, clamps and all other required hardware shall be provided for master box protection. Gamewell, Model 30118 or equal.

17. All components shall be products of one manufacturer where such is obtainable.

PART 3 EXECUTION

A. Installation

1. The system shall be wired with No. 14 XHHW-2 throughout in accordance with the manufacturer's diagrams and requirements. All wires shall be numbered at both ends with typewritten heat shrinkable or sleeve type markers.

2. Upon completion of the installation, the fire alarm system designer and the electrical contractor shall test each and every device including manual station, smoke detector, alarm signals, visual signals, waterflow switches, valves, for proper operation. A certified report shall be submitted to the Engineer indicating date of testing and signatures of the designer's and electrical contractor's personnel that performed the test.

3. Final connections in the system shall be made under the direct supervision of an authorized representative of the manufacturer. Upon completion of the installation and testing indicated above, the manufacturer shall check and test the entire system with a representative of the Fire Department and Engineer present. Submit Fire Department acceptance paperwork to Engineer.

4. Provide the Owner with wiring diagrams including terminal to terminal designations, complete equipment specifications and complete sequence of operation.

B. Cleaning

1. Clean the interior and exterior of electrical equipment in accordance with Section 16000.

END OF SECTION

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SECTION 16741 TELEPHONE SYSTEM

PART 1 GENERAL

A. Scope Of Work

1. Furnish all labor, materials, equipment and incidentals required including telephone stations, exchange equipment, conduit, cabling, outlets, boxes, fittings, terminal cabinets, plywood backboards and pull boxes as shown on the Drawings and as specified herein.

2. Provide dial tone service to all the telephone outlets shown on the Drawings.

3. Provide telephone stations at outlets where indicated on the Drawings.

4. Underground ducts to be encased in concrete.

B. Reference Standards

1. All work shall be done in accordance with current telephone industry standards.

C. Fees

1. Make all necessary arrangements with the Telephone Company Embarq for any participation that may be necessary and furnish all labor and material that may be required and pay all charges the telephone company may have for their service.

PART 2 PRODUCTS

A. Materials

1. Conduit and outlet boxes shall be as specified under Section 16110.

2. Underground materials shall be as specified under Section 16600.

3. Raceways shall be rigid aluminum conduit as shown on the Drawings.

4. Telephone stations shall be of desk and wall types as indicated on the Drawings and have electronic pushbutton dials of color and style as directed.

5. Cabling shall be current industry standards for telephone system applications.

PART 3 EXECUTION

A. Installation

1. The system shall be a completely operable system, capable of the required functions.

END OF SECTION

SECTION 16900 CONCRETE ELECTRICAL DUCT ENCASEMENT

PART 1 GENERAL

A. Scope Of Work

1. Furnish all labor, materials, equipment and incidentals required and place concrete encasement around underground electrical ductwork as shown on the drawings and as specified herein.

B. Related Work

1. All trenching, excavation and backfilling, including sand bedding and surface restoration shall be as specified in Division 2, but the responsibility of furnishing and installing the material shall be that of this Section.

2. Furnishing and installing electrical raceways are specified in Section 16110 and 16600.

PART 2 PRODUCTS

A. Materials

1. Cement, lime, aggregate and all other concrete components shall be as specified in Section 03300 except that aggregate size shall not exceed 3/8-in. Concrete shall have a minimum compressive strength at 28 days of 3000 psi.

PART 3 EXECUTION

A. General

1. Concrete shall be measured, mixed and placed, and compacted as required in Section 03300 for 3000 psi concrete and as specified below.

2. Provide not less than 3-inches of concrete between the outside of a duct and the earth. Provide not less than 2-inches of concrete between adjacent ducts. Refer to drawings for spacing requirements.

3. All duct line concrete pours shall be continuous between manholes or handholes and between manholes or handholes and structures.

4. Where duct lines pass through concrete walls, concrete envelopes shall be extended through the finished flush

with inside surfaces. Watertight construction joints of an approved type shall be provided.

5. Duct banks shall be reinforced when laid on backfill covering new pipelines, roads, parking lots or any are subject to vehicular traffic. Beneath these areas, install reinforcing bars as shown on the Drawings, extending 10-ft beyond area needing protection.

6. Duct lines shall be laid in trenches on backfill of sand not less than 6-inches thick and well graded.

7. The minimum cover for duct banks shall be 24-inches.

8. All electrical duct bank concrete shall be colored red for safety purposes. Red color shall be raked into the top of the duct bank concrete after the concrete is poured.

END OF SECTION

TAGLIST

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 210 Phase I/II Fermentation Basins

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
211	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase I/II Fermentation Basin No. 1 Mixer
212	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase I/II Fermentation Basin No. 2 Mixer

Process 215 Phase I/II First Anoxic Basins

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
216	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase I/II First Anoxic Tank No. 1 Mixer
217	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase I/II First Anoxic Tank No. 2 Mixer
217	-	AE	-	1	DO Probe	-	13315	-	120	Phase I/II First Anoxic Tank 2 DO Probe
217	-	AE	-	2	pH Probe	-	13315	-	120	Phase I/II First Anoxic Tank 2 pH Probe
217	-	AIT	-	1	Transmitter	-	13315	-	120	Phase I/II First Anoxic Tank 2 DO & pH Transmitter
218	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase I/II First Anoxic Tank No. 3 Mixer
218	-	AE	-	1	DO Probe	-	13315	-	120	Phase I/II First Anoxic Tank 3 DO Probe
218	-	AE	-	2	pH Probe	-	13315	-	120	Phase I/II First Anoxic Tank 3 pH Probe
218	-	AIT	-	1	Transmitter	-	13315	-	120	Phase I/II First Anoxic Tank 3 DO & pH Transmitter
219	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase I/II First Anoxic Tank No. 4 Mixer

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 220 Phase I/II Aeration Basins

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
220	-	B	-	1	Blower	3,900 scfm @ 7.9 psi	11373	200	460	Phase I/II Aeration Blower No. 1
220		CP		1	Control Panel	NEMA 4X	11373	-	480	220-B-1 Control Panel
220	-	V	-	1	12 Motorized Butterfly Valve	12V200M	11373, 15100 & 15119	1/2	460	220-B-1 Inlet Throttling Valve
220	-	V	-	2	12 Check Valve	12V760	11373 & 15100	-	-	220-B-1 Discharge Check Valve
220	-	V	-	3	12 Butterfly Valve	12V200	11373 & 15100	-	-	220-B-1 Discharge Isolation Valve
220	-	PI	-	1	Differential Pressure Gauge	0-10 in w.c.	11373	-	-	220-B-1 Inlet Filter Differential Pressure Gauge
220	-	PI	-	2	Pressure Gauge	0-15 psi	11373	-	-	220-B-1 Blower Discahrge Pressure Gauge
220	-	B	-	2	Blower	3,900 scfm @ 7.9 psi	11373	200	460	Phase I/II Aeration Blower No. 2
220		CP		2	Control Panel	NEMA 4X	11373	-	480	220-B-2 Control Panel
220	-	V	-	4	12 Motorized Butterfly Valve	12V200M	11373, 15100 & 15119	1/2	460	220-B-2 Inlet Throttling Valve
220	-	V	-	5	12 Check Valve	12V760	11373 & 15100	-	-	220-B-2 Discharge Check Valve
220	-	V	-	6	12 Butterfly Valve	12V200	11373 & 15100	-	-	220-B-2 Discharge Isolation Valve
220	-	PI	-	3	Differential Pressure Gauge	0-10 in w.c.	11373	-	-	220-B-2 Inlet Filter Differential Pressure Gauge
220	-	PI	-	4	Pressure Gauge	0-15 psi	11373	-	-	220-B-2 Blower Discahrge Pressure Gauge
221	-	AE	-	1	DO Probe	-	13315	-	120	Phase I/II Aeration Basin No. 1 DO Probe
221	-	AE	-	2	pH Probe	-	13315	-	120	Phase I/II Aeration Basin No. 1 pH Probe
221	-	AIT	-	1	DO & pH Transmitter	-	13315	-	120	Aeration Basin No. 1 DO & pH Transmitter
221	-	WG	-	1	Weir Gate	120 x 36	11281	-	-	Aeration Basn No. 1 Effluent Gate
221	-	V	-	1	6 Butterfly Valve	6V210	15100	-	-	Aeration Basin No. 1 Drop Leg, Isolation
221	-	PI	-	1	Pressure Gauge	0-15 psig	13315	-	-	Aeration Basin No. 1 Drop Leg Pressure Gauge
221	-	FE/FI	-	1	6 Venturi Flow Meter	6 inch	13315	-	-	Aeration Basin No. 1 Drop Leg Flow Meter
222	-	AE	-	1	DO Probe	-	13315	-	120	Phase I/II Aeration Basin No. 2 DO Probe
222	-	AE	-	2	pH Probe	-	13315	-	120	Phase I/II Aeration Basin No. 2 pH Probe
222	-	AIT	-	1	DO & pH Transmitter	-	13315	-	120	Aeration Basin No. 2 DO & pH Transmitter
222	-	WG	-	1	Weir Gate	120 x 36	11281	-	-	Aeration Basn No. 2 Effluent Gate

Note:
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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 220 Phase I/II Aeration Basins Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
222	-	AE	-	3	Nitrate Analyzer	-	13315	-	120	Aeration Basin No. 2 Effluent Nitrate Analyzer
222	-	AIT	-	2	Nitrate Transmitter	-	13315	-	120	Aeration Basin No. 2 Effluent Nitrate Transmitter
222	-	V	-	1	6 Butterfly Valve	6V210	15100	-	-	Aeration Basin No. 2 Drop Leg, Isolation
222	-	PI	-	1	Pressure Gauge	0-15 psig	13315	-	-	Aeration Basin No. 2 Drop Leg Pressure Gauge
222	-	FE/FI	-	1	6 Venturi Flow Meter	6 inch	13315	-	-	Aeration Basin No. 2 Drop Leg Flow Meter
223	-	AE	-	1	DO Probe	-	13315	-	120	Phase I/II Aeration Basin No. 3 DO Probe
223	-	AE	-	2	pH Probe	-	13315	-	120	Phase I/II Aeration Basin No. 3 pH Probe
223	-	AIT	-	1	DO & pH Transmitter	-	13315	-	120	Aeration Basin No. 3 DO & pH Transmitter
223	-	WG	-	1	Weir Gate	120 x 36	11281	-	-	Aeration Basn No. 3 Effluent Gate
223	-	AE	-	3	Nitrate Analyzer	-	13315	-	120	Aeration Basin No. 3 Effluent Nitrate Analyzer
223	-	AIT	-	2	Nitrate Transmitter	-	13315	-	120	Aeration Basin No. 3 Effluent Nitrate Transmitter
223	-	V	-	1	6 Butterfly Valve	6V210	15100	-	-	Aeration Basin No. 3 Drop Leg, Isolation
223	-	PI	-	1	Pressure Gauge	-	13315	-	-	Aeration Basin No. 3 Drop Leg Pressure Gauge
223	-	FE/FI	-	1	6 Venturi Flow Meter	6 inch	13315	-	-	Aeration Basin No. 3 Drop Leg Flow Meter
224	-	AE	-	1	DO Probe	-	13315	-	120	Phase I/II Aeration Basin No. 4 DO Probe
224	-	AE	-	2	pH Probe	-	13315	-	120	Phase I/II Aeration Basin No. 4 pH Probe
224	-	AIT	-	1	DO & pH Transmitter	-	13315	-	120	Aeration Basin No. 4 DO & pH Transmitter
224	-	WG	-	1	Weir Gate	120 x 36	11281	-	-	Aeration Basn No. 4 Effluent Gate
224	-	V	-	1	6 Butterfly Valve	6V210	15100	-	-	Aeration Basin No. 4 Drop Leg, Isolation
224	-	PI	-	1	Pressure Gauge	-	13315	-	-	Aeration Basin No. 4 Drop Leg Pressure Gauge
224	-	FE/FI	-	1	6 Venturi Flow Meter	6 inch	13315	-	-	Aeration Basin No. 4 Drop Leg Flow Meter

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 230 - Phase I/II Second Anoxic Tanks

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
231	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Second Anoxic Tank No 1 Mixer
231	-	V	-	1	4 Butterfly Valve	4V210	15100	-	-	Tank No. 1 & 2 Reaeration, Zone 1, Isolation
231	-	V	-	2	4 Butterfly Valve	4V210	15100	-	-	Tank No. 1 & 2 Reaeration, Zone 2, Isolation
231	-	AE	-	1	Nitrate Probe	-	13315	-	120	Tank No. 1 Effluent Nitrate Probe
231	-	AE	-	2	DO Probe	-	13315	-	120	Tank No. 1 Effluent DO Probe
231	-	AE	-	3	pH Probe	-	13315	-	120	Tank No. 1 Effluent pH Probe
231	-	AIT	-	1	Nitrate Transmitter	-	13315	-	120	Tank No. 1 Effluent Nitrate Transmitter
231	-	AIT	-	2	DO/pH Transmitter	-	13315	-	120	Tank No. 1 Effluent DO/pH Transmitter
231	-	WG	-	1	Weir Gate	96 x 36	11281	-	-	Tank No. 1 Effluent Weir Gate, Zone 1 Reair
231	-	SG	-	1	Slide Gate	36 x 36	11281	-	-	Tank No. 1 & 2 Reaeration, Zone 1 &2, Isolation
231	-	PI	-	1	Pressure Gauge	0-15 psig	13315	-	-	Reaeration, Zone 1, Pressure Gauge
231	-	PI	-	2	Pressure Gauge	0-15 psig	13315	-	-	Reaeration, Zone 2, Pressure Gauge
232	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Second Anoxic Tank No 2 Mixer
232	-	AE	-	1	Nitrate Probe	-	13315	-	-	Tank No. 2 Effluent Nitrate Probe
232	-	AE	-	2	DO Probe	-	13315	-	120	Tank No. 2 Effluent DO Analyzer
232	-	AE	-	3	pH Probe	-	13315	-	120	Tank No. 2 Effluent pH Analyzer
232	-	AIT	-	1	Nitrate Transmitter	-	13315	-	120	231-AE-1 Nitrate Transmitter
232	-	AIT	-	2	DO/pH Transmitter	-	13315	-	120	231-AE-2 and 231-AE-3 DO/pH Transmitter
232	-	PI	-	1	Pressure Gauge	0-15 psig	13315	-	-	Reaeration, Zone 3, Pressure Gauge

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 240 Phase I/II Clarifiers

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
241	-	M	-	1	Clarifier Drive (Existing)	---	11336	1	460	Clarifier 1 Dive Motor (Existing)
241	-	LE	-	1	Sludge Blanket Level	---	13315	---	---	Clarifier 1
241	-	LIT	-	1	Sludge Blanket Level Transmitter	---	13315	---	---	Clarifier 1
242	-	M	-	1	Clarifier Drive (Existing)	---	11336	1	460	Clarifier 2 Dive Motor (Existing)
242	-	LE	-	1	Sludge Blanket Level	---	13315	---	---	Clarifier 2
242	-	LIT	-	1	Sludge Blanket Level Transmitter	---	13315	---	---	Clarifier 2
243	-	M	-	1	Clarifier Drive (Existing)	---	11336	1	460	Clarifier 3 Dive Motor (Existing)
243	-	LE	-	1	Sludge Blanket Level	---	13315	---	---	Clarifier 3
243	-	LIT	-	1	Sludge Blanket Level Transmitter	---	13315	---	---	Clarifier 3
244	-	M	-	1	Clarifier Drive (Existing)	---	11336	1	460	Clarifier 4 Dive Motor (Existing)
244	-	LE	-	1	Sludge Blanket Level	---	13315	---	---	Clarifier 4
244	-	LIT	-	1	Sludge Blanket Level Transmitter	---	13315	---	---	Clarifier 4

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 250 Phase I/II RAS/WAS Pump Station

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
Process 251 - Phase V-Secondary Clarifiers 1 and 2 RAS.WAS and Scum Pumping Stations										
251	-	P	-	1	Return Sludge Pump	---	11311B	20	460	Clarifier 1&2 RAS Pump 1
251	-	P	-	2	Return Sludge Pump	---	11311B	20	460	Clarifier 1&2 RAS Pump 2
251	-	P	-	3	Return Sludge Pump	---	11311B	20	460	Clarifier 1&2 RAS Pump 3
251	-	P	-	4	Waste Sludge Pump	---	11311A	5	460	Clarifier 1&2 WAS Pump1
251	-	P	-	5	Waste Sludge Pump	---	11311A	5	460	Clarifier r1&2 WAS Pump 2
251	-	P	-	6	Scum Pump	---	11319	5	460	Clarifier 1 Scum Pump
251	-	P	-	7	Scum Pump	---	11319	5	460	Clarifier 2 Scum Pump
251	-	FE	-	1	RAS Flowmeter	8-inch	13315	---	---	RAS Flow Pump 1 or 2
251	-	FIT	-	1	Flow meter transmitter	---	13315	---	---	251-FE-1 Transmitter
251	-	FE	-	2	RAS Flowmeter	8-inch	13315	---	---	RAS Flow Pump 2 or 3
251	-	FIT	-	2	Flow meter transmitter	---	13315	---	---	251-FE-2 Transmitter
251	-	FE	-	3	WAS Flow meter	3-inch	13315	---	---	WAS flow
251	-	FIT	-	3	Flow meter transmitter	---	13315	---	---	251-FE-3 Transmitter
251	-	LS	-	1	Check Valve Limit Switch	---	13315	---	---	RAS Pump 1 No flow
251	-	LS	-	2	Check Valve Limit Switch	---	13315	---	---	RAS Pump 2 No flow
251	-	LS	-	3	Check Valve Limit Switch	---	13315	---	---	RAS Pump 3 No flow
251	-	LS	-	4	Check Valve Limit Switch	---	13315	---	---	WAS Pump 1 No flow
251	-	LS	-	5	Check Valve Limit Switch	---	13315	---	---	WAS Pump 2 No flow
251	-	LS	-	6	Check Valve Limit Switch	---	13315	---	---	Scum Pump 1 No Flow and Off
251	-	LS	-	7	Check Valve Limit Switch	---	13315	---	---	Scum Pump 2 No Flow and Off
251	-	AE	-	1	Total Solids Meter	---	13315	---	---	TSS % solids Clarifier 1
251	-	AE	-	2	Total Solids Meter	---	13315	---	---	TSS % solids Clarifier 2
251	-	AIT	-	1	Total Solids Transmitter	---	13315	---	---	251-AE-1 and 2 Transmitter

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Process 250 Phase I/II RAS/WAS Pump Station Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
251	-	LSH	-	1	Scum Wetwell Float	---	13315	---	---	Scum Pump (251-P-6) start
251	-	LSHH	-	1	Scum Wetwell Float	---	13315	---	---	Wetwell level high - alarm
251	-	LSH	-	2	Scum Wetwell Float	---	13315	---	---	Scum Pump (251-P-7) start
251	-	LSHH	-	2	Scum Wetwell Float	---	13315	---	---	Wetwell level high - alarm
251	-	V	-	1	Plug Valve	12-inch	15100	---	---	Clarifier 1 isolation
251	-	V	-	2	Plug Valve	12-inch	15100	---	---	RAS Pump 1 or 2 (Clarifier 1)
251	-	V	-	3	Plug Valve	12-inch	15100	---	---	RAS Pump 2 or 3 (Clarifier 2)
251	-	V	-	4	Plug Valve	12-inch	15100	---	---	Clarifier 2 isolation
251	-	V	-	5	Plug Valve	8-inch	15100	---	---	RAS Pump 1 suction
251	-	V	-	6	Plug Valve	8-inch	15100	---	---	RAS Pump 2 suction
251	-	V	-	7	Plug Valve	8-inch	15100	---	---	RAS Pump 3 suction
251	-	V	-	8	Check Valve	8-inch	15100	---	---	RAS Pump 1 (251-LS-1)
251	-	V	-	9	Check Valve	8-inch	15100	---	---	RAS Pump 2 (251-LS-2)
251	-	V	-	10	Check Valve	8-inch	15100	---	---	RAS Pump 3 (251-LS-3)
251	-	V	-	11	Plug Valve	8-inch	15100	---	---	RAS Pump 1 discharge
251	-	V	-	12	Plug Valve	8-inch	15100	---	---	RAS Pump 2 discharge
251	-	V	-	13	Plug Valve	8-inch	15100	---	---	RAS Pump 3 discharge
251	-	V	-	14	Plug Valve	8-inch	15100	---	---	RAS Pump 1 or2 (Clarifier 1)
251	-	V	-	15	Plug Valve	8-inch	15100	---	---	RAS Pump 2 or 3 (Clarifier 2)
251	-	V	-	16	Plug Valve	8-inch	15100	---	---	RAS meter isolation (251-FE-1)
251	-	V	-	17	Plug Valve	8-inch	15100	---	---	RAS meter isolation (251-FE-2)
251	-	V	-	18	Plug Valve	8-inch	15100	---	---	RAS meter isolation (251-FE-1)
251	-	V	-	19	Plug Valve	8-inch	15100	---	---	RAS meter isolation (251-FE-2)

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Process 250 Phase I/II RAS/WAS Pump Station Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
251	-	V	-	20	Plug Valve	16-inch	15100	---	---	RAS discharge piping
251	-	V	-	21	Plug Valve	6-inch	15100	---	---	WAS sludge isolation (Clarifier 1)
251	-	V	-	22	Plug Valve	6-inch	15100	---	---	WAS sludge isolation (Clarifier 2)
251	-	V	-	23	Plug Valve	6-inch	15100	---	---	WAS Pump 1 or2
251	-	V	-	24	Plug Valve	4-inch	15100	---	---	WAS Pump 1 suction
251	-	V	-	25	Plug Valve	4-inch	15100	---	---	WAS Pump 2 suction
251	-	V	-	26	Check Valve	4-inch	15100	---	---	WAS Pump 1 (251-LS-4)
251	-	V	-	27	Check Valve	4-inch	15100	---	---	WAS Pump 2 (251-LS-5)
251	-	V	-	28	Plug Valve	4-inch	15100	---	---	WAS Pump 3 discharge
251	-	V	-	29	Plug Valve	4-inch	15100	---	---	WAS Pump 3 discharge
251	-	V	-	30	Plug Valve	3-inch	15100	---	---	WAS meter isolation (251-FE-3)
251	-	V	-	31	Plug Valve	3-inch	15100	---	---	WAS meter isolation (251-FE-3)
251	-	V	-	32	Check Valve	4-inch	15100	---	---	Scum Pump 1 (251-LS-6)
251	-	V	-	33	Check Valve	4-inch	15100	---	---	Scum Pump 2 (251-LS-7)
251	-	V	-	34	Plug Valve	4-inch	15100	---	---	Scum Pump 1 discharge
251	-	V	-	35	Plug Valve	4-inch	15100	---	---	Scum Pump 2 discharge

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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Process 250 Phase I/II RAS/WAS Pump Station Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
Process 252 - Phase V-Secondary Clarifiers 3 and 4 RAS.WAS and Scum Pumping Stations										
252	-	P	-	1	Return Sludge Pump	---	11311B	20	460	Clarifier 3&4 RAS Pump 1
252	-	P	-	2	Return Sludge Pump	---	11311B	20	460	Clarifier 3&4 RAS Pump 2
252	-	P	-	3	Return Sludge Pump	---	11311B	20	460	Clarifier 3&4 RAS Pump 3
252	-	P	-	4	Waste Sludge Pump	---	11311A	5	460	Clarifier 3&4 WAS Pump 1
252	-	P	-	5	Waste Sludge Pump	---	11311A	5	460	Clarifier 3&4 WAS Pump 2
252	-	P	-	6	Scum Pump	---	11319	5	460	Clarifier 3 Scum Pump
252	-	P	-	7	Scum Pump	---	11319	5	460	Clarifier 4 Scum Pump
252	-	FE	-	1	RAS Flowmeter	8-inch	13315	---	---	RAS Flow Pump 1 or 2
252	-	FIT	-	1	Flow meter transmitter	---	13315	---	---	252-FE-1 Transmitter
252	-	FE	-	2	RAS Flowmeter	8-inch	13315	---	---	RAS Flow Pump 2 or 3
252	-	FIT	-	2	Flow meter transmitter	---	13315	---	---	252-FE-2 Transmitter

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Process 250 Phase I/II RAS/WAS Pump Station Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
252	-	FE	-	3	WAS Flow meter	3-inch	13315	---	---	WAS flow
252	-	FIT	-	3	Flow meter transmitter	---	13315	---	---	252-FE-3 Transmitter
252	-	LS	-	1	Check Valve Limit Switch	---	13315	---	---	RAS Pump 1 No flow
252	-	LS	-	2	Check Valve Limit Switch	---	13315	---	---	RAS Pump 2 No flow
252	-	LS	-	3	Check Valve Limit Switch	---	13315	---	---	RAS Pump 3 No flow
252	-	LS	-	4	Check Valve Limit Switch	---	13315	---	---	WAS Pump 1 No flow
252	-	LS	-	5	Check Valve Limit Switch	---	13315	---	---	WAS Pump 2 No flow
252	-	LS	-	6	Check Valve Limit Switch	---	13315	---	---	Scum Pump 1 No Flow and Off
252	-	LS	-	7	Check Valve Limit Switch	---	13315	---	---	Scum Pump 2 No Flow and Off
252	-	AE	-	1	Total Solids Meter	---	13315	---	---	TSS % solids Clarifier 3
251	-	AE	-	2	Total Solids Meter	---	13315	---	---	TSS % solids Clarifier 4
252	-	AIT	-	1	Total Solids Transmitter	---	13315	---	---	252-AE-1 and 2 Transmitter
252	-	LSH	-	1	Scum Wetwell Float	---	13315	---	---	Scum Pump (252-P-6) start
252	-	LSHH	-	1	Scum Wetwell Float	---	13315	---	---	Wetwell level high - alarm
252	-	LSH	-	2	Scum Wetwell Float	---	13315	---	---	Scum Pump (251-P-7) start
252	-	LSHH	-	2	Scum Wetwell Float	---	13315	---	---	Wetwell level high - alarm
252	-	V	-	1	Plug Valve	12-inch	15100	---	---	Clarifier 3 isolation
252	-	V	-	2	Plug Valve	12-inch	15100	---	---	RAS Pump 1 or 2 (Clarifier 3)
252	-	V	-	3	Plug Valve	12-inch	15100	---	---	RAS Pump 2 or 3 (Clarifier 4)
252	-	V	-	4	Plug Valve	12-inch	15100	---	---	Clarifier 4 isolation
252	-	V	-	5	Plug Valve	8-inch	15100	---	---	RAS Pump 1 suction
252	-	V	-	6	Plug Valve	8-inch	15100	---	---	RAS Pump 2 suction
252	-	V	-	7	Plug Valve	8-inch	15100	---	---	RAS Pump 3 suction

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 250 Phase I/II RAS/WAS Pump Station Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
252	-	V	-	8	Check Valve	8-inch	15100	---	---	RAS Pump 1 (252-LS-1)
252	-	V	-	9	Check Valve	8-inch	15100	---	---	RAS Pump 2 (252-LS-2)
252	-	V	-	10	Check Valve	8-inch	15100	---	---	RAS Pump 3 (252-LS-3)
252	-	V	-	11	Plug Valve	8-inch	15100	---	---	RAS Pump 1 discharge
252	-	V	-	12	Plug Valve	8-inch	15100	---	---	RAS Pump 2 discharge
252	-	V	-	13	Plug Valve	8-inch	15100	---	---	RAS Pump 3 discharge
252	-	V	-	14	Plug Valve	8-inch	15100	---	---	RAS Pump 1 or 2 (Clarifier 3)
252	-	V	-	15	Plug Valve	8-inch	15100	---	---	RAS Pump 2 or 3 (Clarifier 4)
252	-	V	-	16	Plug Valve	8-inch	15100	---	---	RAS meter isolation (252-FE-1)
252	-	V	-	17	Plug Valve	8-inch	15100	---	---	RAS meter isolation (252-FE-2)
252	-	V	-	18	Plug Valve	8-inch	15100	---	---	RAS meter isolation (252-FE-1)
252	-	V	-	19	Plug Valve	8-inch	15100	---	---	RAS meter isolation (252-FE-2)
252	-	V	-	20	Not Used	---	---	---	---	---
252	-	V	-	21	Plug Valve	6-inch	15100	---	---	WAS sludge isolation (Clarifier 3)
252	-	V	-	22	Plug Valve	6-inch	15100	---	---	WAS sludge isolation (Clarifier 4)
252	-	V	-	23	Plug Valve	6-inch	15100	---	---	WAS Pump 1 or2
252	-	V	-	24	Plug Valve	4-inch	15100	---	---	WAS Pump 1 suction
252	-	V	-	25	Plug Valve	4-inch	15100	---	---	WAS Pump 2 suction
252	-	V	-	26	Check Valve	4-inch	15100	---	---	WAS Pump 1 (252-LS-4)
252	-	V	-	27	Check Valve	4-inch	15100	---	---	WAS Pump 2 (252-LS-5)
252	-	V	-	28	Plug Valve	4-inch	15100	---	---	WAS Pump 3 discharge
252	-	V	-	29	Plug Valve	4-inch	15100	---	---	WAS Pump 3 discharge

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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 250 Phase I/II RAS/WAS Pump Station Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
252	-	V	-	30	Plug Valve	3-inch	15100	---	---	WAS meter isolation (252-FE-3)
252	-	V	-	31	Plug Valve	3-inch	15100	---	---	WAS meter isolation (252-FE-3)
252	-	V	-	32	Check Valve	4-inch	15100	---	---	Scum Pump 1 (252-LS-6)
252	-	V	-	33	Check Valve	4-inch	15100	---	---	Scum Pump 2 (252-LS-7)
252	-	V	-	34	Plug Valve	4-inch	15100	---	---	Scum Pump 1 discharge
252	-	V	-	35	Plug Valve	4-inch	15100	---	---	Scum Pump 2 discharge

Note:
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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 250 Phase I/II RAS/WAS Pump Station Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
Process 253 - Phase V-Secondary Clarifiers 7 aand 8 WAS Pumping Station										
253	-	FE	-	1	3-inch WAS Flow Meter	3-inch	13315	---	---	WAS flow
253	-	FIT	-	1	Flow Meter Transmitter	---	13315	---	---	253-FE-1 Transmitter
253	-	LS	-	1	Check Valve Limit Switch	---	13315	---	---	WAS Pump 1 No flow
253	-	LS	-	2	Check Valve Limit Switch	---	13315	---	---	WAS Pump 2 No flow
253	-	AE	-	1	Total Solids Meter	---	13315	---	---	TSS % solids in WAS
253	-	AIT	-	1	Total Solids Transmitter	---	13315	---	---	253-AE-1 Transmitter
253	-	V	-	1	Plug Valve	6-inch	15100	---	---	WAS From Clarifier 7
253	-	V	-	2	Plug Valve	6-inch	15100	---	---	WAS From Clarifier 8
253	-	V	-	3	Plug Valve	4-inch	15100	---	---	WAS Pump 1 suction
253	-	V	-	4	Plug Valve	4-inch	15100	---	---	WAS Pump 2 suction
253	-	V	-	5	Check Valve	4-inch	15100	---	---	WAS Pump 1 (253-LS-1)
253	-	V	-	6	Check Valve	4-inch	15100	---	---	WAS Pump 2 (253-LS-2)
253	-	V	-	7	Plug Valve	4-inch	15100	---	---	WAS Pump 1 discharge
253	-	V	-	8	Plug Valve	4-inch	15100	---	---	WAS Pump 2 discharge
253	-	V	-	9	Plug Valve	3-inch	15100	---	---	WAS Meter isolation (253-FE-1)
253	-	V	-	10	Plug Valve	3-inch	15100	---	---	WAS Meter isolation (253-FE-2)

Note:
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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 310 Phase III Fermentation Basins

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
311	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III Fermentation Basin No. 1 Mixer
312	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III Fermentation Basin No. 2 Mixer
313		M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III Fermentation Basin No. 3 Mixer
314	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III Fermentation Basin No. 4 Mixer

Process 315 Phase III First Anoxic Basins

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
316	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III First Anoxic Tank No. 1 Mixer
317	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III First Anoxic Tank No. 2 Mixer
317	-	AE/AIT	-	1	DO Probe & Transmitter	-	13315	-	120	Phase III First Anoxic Tanks 1 & 2 DO Probe & Transmitter
318	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III First Anoxic Tank No. 3 Mixer
318	-	AE/AIT	-	1	DO Probe & Transmitter	-	13315	-	120	Phase III First Anoxic Tanks 3 & 4 DO Probe & Transmitter
319	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Phase III First Anoxic Tank No. 4 Mixer

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 320 Phase III Aeration Basins

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
320	-	B	-	1	Blower	3,900 scfm @ 7.9 psi	11373	200	460	Phase III Aeration Blower No. 1
320		CP		1	Control Panel	NEMA 4X	11373	-	480	320-B-1 Control Panel
320	-	V	-	1A	12 Motorized Butterfly Valve	12V200M	11373, 15100 & 15119	1/2	460	320-B-1 Inlet Throttling Valve
320	-	V	-	2	16 Check Valve	Existing	-	-	-	320-B-1 Discharge Check Valve, Existing
320	-	V	-	3	12 Butterfly Valve	12V200	11373 & 15100	-	-	320-B-1 Discharge Isolation Valve
320	-	PI	-	1	Differential Pressure Gauge	0-10 in w.c.	11373	-	-	320-B-1 Inlet Filter Differential Pressure Gauge
320	-	B	-	2	Blower	3,900 scfm @ 7.9 psi	11373	200	460	Phase III Aeration Blower No. 2
320		CP		2	Control Panel	NEMA 4X	11373	-	480	320-B-2 Control Panel
320	-	V	-	2A	12 Motorized Butterfly Valve	12V200M	11373, 15100 & 15119	1/2	460	320-B-2 Inlet Throttling Valve
320	-	V	-	5	12 Check Valve	Existing	-	-	-	320-B-2 Discharge Check Valve, Existing
320	-	V	-	6	12 Butterfly Valve	12V200	11373 & 15100	-	-	320-B-2 Discharge Isolation Valve
320	-	PI	-	3	Differential Pressure Gauge	0-10 in w.c.	11373	-	-	320-B-2 Inlet Filter Differential Pressure Gauge
325	-	AIT	-	2	Nitrate Transmitter	-	13315	-	120	325-AE-2 Transmitter
325	-	V	-	1	8 Butterfly Valve	8V210	15100	-	-	Basin No. 5 Drop Leg Isolation Valve, Zone 3
325	-	V	-	2	8 Butterfly Valve	8V210	15100	-	-	Basin No. 5 Drop Leg Isolation Valve, Zone 3
325	-	FE/FI	-	1	8 Venturi Flow Meter	8 inch	13315	-	120	Basin No. 5 Drop Leg Flow Meter, Zone 3
325	-	PI	-	1	Pressure Gauge	-	13315	-	-	Basin No. 5 Drop Leg Pressure Gauge, Zone 3
325	-	PI	-	2	Pressure Gauge	-	13315	-	-	Basin No. 5 Drop Leg Pressure Gauge, Zone 3
325	-	AE	-	1	DO Probe	-	13315	-	120	Aeration Basin No. 5 DO Probe
325	-	AE	-	2	pH Probe	-	13315	-	120	Aeration Basin No. 5 pH Probe
325	-	AE	-	3	Nitrate Probe	-	13315	-	120	Aeration Basin No. 5 Effluent Nitrate Probe
325	-	AIT	-	1	DO/pH Transmitter	-	13315	-	120	Aeration Basin No. 5 DO/pH Transmitter
325	-	AIT	-	2	Nitrate Transmitter	-	13315	-	120	Aeration Basin No. 5 Effluent Nitrate Transmitter

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Process 320 Phase III Aeration Basins Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
325	-	PI	-	3	Pressure Gauge		13315			Basin No. 5 Drop Leg Pressure Gauge, Zone 4
325	-	V	-	7	8 Butterfly Valve	8V210	15100	-	-	Basin No. 5 Drop Leg Isolation Valve, Zone 4
325	-	V	-	8	8 Butterfly Valve	8V210	15100	-	-	Basin No. 5 Drop Leg Isolation Valve, Zone 4
325	-	FE/FI	-	4	8 Venturi Flow Meter	8 inch	13315	-	120	Basin No. 5 Drop Leg Flow Meter, Zone 4
325	-	PI	-	4	Pressure Gauge		13315			Basin No. 5 Drop Leg Pressure Gauge, Zone 4
326	-	AE	-	1	DO Probe	-	13315	-	120	Aeration Basin No. 6 DO Probe
326	-	AE	-	2	pH Probe	-	13315	-	120	Aeration Basin No. 6 pH Probe
326	-	AE	-	3	Nitrate Probe	-	13315	-	120	Aeration Basin No. 6 Nitrate Probe
326	-	AIT	-	1	DO/pH Transmitter	-	13315	-	120	Basin No. 6, 326-AE-1/2 DO/pH Transmitter
326	-	AIT	-	2	Nitrate Transmitter	-	13315	-	120	Basin No. 6, 326-AE-3 Nitrate Transmitter
326	-	V	-	1	8 Butterfly Valve	8V210	15100	-	-	Basin No. 6 Drop Leg Isolation Valve, Zone 3
326	-	FE/FI	-	1	8 Venturi Flow Meter	8 inch	13315	-	120	Basin No. 6 Drop Leg Flow Meter, Zone 3
326	-	V	-	2	8 Butterfly Valve	8V210	15100	-	-	Basin No. 6 Drop Leg Isolation Valve, Zone 3
326	-	PI	-	1	Pressure Gauge	-	13315	-	-	Basin No. 6 Drop Leg Pressure Gauge, Zone 3
326	-	PI	-	2	Pressure Gauge	-	13315	-	-	Basin No. 6 Drop Leg Pressure Gauge, Zone 3
326	-	V	-	7	8 Butterfly Valve	8V210	15100	-	-	Basin No. 6 Drop Leg Isolation Valve, Zone 4
326	-	FE/FI	-	4	8 Venturi Flow Meter	8 inch	13315	-	120	Basin No. 6 Drop Leg Flow Meter, Zone 4
326	-	V	-	8	8 Butterfly Valve	8V210	15100	-	-	Basin No. 6 Drop Leg Isolation Valve, Zone 4
326	-	PI	-	3	Pressure Gauge	-	13315	-	-	Basin No. 6 Drop Leg Pressure Gauge, Zone 3
326	-	PI	-	4	Pressure Gauge	-	13315	-	-	Basin No. 6 Drop Leg Pressure Gauge, Zone 3

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 330 - Phase III Second Anoxic Tanks

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
335	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Second Anoxic Tank No 5 Mixer
335	-	M	-	2	Mixer	Ref Spec	11338	Ref Spec	460	Second Anoxic Tank No. 5 Mixer
335	-	V	-	1	6 Butterfly Valve	6V210	15100	-	-	Tank No. 5 Reaeration, Zone 1, Isolation
335	-	V	-	2	6 Butterfly Valve	6V210	15100	-	-	Tank No. 5 Reaeration, Zone 2, Isolation
335	-	V	-	3	6 Butterfly Valve	6V210	15100	-	-	Tank No. 5 Reaeration, Zone 3, Isolation
335	-	AE	-	1	Nitrate Probe	-	13315	-	-	Tank No. 5 Effluent Nitrate Analyzer
335	-	AIT	-	2	DO/pH Transmitter	-	13315	-	120	Tank No. 5 Eff. DO/pH Transmitter, Reaer. Zone 2
335	-	AIT	-	2	DO/pH Transmitter	-	13315	-	120	Tank No. 5 Eff. DO/pH Transmitter, Reaer. Zone 3
335	-	WG	-	1	Weir Gate	120 x 48	11281	-	-	Tank No. 5 Effluent Weir Gate
335	-	WG	-	2	Weir Gate	120 x 48	11281	-	-	Tank No. 5 Effluent Weir Gate
335	-	SG	-	1	Slide Gate	36 x 36	11281	-	-	Tank No. 5 Reaeration, Isolation
335	-	PI	-	1	Pressure Gauge	-	13315	-	-	Reaeration Zone 1, Pressure Gauge
335	-	PI	-	2	Pressure Gauge	-	13315	-	-	Reaeration Zone 2, Pressure Gauge
335	-	PI	-	3	Pressure Gauge	-	13315	-	-	Reaeration Zone 3, Pressure Gauge
336	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Second Anoxic Tank No. 6 Mixer
336	-	M	-	2	Mixer	Ref Spec	11338	Ref Spec	460	Second Anoxic Tank No. 6 Mixer
336	-	V	-	1	6 Butterfly Valve	6V210	15100	-	-	Tank No. 6 Reaeration, Zone 1, Isolation
336	-	V	-	2	6 Butterfly Valve	6V210	15100	-	-	Tank No. 6 Reaeration, Zone 2, Isolation
336	-	V	-	3	6 Butterfly Valve	6V210	15100	-	-	Tank No. 6 Reaeration, Zone 3, Isolation
336	-	AE	-	1	Nitrate Probe	-	13315	-	-	Tank No. 6 Effluent Nitrate Probe
336	-	AE	-	2	DO/pH Probe	-	13315	-	120	Tank No. 6 Effluent DO/pH Analyzer

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Process 330 - Phase III Second Anoxic Tanks Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
335/336	-	AIT	-	1	Nitrate Transmitter	-	13315	-	120	335-AE-1 and 336-AE-1 Analyzer & Transmitter
336	-	AIT	-	2	DO/pH Transmitter	-	13315	-	120	Tank No. 6 Effluent Nitrate Transmitter
336	-	WG	-	1	Weir Gate	120 x 48	11281	-	-	Tank No. 6 Effluent Weir Gate
336	-	WG	-	2	Weir Gate	120 x 48	11281	-	-	Tank No. 6 Effluent Weir Gate
336	-	SG	-	1	Slide Gate	36 x 36	11281	-	-	Tank No. 6 Reaeration, Isolation
336	-	PI	-	1	Pressure Gauge	-	13315	-	-	Reaeration Zone 1, Pressure Gauge
336	-	PI	-	2	Pressure Gauge	-	13315	-	-	Reaeration Zone 2, Pressure Gauge
336	-	PI	-	3	Pressure Gauge	-	13315	-	-	Reaeration Zone 3, Pressure Gauge

Note:
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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 352 - Phase III Clarifier No. 9 WAS Pump Station

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
352	-	P	-	1	Waste Sludge Pump	---	11311A	7.5	460	Clarifier 9 WAS Pump 1
352	-	P	-	2	Waste Sludge Pump	---	11311A	7.5	460	Clarifier 9 WAS Pump 2
352	-	FE	-	1	RAS Flow Meter	10-inch	13315	---	---	RAS flow
352	-	FE	-	2	WAS Flow Meter	4-inch	13315	---	---	WAS flow
352	-	FIT	-	1	RAS Flow Meter Transmitter	---	13315	---	---	352-FE-1 Transmitter
352	-	FIT	-	2	WAS Flow Meter Transmitter	---	13315	---	---	352-FE-2 Transmitter
352	-	LS	-	1	Check Valve Limit Switch	---	13315	---	---	WAS Pump 1 No flow
352	-	LS	-	2	Check Valve Limit Switch	---	13315	---	---	WAS Pump 2 No flow
352	-	AE	-	1	Total Solids Meter	---	13315	---	---	TSS % solids in WAS
352	-	AIT	-	1	Total Solids Transmitter	---	13315	---	---	352-AE-1 Transmitter
352	-	V	-	1	Plug Valve	6-inch	15100	---	---	WAS Pump 1 suction
352	-	V	-	2	Plug Valve	6-inch	15100	---	---	WAS Pump 2 suction
352	-	V	-	3	Check Valve	4-inch	15100	---	---	WAS Pump 1 (352-LS-1)
352	-	V	-	4	Check Valve	4-inch	15100	---	---	WAS Pump 2 (352-LS-2)
352	-	V	-	5	Plug Valve	4-inch	15100	---	---	WAS Pump 1 discharge
352	-	V	-	6	Plug Valve	4-inch	15100	---	---	WAS Pump 2 discharge
352	-	V	-	7	Plug Valve	10-inch	15100	---	---	RAS Meter isolation (352-FE-1)
352	-	V	-	8	Plug Valve	4-inch	15100	---	---	WAS Meter isolation (352-FE-2)
352	-	V	-	9	Plug Valve	10-inch	15100	---	---	RAS Meter isolation (352-FE-1)
352	-	V	-	10	Plug Valve	4-inch	15100	---	---	WAS Meter isolation (352-FE-2)

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 360 - Filter Splitter Box

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
360	-	WG	-	1	Weir Gate with Motorized Actuator	96 x 48	11281 & 15119	1/2	460	Alternate Flow Control Gate - ABW Filters
360	-	WG	-	2	Weir Gate with Motorized Actuator	96 x 48	11281 & 15119	1/2	460	SE Reject/Flow Equalization Gate
360	-	WG	-	3	Weir Gate with Motorized Actuator	96 x 48	11281 & 15119	1/2	460	Alternate Flow Control Gate - Future Disk Filters
360	-	SG	-	1	Slide Gate	48 x 48	11281	-	-	Isolation Gate AWB Filters
360	-	SG	-	2	Slide Gate	48 x 48	11281	-	-	Isolation Gate AWB Filters
360	-	SG	-	3	Slide Gate	48 x 48	11281	-	-	Isolation Gate AWB Filters
360	-	SG	-	4	Slide Gate	48 x 48	11281	-	-	Isolation Gate Disk Filters
360	-	SG	-	5	Slide Gate	48 x 48	11281	-	-	Isolation Gate Disk Filters
360	-	SG	-	6	Slide Gate	48 x 48	11281	-	-	Isolation Gate Disk Filters
360	-	SG	-	7	Slide Gate	48 x 48	11281	-	-	Isolation Gate Disk Filters
360	-	LE/LIT	-	1	Level Control Element & Transmitter	Ultrasonic	13315	-	-	Influent Channel Level Control Element
360	-	P	-	1	Filter Feed Pump	4,167 gpm @ 14 ft	11308	25	460	Relocated Disk Filter Feed Pump
360	-	V	-	1	16 Check Valve	8V728	15100	-	-	360-P-1 Discharge Check Valve
360	-	V	-	2	2 Air Release Valve	2V1225	15108	-	-	360-P-1 Air Release Valve
360	-	V	-	3	16 Gate Valve	8V130	15100	-	-	360-P-1 Effluent Isolation Valve
360	-	P	-	2	Filter Feed Pump	4,167 gpm @ 14 ft	11308	25	460	Relocated Disk Filter Feed Pump
360	-	V	-	4	16 Check Valve	8V728	15100	-	-	360-P-2 Discharge Check Valve
360	-	V	-	5	2 Air Release Valve	2V1225	15108	-	-	360-P-2 Air Release Valve
360	-	V	-	6	16 Gate Valve	8V130	15100	-	-	360-P-2 Effluent Isolation Valve
	-		-					-	-	

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 390 - Phase III Effluent Pump Station

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
390	-	V	-	21	16 Check Valve	16V742	15100	-	-	390-P-1 Discharge Check Valve
390	-	V	-	22	16 Check Valve	16V742	15100	-	-	390-P-2 Discharge Check Valve
390	-	V	-	23	16 Check Valve	16V742	15100	-	-	390-P-3 Discharge Check Valve
390	-	P	-	4	Vertical Turbine Pump	9,000 gpm @ 51 ft	11214	200	460	Effluent Pump No 4
390	-	V	-	1	2 Air Release & Vac Valve for VTPs	2V1207	15108	-	-	390-P-4 Discharge ARV
390	-	V	-	2	20 Check Valve	20V742	15100	-	-	390-P-4 Discharge Check Valve
390	-	P	-	5	Vertical Turbine Pump	9,000 gpm @ 51 ft	11214	200	460	Effluent Pump No 5
390	-	V	-	3	2 Air Release & Vac Valve for VTPs	2V1207	15108	-	-	390-P-5 Discharge ARV
390	-	V	-	4	20 Check Valve	20V742	15100	-	-	390-P-5 Discharge Check Valve
390	-	P	-	6	Vertical Turbine Pump	9,000 gpm @ 51 ft	11214	200	460	Effluent Pump No 6
390	-	V	-	5	2 Air Release & Vac Valve for VTPs	2V1207	15108	-	-	390-P-6 Discharge ARV
390	-	V	-	6	20 Check Valve	20V742	15100	-	-	390-P-6 Discharge Check Valve
390	-	P	-	7	Vertical Turbine Pump	9,000 gpm @ 51 ft	11214	200	460	Effluent Pump No 7
390	-	V	-	7	2 Air Release & Vac Valve for VTPs	2V1207	15108	-	-	390-P-7 Discharge ARV
390	-	V	-	8	20 Check Valve	20V730	15100	-	-	390-P-7 Discharge Check Valve
390	-	P	-	8	Vertical Turbine Pump	9,000 gpm @ 51 ft	11214	200	460	Effluent Pump No 8
390	-	V	-	9	2 Air Release & Vac Valve for VTPs	2V1207	15108	-	-	390-P-8 Discharge ARV
390	-	V	-	10	20 Check Valve	20V742	15100	-	-	390-P-8 Discharge Check Valve
390	-	V	-	11	3 Combo Air Release & Vac Valve	3V1230	15108	-	-	Effluent Pump Header ARV
390	-	V	-	12	3 Combo Air Release & Vac Valve	3V1230	15108	-	-	Effluent Pump Header ARV
390	-	PIT	-	1	Pressure Indicating Transmitter	-	13315	-	120	Effluent Pump Header PIT
390	-	LE/LIT	-	1	Level Indicating Element and Transmitter	-	13315	-	120	Effluent Pump Station LE/LIT
395	-	P	-	1	Vertical Turbine Pump	1,200 @ 237 ft	11214	100	460	In Plant Reuse Water Pump No. 1

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 390 - Phase III Effluent Pump Station Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
390	-	V	-	17	1 Air Release Valve	1V1204	15108	-	-	395-P-1 Discharge ARV
390	-	V	-	15	8 Check Valve	8V742	15100	-	-	395-P-1 Discharge Check Valve
395	-	P	-	2	Vertical Turbine Pump	1,200 @ 237 ft	11214	100	460	In Plant Reuse Water Pump No. 2
390	-	V	-	18	1 Air Release Valve	1V1204	15108	-	-	395-P-2 Discharge ARV
390	-	V	-	16	8 Check Valve	8V742	15100	-	-	395-P-2 Discharge Check Valve
395	-	P	-	3	Vertical Turbine Pump	1,200 @ 237 ft	11214	100	460	In Plant Reuse Water Pump No. 3
390	-	V	-	19	1 Air Release Valve	1V1204	15108	-	-	395-P-3 Discharge ARV
390	-	V	-	13	8 Check Valve	8V742	15100	-	-	395-P-3 Discharge Check Valve
395	-	P	-	4	Vertical Turbine Pump	1,200 @ 237 ft	11214	100	460	In Plant Reuse Water Pump No. 4
390	-	V	-	20	1 Air Release Valve	1V1204	15108	-	-	395-P-4 Discharge ARV
390	-	V	-	14	8 Check Valve	8V742	15100	-	-	395-P-4 Discharge Check Valve
390	-	FE/FIT	-	1	8 Magnetic Flow Meter	8-inch	13315	-	120	In Plant Reuse Flow Meter
390	-	PIT	-	2	Pressure Indicating Transmitter	-	13315	-	120	In Plant Reuse Header PIT
390	-	V	-	24	8 Butterfly Valve	8V200	15100	-	-	390-FE/FIT-1 Isolation Valve
390	-	V	-	25	8 Butterfly Valve	8V200	15100	-	-	390-FE/FIT-1 Isolation Valve
390	-	V	-	26	1 ARV	1V1204	15108	-	-	Pump Discharge Header ARV
390	-	V	-	27	8 Butterfly Valve	8V200	15100	-	-	390-FE/FIT-1 Bypass Valve
390	-	V	-	28	4 Gate Valve	4V185	15100	-	-	Isolation valve for 4 Pressure Relief Valve
390	-	V	-	29	4 Pressure Relief Valve w/ Pressure Gauge	-	15110&13315	-	-	Pressure Relief Vavle for Pump Discharge Header
390	-	AE/AIT	-	1	pH Probe	-	13315	-	120	pH probe
390	-	CS	-	1	Composite Sampler	Ref Spec	13448	-	Ref Spec	Composite Sampler
390	-	LE/LIT	-	1	Level Element/Transmitter	-	13315	-	120	Wet Well Level Element/Transmitter

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 420 - Phase IV Basin No. 7

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
420	-	B	-	4	Blower	3,900 scfm @ 7.9 psi	11373	200	460	Phase IV Aeration Blower No. 4
420	-	V	-	4A	12 Motorized Butterfly Valve	12V210	11373	1/2	460	420-B-4 Inlet Throttling Valve
420	-	V	-	4B	16 Check Valve	12V728	11373	1/2	460	420-B-4 Discharge Check Valve
420	-	V	-	4C	16 Butterfly Valve	12V210	11373	-	-	420-B-4 Isolation Valve
420	-	V	-	5	30 Butterfly Valve	30V210	11373	-	-	Blower Header Isolation Valve
420	-	PI	-	7	Differential Pressure Gauge	0-10 in w.c.	11373	-	-	420-B-4 Inlet Filter Differential Pressure Gauge
420	-	PI	-	8	Pressure Gauge	0-15 psi	13315	-	-	420-B-4 Blower Discahrge Pressure Gauge
421	-	AE	-	1	Nitrate Analyzer	-	13315	-	120	Basin No. 7 East, Influent Nitrate Analyzer
421	-	AE	-	2	Nitrate Analyzer	-	13315	-	120	Basin No. 7 East, Effluent Nitrate Analyzer
421	-	AIT	-	1	Transmitter	-	13315	-	120	Basin No. 7 East Nitrate Transmitter for AE-1 & AE-2
422	-	AE	-	1	Nitrate Analyzer	-	13315	-	120	Basin No. 7 West, Influent Nitrate Analyzer
422	-	AE	-	2	Nitrate Analyzer	-	13315	-	120	Basin No. 7 West, Effluent Nitrate Analyzer
422	-	AIT	-	1	Transmitter	-	13315	-	120	Basin No. 7 West Nitrate Transmitter for AE-1 & AE-2

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 450 - Phase V-Secondary Clarifiers 10/11 RAS and Scum Pumping Stations

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
450	-	P	-	3	Return Sludge Pump	---	11311B	20	460	Clarifier11; RAS Pump 3
450	-	P	-	7	Scum Pump	---	11319	5	460	Clarifier 11 Scum Pump
450	-	FE	-	3	RAS Flow Meter	16-inch	13315	---	---	RAS flow (Clarifier 10 or 11)
450	-	FIT	-	3	RAS Flow Meter Transmitter	---	13315	---	---	450-FE-3 Transmitter
450	-	LS	-	3	Check Valve Limit Switch	---	13315	---	---	RAS Pump 3 No flow
450	-	LS	-	7	Check Valve Limit Switch	---	13315	---	---	Scum Pump 7 No flow
450	-	AE	-	1	Total Solids Meter	---	13315	---	---	TSS % solids Clarifier 10 (Existing)
450	-	AE	-	2	Total Solids Meter	---	13315	---	---	TSS % solids Clarifier 11
450	-	AIT	-	1	Total Solids Transmitter	---	13315	---	---	450-AE-1& 2 Transmitter (Relocated)
450	-	LSH	-	1	Scum Wetwell Float	---	13315	---	---	Scum Pump (450-P-7) start
450	-	LSHH	-	1	Scum Wetwell Float	---	13315	---	---	Wetwell level high - alarm
450	-	V	-	1	Plug Valve	14-inch	15100	---	---	RAS Pump 3 suction
450	-	V	-	2	Check Valve	16-inch	15100	---	---	WAS Pump 1 (352-LS-1)
450	-	V	-	3	Plug Valve	16-inch	15100	---	---	RAS Pump 3 discharge
450	-	V	-	4	Plug Valve	16-inch	15100	---	---	RAS meter isolation (450-FE-3)
450	-	V	-	5	Plug Valve	16-inch	15100	---	---	RAS meter isolation (450-FE-3)
450	-	V	-	6	Plug Valve	20-inch	15100	---	---	RAS discharge piping
450	-	V	-	7	Check Valve	4-inch	15100	---	---	Scum Pump 2 (450-LS-7)
450	-	V	-	8	Plug Valve	4-inch	15100	---	---	Scum Pump 2 discharge

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 470 - Phase IV Disk Filter

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
470	-	AE/AIT	-	1	Turbidimeter	---	13315	---	120	470-DF-1 Effluent Turbidimeter No. 1
470	-	AE/AIT	-	2	Turbidimeter	---	13315	---	120	470-DF-1 Effluent Turbidimeter No. 2
470	-	CP	-	1	Control Panel	---	---	---	480	Relocated Exsiting 470-DF-1 Control Panel
	-		-							

Process 495 - Phase IV In-Plant Lift Station

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
495	- -	P	- -	3	Submersible Pump	1,200 gpm@ 60 ft	11308	30	460	In-Plant Lift Station Pump No. 3

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 500 - Preliminary Treatment Structure

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
500	-	HC	-	1	Headcell	12 ft dia x 13 tray	11320	-	-	Headcell Unit No 1
500	-	HC	-	2	Headcell	12 ft dia x 13 tray	11320	-	-	Headcell Unit No 2
500	-	HC	-	3	Headcell	12 ft dia x 13 tray	11320	-	-	Headcell Unit No 3
500	-	HC	-	4	Headcell	12 ft dia x 13 tray	11320	-	-	Headcell Unit No 4 (Future)
500	-	P	-	1	Recessed Impeller Pump	300 gpm @ 49 ft	11314	15	460	Grit Pump No. 1
500	-	V	-	1	4 Plug Valve	4V510	15100	-	-	500-P-1 Inlet Isolation Valve
500	-	V	-	2	4 Check Valve	4V728	15100	-	-	500-P-1 Discharge Check Valve
500	-	V	-	3	4 Plug Valve	4V510	15100	-	-	500-P-1 Discharge Isolation Valve
500	-	P	-	2	Recessed Impeller Pump	300 gpm @ 49 ft	11314	15	460	Grit Pump No. 2
500	-	V	-	4	4 Plug Valve	4V510	15100	-	-	500-P-2 Inlet Isolation Valve
500	-	V	-	5	4 Check Valve	4V728	15100	-	-	500-P-2 Discharge Check Valve
500	-	V	-	6	4 Plug Valve	4V510	15100	-	-	500-P-2 Discharge Isolation Valve
500	-	P	-	3	Recessed Impeller Pump	300 gpm @ 49 ft	11314	15	460	Grit Pump No. 3
500	-	V	-	7	4 Plug Valve	4V510	15100	-	-	500-P-3 Inlet Isolation Valve
500	-	V	-	8	4 Check Valve	4V728	15100	-	-	500-P-3 Discharge Check Valve
500	-	V	-	9	4 Plug Valve	4V510	15100	-	-	500-P-3 Discharge Isolation Valve
500	-	P	-	4	Recessed Impeller Pump	300 gpm @ 49 ft	11314	15	460	Grit Pump No. 4
500	-	V	-	10	4 Plug Valve	4V510	15100	-	-	500-P-4 Inlet Isolation Valve
500	-	V	-	11	4 Check Valve	4V728	15100	-	-	500-P-4 Discharge Check Valve
500	-	V	-	12	4 Plug Valve	4V510	15100	-	-	500-P-4 Discharge Isolation Valve
500	-	P	-	5	Recessed Impeller Pump	300 gpm @ 49 ft	11314	15	460	Grit Pump No. 5
500	-	V	-	13	4 Plug Valve	4V510	15100	-	-	500-P-5 Inlet Isolation Valve

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 500 - Preliminary Treatment Structure Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
500	-	V	-	14	4 Check Valve	4V728	15100	-	-	500-P-5 Discharge Check Valve
500	-	V	-	15	4 Plug Valve	4V510	15100	-	-	500-P-5 Discharge Isolation Valve
500	-	P	-	6	Recessed Impeller Pump	300 gpm @ 49 ft	11314	15	460	Grit Pump No. 6 (Future)
500	-	V	-	16	4 Plug Valve	4V510	15100	-	-	500-P-6 Inlet Isolation Valve (Future)
500	-	V	-	17	4 Check Valve	4V728	15100	-	-	500-P-6 Discharge Check Valve
500	-	V	-	18	4 Plug Valve	4V510	15100	-	-	500-P-6 Discharge Isolation Valve
500	-	V	-	19	4 Plug Valve	4V510	15100	-	-	500-P-1 & 500-P-3 Bypass Isolation Valve
500	-	V	-	20	4 Plug Valve	4V510	15100	-	-	500-P-3 & 500-P-5 Bypass Isolation Valve
500	-	V	-	21	4 Plug Valve	4V510	15100	-	-	500-P-2 & 500-P-4 Bypass Isolation Valve
500	-	V	-	22	4 Plug Valve	4V510	15100	-	-	500-P-4 & 500-P-6 Bypass Isolation Valve
500	-	V	-	23	4 Plug Valve	4V510	15100	-	-	500-P-1 & 500-P-3 Bypass Isolation Valve
500	-	V	-	24	4 Plug Valve	4V510	15100	-	-	500-P-3 & 500-P-5 Bypass Isolation Valve
500	-	V	-	25	4 Plug Valve	4V510	15100	-	-	500-P-2 & 500-P-4 Bypass Isolation Valve
500	-	V	-	26	4 Plug Valve	4V510	15100	-	-	500-P-4 & 500-P-6 Bypass Isolation Valve
500	-	SC	-	1	Slurry Cup	32 in dia	11320	-	-	500-GS-1 Slurry Cup No. 1
500	-	SC	-	2	Slurry Cup	32 in dia	11320	-	-	500-GS-1 Slurry Cup No. 2
500	-	GS	-	3	Grit Snail	4.0 cy/hr	11320	1/3	460	Grit Dewatering Unit No. 1
500	-	SC	-	4	Slurry Cup	32 in dia	11320	-	-	500-GS-2 Slurry Cup No. 1
500	-	SC	-	1	Slurry Cup	32 in dia	11320	-	-	500-GS-2 Slurry Cup No. 2
500	-	GS	-	2	Grit Snail	4.0 cy/hr	11320	1/3	460	Grit Dewatering Unit No. 2
500	-	CP	-	5	Grit Equipment Control Panel	NEMA 4X	11320	-	480	500-HC-1/2, 500-SC-1/2 & 500-GS-1 Control Panel
	-		-							

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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 500 - Preliminary Treatment Structure Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
500	-	CP	-	6	Grit Equipment Control Panel	NEMA 4X	11320	-	480	500-HC-3/4, 500-SC-3/4 & 500-GS-2 Control Panel
500	-	MS	-	1	Mechanical Band Screen	5 mm, 35.6 mgd (peak)	11328	Ref Spec	460	Band Screen No. 1
500	-	MS	-	2	Mechanical Band Screen	5 mm, 35.6 mgd (peak)	11328	Ref Spec	460	Band Screen No. 2
500	-	MS	-	3	Mechanical Band Screen	5 mm, 35.6 mgd (peak)	11328	Ref Spec	460	Band Screen No. 3
500	-	MS	-	4	Mechanical Band Screen	5 mm, 35.6 mgd (peak)	11328	Ref Spec	460	Band Screen No. 4 (future)
500	-	CM	-	1	Screenings Compactor	150 cf/hr (min)	11328	Ref Spec	460	Compactor No. 1
500	-	CM	-	2	Screenings Compactor	150 cf/hr (min)	11328	Ref Spec	460	Compactor No. 2
500	-	CM	-	3	Screenings Compactor	150 cf/hr (min)	11328	Ref Spec	460	Compactor No. 3
500	-	CM	-	4	Screenings Compactor	150 cf/hr (min)	11328	Ref Spec	460	Compactor No. 4 (future)
500	-	CP	-	1	Screenings Control Panel	NEMA 4X	11328	-	480	500-MS-1 & 500-CM-1 Control Panel
500	-	CP	-	2	Screenings Control Panel	NEMA 4X	11328	-	480	500-MS-2 & 500-CM-2 Control Panel
500	-	CP	-	3	Screenings Control Panel	NEMA 4X	11328	-	480	500-MS-3 & 500-CM-3 Control Panel
500	-	CP	-	4	Screenings Control Panel	NEMA 4X	11328	-	480	Future Control Panel
500	-	V	-	27	6 Plug Valve	6V510	15100	-	-	Screenings Channel Drain
500	-	V	-	28	6 Plug Valve	6V510	15100	-	-	Screenings Channel Drain
500	-	V	-	29	6 Plug Valve	6V510	15100	-	-	Screenings Channel Drain
500	-	V	-	30	6 Plug Valve	6V510	15100	-	-	Screenings Channel Drain
500	-	FE/FIT	-	1	20 Magnetic Flow Meter	20 inch	13315	-	120	InPlant Return Flowmeter
500	-	V	-	31	20 Plug Valve	20V520	15100	-	-	500-FE/FIT-X Isolation Valve
500	-	V	-	32	48 Plug Valve	48V520	15100	-	-	48 RS-1 Isolation Valve
500	-	V	-	33	12 Plug Valve	12V510	15100	-	-	500-FE/FIT-6 Isolation Valve
500	-	V	-	34	12 Plug Valve	12V510	15100	-	-	500-FE/FIT-6 Isolation Valve
500	-	V	-	35	48 Plug Valve	48V520	15100	-	-	48 RS-1 Isolation Valve
	-		-							

Note:
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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 500 - Preliminary Treatment Structure Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
500	-	V	-	36	48 Plug Valve	48V520	15100	-	-	48 RS-1 Isolation Valve
500	-	V	-	37	36 Plug Valve	36V520	15100	-	-	36 RS-1 Isolation Valve
500	-	SG	-	1	Motorized Slide Gate	60 x 96	11284	1/2	460	North Screenings Bypass Gate - NEMA 7 EMA
500	-	SG	-	2	Slide Gate	60 x 96	11284	-	-	500-MS-4 Influent Screen
500	-	SG	-	3	Slide Gate	60 x 96	11284	-	-	500-MS-3 Influent Screen
500	-	SG	-	4	Slide Gate	60 x 96	11284	-	-	500-MS-2 Influent Screen
500	-	SG	-	5	Slide Gate	60 x 96	11284	-	-	500-MS-4 Influent Screen
500	-	SG	-	6	Slide Gate	60 x 96	11284	-	-	South Screenings Bypass Gate
500	-	SG	-	7	Slide Gate	60 x 96	11284	-	-	South Screenings Bypass Gate
500	-	SG	-	8	Slide Gate	60 x 96	11284	-	-	500-MS-1 Effluent Screen
500	-	SG	-	9	Slide Gate	60 x 96	11284	-	-	500-MS-2 Effluent Screen
500	-	SG	-	10	Slide Gate	60 x 96	11284	-	-	500-MS-3 Effluent Screen
500	-	SG	-	11	Slide Gate	60 x 96	11284	-	-	500-MS-4 Effluent Screen
500	-	SG	-	13	Slide Gate	60 x 96	11284	-	-	500-HC-1 Isolation Gate
500	-	SG	-	14	Slide Gate	60 x 96	11284	-	-	500-HC-2 Isolation Gate
500	-	SG	-	15	Slide Gate	60 x 96	11284	-	-	500-HC-3 Isolation Gate
500	-	SG	-	16	Slide Gate	60 x 96	11284	-	-	500-HC-4 Isolation Gate
500	-	SG	-	12	Slide Gate	60 x 96	11284	-	-	North Headcell Bypass Gate
500	-	SG	-	17	Slide Gate	60 x 96	11284	-	-	South Headcell Bypass Gate
500	-	WG	-	1	Weir Gate	120 x 60	11284	-	-	Phase I/II Effluent Gate
500	-	WG	-	2	Weir Gate	120 x 60	11284	-	-	Phase III Effluent Gate
500	-	WG	-	3	Weir Gate	120 x 60	11284	-	-	Phase IV Effluent Gate
500	-	WG	-	4	Weir Gate	120 x 60	11284	-	-	Future Phase Effluent Gate
	-		-							

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 500 - Preliminary Treatment Structure Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
500	-	B	-	1	FRP Blower	7,000 cfm @ 14 in wc	11395	20	460	Odorous Air Blower No. 1
500	-	B	-	2	FRP Blower	7,000 cfm @ 14 in wc	11395	20	460	Odorous Air Blower No. 2
500	-	BF	-	1	Biotrickling Filter	Ref Spec	11530	-	-	FRP Vessel & Tank w/ Media
500	-	CU	-	1	Carbon Unit	Ref Spec	11530	-	-	FRP Vessel & Tank w/ Media
500	-	T	-		Nutrient Feed Tank w/ Mixer	400 gallon	11530	-	460	500-BF-1 Nutient Storage Tank
500	-	P	-	7	Recirculation Pump	80 gpm	11530	7.5	460	Recirculation Pump
500	-	P	-	8	Recirculation Pump	80 gpm	11530	7.5	460	Recirculation Pump (Uninstalled)
500	-	P	-	9	Nutrient Feed Pump	per MFR	11530	<1	120	Nurtient Feed Pump
500	-	P	-	10	Nutrient Feed Pump	per MFR	11530	<1	120	Nurtient Feed Pump (Uninstalled)
500	-	CP	-	7	Control Panel	NEMA 4X	11530	-	480	Biotricking Filter Control Panel
500	-	CP	-	8	Water Cabinet/Nutrient Rack	NEMA 4X	11530	-	480	Irrigation/Nutient Feed Control Panel
500	-	FE/FIT	-	2	30 Magnetic Flow Meter	30 inch	13315	-	120	Phase I/II Flowmeter
500	-	V	-	38	30 Plug Valve	30V520	15100	-	-	500-FE/FIT-2 Isolation Valve
500	-	V	-	39	42 Plug Valve	42V520	15100	-	-	500-FE/FIT-2 Bypass Valve
500	-	V	-	40	30 Plug Valve	30V520	15100	-	-	500-FE/FIT-2 Isolation Valve
500	-	FE/FIT	-	3	36 Magnetic Flowmeter	36 inch	13315	-	120	Influent Flow Meter
500	-	V	-	41	36 Plug Valve	36V520	15100	-	-	500-FE/FIT-3 Isolation Valve
500	-	V	-	42	48 Plug Valve	48V520	15100	-	-	500-FE/FIT-3 Bypass Valve
500	-	V	-	43	36 Plug Valve	36V520	15100	-	-	500-FE/FIT-3 Isolation Valve
500	-	FE/FIT	-	4	36 Magnetic Flowmeter	36 inch	13315	-	120	Influent Flow Meter
500	-	V	-	44	36 Plug Valve	36V520	15100	-	-	500-FE/FIT-4 Isolation Valve
500	-	V	-	45	48 Plug Valve	48V520	15100	-	-	500-FE/FIT-4 Bypass Valve
	-		-							

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 500 - Preliminary Treatment Structure Continued...

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
500	-	V	-	46	36 Plug Valve	36V520	15100	-	-	500-FE/FIT-4 Isolation Valve
500	-	FE/FIT	-	5	30 Magnetic Flowmeter	30 inch	13315	-	120	Phase III Flowmeter
500	-	V	-	47	30 Plug Valve	30V520	15100	-	-	500-FE/FIT-5 Isolation Valve
500	-	V	-	48	30 Plug Valve	30V520	15100	-	-	500-FE/FIT-5 Bypass Valve
500	-	V	-	49	30 Plug Valve	30V520	15100	-	-	500-FE/FIT-5 Isolation Valve
500	-	V		50	2 Air Release Valve	2V1225	15108	-	-	500-FE/FIT-2 ARV
500	-	V		51	2 Air Release Valve	2V1225	15108	-	-	500-FE/FIT-3 ARV
500	-	V		52	2 Air Release Valve	2V1225	15108	-	-	500-FE/FIT-4 ARV
500	-	V		53	2 Air Release Valve	2V1225	15108	-	-	500-FE/FIT-5 ARV
500	-	V		54	6 Plug Valves	6V510	15100	-	-	InPlant Return Isolation Valve
500	-	V		55	6 Plug Valves	6V510	15100	-	-	InPlant Return Isolation Valve
500	-	V		56	6 Plug Valves	6V510	15100	-	-	Scum Return Isolation Valve
500	-	V		57	6 Plug Valves	6V510	15100	-	-	Scum Return Isolation Valve
	-		-							

Note:
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Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 520 - Supplemental Carbon Feed and Storage

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
520	-	TK	-	1	Polyethylene Storage Tank	6,000 gallons	13090	-	-	Chemical Storage Tank No. 1
520	-	LE	-	1	Level Element	-	13315	-	-	520-TK-1 Level Element
520	-	LIT	-	1	Level Indicator & Transmitter	-	13315	-	-	520-LE-1 Transmitter
520	-	TK	-	2	Polyethylene Storage Tank	6,000 gallons	13090	-	-	Chemical Storage Tank No. 2
520	-	LE	-	2	Level Element	-	13315	-	-	520-TK-2 Level Element
520	-	LIT	-	2	Level Indicator & Transmitter	-	13315	-	-	520-LE-2 Transmitter
520	-	EW	-	1	Eyewash Station	Detail 8/D-504	-	-	-	Eyewash/Shower No. 1
520	-	FS	-	1	Flow Switch	-	13315	-	-	520-EW-1 Flow Switch
520	-	EW	-	2	Eyewash Station	Detail 8/D-504	-	-	-	Eyewash/Shower No. 2
520	-	FS	-	2	Flow Switch	---	13315	-	---	520-EW-2 Flow Switch
520	-	P	-	1	Peristaltic Metering Pump	28 gph @ 32 psi	11345	1/2	120	Phase I/II Chemical Feed Pump No. 1
520	-	P	-	2	Peristaltic Metering Pump	28 gph @ 32 psi	11345	1/2	120	Phase I/II Chemical Feed Pump No. 2
520	-	P	-	3	Peristaltic Metering Pump	34 gph @ 32 psi	11345	1/2	120	Phase III Chemical Feed Pump No. 1
520	-	P	-	4	Peristaltic Metering Pump	34 gph @ 32 psi	11345	1/2	120	Phase III Chemical Feed Pump No. 2
520	-	CP	-	1	Control Panel	NEMA 4X	11345	-	480	Phase I/II Feed Pump Skid Control Panel
520	-	CP	-	1	Control Panel	NEMA 4X	11345	-	480	Phase III Feed Pump Skid Control Panel
	-		-							

Process 540 - Phase V-Secondary Clarifiers 11

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
540	-	M	-	1	Clarifier Drive	---	11336	1	460	Clarifier 11 Dive Motor
540	-	LE	-	1	Sludge Blanket Level	---	13315	---	---	Clarifier 11
540	-	LIT	-	1	Sludge Blanket Level Transmitter	---	13315	---	---	Clarifier 11

Note:
1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 560 - Secondary Effluent Reject Pump Station

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
560	-	P	-	1	Submersible Pump	7,600 gpm @ 37 ft	11308	85	460	SE EFF REJ Pump No. 1
560	-	PI	-	1	Pressure Gauge	-	13315	-	-	560-P-1 Discharge Pressure Gauge
560	-	V	-	1	18 Check Valve	18V728	15100	-	-	560-P-1 Discharge Check Valve
560	-	V	-	2	18 Plug Valve	18V520	15100	-	-	560-P-1 Effluent Isolation Valve
560	-	V	-	3	2 Air Release Valve	2V1225	15108	-	-	560-P-1 Discharge ARV
560	-	P	-	2	Submersible Pump	7,600 gpm @ 37 ft	11308	85	460	SE EFF REJ Pump No. 2
560	-	PI	-	2	Pressure Gauge	-	13315	-	-	560-P-2 Discharge Pressure Gauge
560	-	V	-	4	18 Check Valve	18V728	15100	-	-	560-P-2 Discharge Check Valve
560	-	V	-	5	18 Plug Valve	18V520	15100	-	-	560-P-2 Effluent Isolation Valve
560	-	V	-	6	2 Air Release Valve	2V1225	15108	-	-	560-P-2 Discharge ARV
560	-	P	-	3	Submersible Pump	7,600 gpm @ 37 ft	11308	85	460	SE EFF REJ Pump No. 3
560	-	PI	-	3	Pressure Gauge	-	13315	-	-	560-P-3 Discharge Pressure Gauge
560	-	V	-	7	18 Check Valve	18V728	15100	-	-	560-P-3 Discharge Check Valve
560	-	V	-	8	18 Plug Valve	18V520	15100	-	-	560-P-3 Effluent Isolation Valve
560	-	V	-	9	2 Air Release Valve	2V1225	15108	-	-	560-P-3 Discharge ARV
560	-	P	-	4	Submersible Pump	7,600 gpm @ 37 ft	11308	85	460	SE EFF REJ Pump No. 4
560	-	PI	-	4	Pressure Gauge	-	13315	-	-	560-P-4 Discharge Pressure Gauge
560	-	V	-	10	18 Check Valve	18V728	15100	-	-	560-P-4 Discharge Check Valve
560	-	V	-	11	18 Plug Valve	18V520	15100	-	-	560-P-4 Effluent Isolation Valve
560	-	V	-	12	2 Air Release Valve	2V1225	15108	-	-	560-P-4 Discharge ARV
	-		-							

Note:
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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Orange County Utilities
Eastern Water Reclamation Facility
Phase V Improvements
Bid Package A
Tag List

Process 560 - Secondary Effluent Reject Pump Station Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
560	-	V	-	22	36 Double Door Check Valve	36V760	15100	-	-	Influent Check Valve Clarifier Nos 1-8
560	-	V	-	23	36 Double Door Check Valve	36V760	15100	-	-	Influent Check Valve Clarifier Nos 9-11
560	-	LE/LIT	-	1	Level Control Element & Transmitter	-	13315	-	120	Wet Well Level Indicator & Transmitter
560	-	FE/FIT	-	1	24 Flowmeter & Transmitter	24 Mag Meter	13315	-	120	Reject Return Flowmeter to PTS
560	-	V	-	13	24 Butterfly Valve	24V200	15100	-	-	560-FE/FIT-1 Bypass Isolation Valve
560	-	V	-	14	24 Butterfly Valve	24V200	15100	-	-	560-FE/FIT-1 Upstream Isolation Valve
560	-	V	-	15	24 Motorized Butterfly Valve	24V200M	15100 & 15119	-	-	560-FE/FIT-1 Control Valve
560	-	V	-	18	2 Air Release Valve	2V1225	15108	-	-	560-FE/FIT-1 Downstream ARV
560	-	FE/FIT	-	2	30 Flowmeter & Transmitter	30 Mag Meter	13315	-	120	Reject Return Flowmeter to Pond
560	-	V	-	20	30 Butterfly Valve	30V200	15100	-	-	560-FE/FIT-2 Bypass Isolation Valve
560	-	V	-	21	30 Butterfly Valve	30V200	15100	-	-	560-FE/FIT-2 Upstream Isolation Valve
560	-	V	-	16	30 Motorized Butterfly Valve	30V200M	15100 & 15119	-	-	560-FE/FIT-2 Control Valve
560	-	V	-	19	2 Air Release Valve	2V1225	15108	-	-	560-FE/FIT-2 Downstream ARV
560	-	V	-	17	42 Motorized Butterfly Valve	42V200M	15100	-	-	Reject Return Control Valve
561	-	WG	-	1	Motorized Weir Gate	96 x 36	11281 & 15119	1/2	460	Phase I/II Effluent Diversion Control Gate
561	-	SG	-	1	Motorized Slide Gate	42 x 42	11281 & 15119	1/2	460	Phase I/II Effluent Diversion Control Gate
561	-	LE/LIT	-	1	Level Control Element & Transmitter	Ultrasonic	13315	-	120	Diversion Box Level Indicator & Transmitter
562	-	WG	-	1	Motorized Weir Gate	108 x 18	11281 & 15119	1/2	460	Phase I/II Effluent Diversion Control Gate
562	-	SG	-	1	Motorized Slide Gate	54 x 54	11281 & 15119	1/2	460	Phase I/II Effluent Diversion Control Gate
562	-	LE/LIT	-	1	Level Control Element & Transmitter	Ultrasonic	13315	-	120	Diversion Box Level Indicator & Transmitter
563	-	WG	-	1	Motorized Weir Gate	108 x 18	11281 & 15119	1/2	460	Phase III Effluent Diversion Control Gate
563	-	SG	-	1	Motorized Slide Gate	60 x 60	11281 & 15119	1/2	460	Phase III Effluent Diversion Control Gate
563	-	LE/LIT	-	1	Level Control Element & Transmitter	Ultrasonic	13315	-	120	Diversion Box Level Indicator & Transmitter
	-		-							

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1. This tag list includes only those valves and equipment that have been assigned a tag number. This list is not intended to be a complete list of all valves and items of equipment to be furnished on the project. Please refer to the plans and specifications for other valves and equipment to be furnished on the project.
2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

Process 560 - Secondary Effluent Reject Pump Station Continued…

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
564	-	WG	-	1	Motorized Weir Gate	84 x 24	11281 & 15119	1/2	460	Phase III Effluent Diversion Control Gate
564	-	SG	-	1	Motorized Slide Gate	36 x 36	11281 & 15119	1/2	460	Phase III Effluent Diversion Control Gate
564	-	LE/LIT	-	1	Level Control Element & Transmitter	Ultrasonic	13315	-	120	Diversion Box Level Indicator & Transmitter
564	-	WG	-	2	Motorized Weir Gate	84 x 24	11281 & 15119	1/2	460	Phase IV Effluent Diversion Control Gate
564	-	SG	-	2	Motorized Slide Gate	36 x 36	11281 & 15119	1/2	460	Phase IV Effluent Diversion Control Gate
564	-	LE/LIT	-	2	Level Control Element & Transmitter	Ultrasonic	13315	-	120	Diversion Box Level Indicator & Transmitter
565	-	SG	-	1	Slide Gate	48x48	11281	-	-	Reject Storage Pond Isolation Gate

Process 580 - Chlorine Contact Tank

Proc.		Type		No.	Description	Size or Type	Spec. Sect.	Hp. Req	Voltage	Comments/Notes
580	-	LE/LIT	-	1	Ultrasonic Level Control Element	-	13315	-	120	Level Indicator/Transmitter (Effluent Flow Measurement)
580	-	SG	-	1	Slide Gate	48"X48"	11284	-	-	48 RW-1 Effluent Gate
580	-	SG	-	2	Slide Gate	24"x24"	11284	-	-	24 FE-1 Influent Gate
580	-	SG	-	3	Slide Gate	48"x48"	11284	-	-	48 SE-1 Influent Gate
580	-	M	-	1	Mixer	Ref Spec	11338	Ref Spec	460	Influent Mixer
580	-	V	-	1	48 BFV	48V200	15100	-	-	Future Disk Filter Isolation Valve

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2. Weir gate dimensions are shown as "inches width (A)" x "inches height (B)" as shown on the details.

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ATTACHMENTS

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Attachment A - Orange County Utilities Standards and Construction Specifications Manual
Appendix D: List of Approved Products
February 11, 2011

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APPENDIX D **LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Air Release	ARV Enclosure	**All ARV above ground enclosures shall be vented with tamper proof locking device**						
		Water Plus Polyethylene Enclosure	131632 H30-B	Blue 44" Tall	131632 H30-P	Pantone 44"	131632 H30-G	Green 44" Tall
			171730 H40-B	Blue 30" Tall	171730 H40-P	Pantone 30"	171730 H40-G	Green 30" Tall
		Hot Box Vent Guard Fiberglass Enclosure	AVG2036 Encl GP3232 Base	Blue 36" Tall	AVG2036 Encl GP3232 Base	Pantone 36" Tall	AVG2036 Encl GP3232 Base	Green 36" Tall
			AVG2041 Encl GP3232 Base	Blue 41" Tall	AVG2041 Encl GP3232 Base	Pantone 41" Tall	AVG2041 Encl GP3232 Base	Green 41" Tall
		Safety-Guard/Hydro Guard	15100 Encl	Blue 34" Tall	15100 Encl	Pantone 34" Tall	15100 Encl	Green 34" Tall
	Air Release Valves	**Air Release Valves shall be Combination Type, 316 SS**						
		ARI	D-040SS	Combination	D-040SS	Combination	D-020 (SS)	Combination
		H-TEC	NA	NA	NA	NA	986 (316SS)	Combination
		Vent-O-Mat	Series RBX DN50	2"	Series RBX DN50	2"	RGX series	
	ARV Vault	**Air Release Valve Frame and Cover**						
		US Foundry	NA	NA	NA	NA	USF 7665-HH-HJ	
Blow Off	Auto Blow Off	**Automatic Blow Off Valve**						
		Hydro Guard	HG-1 Standard Unit	Automatic	NA	NA	NA	NA
	Blow Off Valve	**Blow Off Valve - Fits standard 5-1/4 inch Valve Box**						
		Kupferle Foundry Co	Truflo Series TF #550		Truflo Series TF #550		NA	NA
		Water Plus Corp	The Hydrant Plus Series VB 2000B		The Hydrant Plus Series VB 2000B		NA	NA
Casing Seals / Spacers	Casing End Seals	**Casing End Seals. Annular space between pipe and steel casing shall be brick and mortar with end seals to secure ends.**						
		Advance Products	Model AC and AW		Model AC and AW		Model AC and AW	
		BWM Company	Model WR and PO		Model WR and PO		Model WR and PO	
		Cascade Water Works	Model CCES		Model CCES		Model CCES	
		CCI Pipeline	Model ESW and ESC		Model ESW and ESC		Model ESW and ESC	
		Pipeline Seal & Insulator, Inc (PSI)	Model C and W		Model C and W		Model C and W	
		Power Seal	Model 4810ES		Model 4810ES		Model 4810ES	

APPENDIX D **LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Casing Seals / Spacers	Casing spacer	**Casing spacers shall be a min. 8-inches wide for pipe 12" Dia or less or min. 12-inches wide for pipe 16 or greater , shall have a minimum 14 gauge 304 stainless steel shell/band, minimum 10 gauge 304 reinforced risers; minimum thickness of 0.090 EPDM or PVC interior liners, glass reinforces polymer or ultra high molecular weight polyethylene and 304 stainless bolts, nuts and washers.**						
		Advance Products	SSI8 / SSI12		SSI8 / SSI12		SSI8 / SSI12	
		BWM Company	BWM-SS-8 / SS-12		BWM-SS-8 / SS-12		BWM-SS-8 / SS-12	
		Cascade Water Works	Series CCS 8" / 12"		Series CCS 8" / 12"		Series CCS 8" / 12"	
		CCI Pipeline	Model CCS8 / CSS12		Model CCS8 / CSS12		Model CCS8 / CSS12	
		Pipeline Seal & Insulator, Inc (PSI)	Series S8G-2 / S12G-2		Series S8G-2 / S12G-2		Series S8G-2 / S12G-2	
Coatings	Exterior Coatings for Exposed Metal Assets	**Coatings: Aerial pipe, hydrants, above ground piping, fittings, valves and Appurtenances - System 1 Zinc / Urethane / Fluoropolymer application and color code per Section 3119 Coatings & Linings. Coating shall not be in contact with Potable water unless NSF 61 approved.**						
		Carboline	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils
			Carbothane 133 HB	3.0 -5.0 mils	Carbothane 133 HB	3.0 -5.0 mils	Carbothane 133 HB	3.0 -5.0 mils
			Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils
		Tnemec	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils
			Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils
			EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils
			Hydroflon Series 700	2.0 - 3.0 mils	Hydroflon Series 700	2.0 - 3.0 mils	Hydroflon Series 700	2.0 - 3.0 mils
	Exterior Coatings for Exposed Metal Assets	**Coatings: Aerial pipe, hydrants, above ground piping, fittings, valves and Appurtenances - System 2 Zinc / Epoxy / Urethane application and color code per Section 3119 Coatings & Linings. Coating shall not be in contact with Potable water unless NSF 61 approved.**						
		Carboline	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils	Carbozinc 621	3.0 - 8.0 mils
			Carboguard 60	4.0 -6.0 mils	Carboguard 60	4.0 -6.0 mils	Carboguard 60	4.0 -6.0 mils
			Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils	Carboxane 950	2.0 - 3.0 mils
		Tnemec	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils	Zinc Series 90-97	2.5 - 3.5 mils
			Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils	Typoxy Series 27WB	4.0 -14.0 mils
			Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils	Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils	Hi-Build Epoxoline II Series N69	4.0 - 10.0 mils
			EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils	EnduraShield Series73	2.0 - 3.0 mils
		PPG / Ameron	Amercoat 68HS	Min 3.0 mils	Amercoat 68HS	Min 3.0 mils	Amercoat 68HS	Min 3.0 mils
			Amercoat 385	4.0 - 6.0 mils	Amercoat 385	4.0 - 6.0 mils	Amercoat 385	4.0 - 6.0 mils
			Amercoat 450H	2.0 - 3.0 mils	Amercoat 450H	2.0 - 3.0 mils	Amercoat 450H	2.0 - 3.0 mils

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Fittings	Fittings	**Ductile Iron Fittings C153 SSB / C110 FLG: (Water & Reclaimed Water fittings shall cement lined or holiday free fusion bonded epoxy lined) (Wastewater fittings interior shall be Protecto 401 and holiday free)**						
		American	30" & up	FBE / Cement	30" & up	FBE / Cement	30" & up	Protecto 401
		Sigma		FBE / Cement		FBE / Cement		Protecto 401
		Star		FBE / Cement		FBE / Cement		Protecto 401
		Tyler Union & Clow		FBE / Cement		FBE / Cement		Protecto 401
Flow	Flow Meter	**Flow Meters With Replaceable Sensors**						
		EMCO	NA	NA	NA	NA	Unimag 4411E	
Hydrants	Hydrants	**Hydrants Shall open left, 1-1/2 Pentagon operating nut, NST hose & pumper thread, rotate 360 degrees, closed drains, epoxy on shoe in & out and 304 SS nuts & bolts below ground.**						
		American Flow Control	B-84-B (6 inch)		NA	NA	NA	NA
		Clow	Medallion 2545		NA	NA	NA	NA
		Mueller	Super Centurion 250		NA	NA	NA	NA
Joint Restraints	Ductile iron pipe MJ Restraints	**Mechanical Joint Wedge-action Restraining Gland, Epoxy Coated Restrain ductile iron pipe to mechanical joint fittings, pipe and appurtenances.**						
		EBAA Iron Inc	Megalug Series 1100		Megalug Series 1100		Megalug Series 1100	
		Ford / Uni-Flange	UFR-1400		UFR-1400		UFR-1400	
		Sigma	OneLok Series SLD/SLDE		OneLok Series SLD/SLDE		OneLok Series SLD/SLDE	
		Smith Blair	Cam Lok Series 111		Cam Lok Series 111		Cam Lok Series 111	
		Star	Star Grip Series 3000		Star Grip Series 3000		Star Grip Series 3000	
		Tyler Union	TufGrip Series TLD		TufGrip Series TLD		TufGrip Series TLD	
	DIP Bell Joint Restraints (4"-12") (New & Existing)	**Bell Joint Restraints for Ductile Iron Pipe (4"-12") (New & Existing) - All restraints split serrated on bell and spigot ends. Pipe 16" and greater shall have restraint gaskets or locking bells. (Wastewater only for restraint of existing DIP FM)**						
		EBAA Iron Inc	Tru-Dual Series 1500TD		Tru-Dual Series 1500TD		Tru-Dual Series 1500TD	
		Ford / Uni-Flange	Uni-Flange Series 1390C		Uni-Flange Series 1390C		Uni-Flange Series 1390C	
		Sigma	PV-Lok Series PWP-C		PV-Lok Series PWP-C		PV-Lok Series PWP-C	
		Smith Blair	Bell-Lock Series 165		Bell-Lock Series 165		Bell-Lock Series 165	
		Star	StarGrip Series 3100S		StarGrip Series 3100S		StarGrip Series 3100S	
		Tyler Union	TufGrip-Series 300C		TufGrip-Series 300C		TufGrip-Series 300C	
	DIP Bell Joint Restraints (16" & Greater)	**Ductile Iron Pipe Bell Joint Restraints for Ductile Iron Pipe (16" & Greater) - All restraints shall have a split back-up ring for the bell and a serrated or wedge action gland for the spigot end. New installation for water & reclaimed water piping 16" and greater shall have restraint gaskets or locking bells.**						
		EBAA Iron Inc	Series 1100HD	Existing Only	Series 1100HD	Existing Only	Series 1100HD	Existing Only
		Sigma	Series SSLDH	Existing Only	Series SSLDH	Existing Only	Series SSLDH	Existing Only
		Star	Series 3100S	Existing Only	Series 3100S	Existing Only	Series 3100S	Existing Only

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Joint Restraints	Ductile iron pipe Bell Joint Restraint Gaskets and Locking Bell (4" & Above)	**Bell Joint Restraint Gaskets and Locking Bell (4" & Above) Stainless Steel locking wedges built into the gasket-rubber. ANSI/AWWA C111/A21.11 Standard for Rubber-Gasket Joints for Ductile Iron Pressure Pipe. Ductile Iron Bell Joint Restraint for Push-On Pipe- Locking bell joint system that prevents joint separation and allows for joint deflection. Bells shall be painted red to verify restrained gasket.**						
		American	Fast Grip Gasket	Gasket	Fast Grip Gasket	Gasket	NA	NA
			Flex-Ring Joint	Bell Lock	Flex-Ring Joint	Bell Lock	NA	NA
			Lok-Ring Joint	Bell Lock	Lok-Ring Joint	Bell Lock	NA	NA
		Griffin	Talon RJ Gasket	Gasket	Talon RJ Gasket	Gasket	NA	NA
			Snap-Lok	Bell Lock	Snap-Lok	Bell Lock	NA	NA
		McWane Inc. DI Pipe Group	Sure Stop 350 Gasket	Gasket	Sure Stop 350 Gasket	Gasket	NA	NA
			Thrust-Lock	Bell Lock	Thrust-Lock	Bell Lock	NA	NA
			TR-Flex	Bell Lock	TR-Flex	Bell Lock	NA	NA
			Super-Lock	Bell Lock	Super-Lock	Bell Lock	NA	NA
		US Pipe	Field Lok 350 Gasket	Gasket	Field Lok 350 Gasket	Gasket	NA	NA
			Field Lok Gasket	Gasket	Field Lok Gasket	Gasket	NA	NA
			TR-Flex	Bell Lock	TR-Flex	Bell Lock	NA	NA
			HP Lok Restraint Joint	Bell Lock	HP Lok Restraint Joint	Bell Lock	NA	NA
	SS to DIP Transition Restraint	**SS to DIP Transition Restraint -Flanged stainless steel pipe from Wetwell to Valve box restrained joint transition (epoxy coated, SS hardware) Flg x PE RJ.**						
		EBAA Iron Inc	NA	NA	NA	NA	Megaflange 2100	
		Sigma	NA	NA	NA	NA	SigmaFlange with One Lock SLDE	
		Smith Blair	NA	NA	NA	NA	911 Flange - Lock Restrained FCA	
	PVC Pipe MJ Restraints	**Mechanical Joint Wedge-action Restraining Gland, Epoxy Coated Restrain PVC pipe to mechanical joint fittings, and appurtenances.**						
		EBAA Iron Inc	Mega-lug Series 2000PV		Mega-lug Series 2000PV		Mega-lug Series 2000PV	
			NA	NA	NA	NA	Megalug Series 2200	(42"-48")
		Ford / Uni-Flange	UFR 1500 Series		UFR 1500 Series		UFR 1500 Series	
		Sigma	One Lok Series SLC/SLCE		One Lok Series SLC/SLCE		One Lok Series SLC/SLCE	
		Smith Blair	Cam Lok Series 120		Cam Lok Series 120		Cam Lok Series 120	
		Star	Star Grip Series 4000		Star Grip Series 4000		Star Grip Series 4000	
		Tyler Union	TufGrip Series TLP		TufGrip Series TLP		TufGrip Series TLP	
	PVC Bell Joint Restraints (4" - 12") (New & Existing)	**PVC Bell Joint Restraints: PVC pipe Split Serrated on Bell End and Spigot End. (4" - 12") (New & Existing)**						
		EBAA Iron Inc	Tru-Dual Series 1500TD		Tru-Dual Series 1500TD		Tru-Dual Series 1500TD	
		Ford / Uni-Flange	Uni-Flange Series 1390		Uni-Flange Series 1390		Uni-Flange Series 1390	
		Sigma	PV-Lok Series PWP		PV-Lok Series PWP		PV-Lok Series PWP	
		Smith Blair	Bell-Lock Series 165		Bell-Lock Series 165		Bell-Lock Series 165	
		Star	Series 1100C		Series 1100C		Series 1100C	
		Tyler Union	TufGrip 300C		TufGrip 300C		TufGrip 300C	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Joint Restraints	PVC Bell Joint Restraints (16" & Greater)	**PVC Bell Joint Restraints: (16" & Greater) PVC pipe Split Serrated on Bell End and Spigot End. Water & Reclaimed Water Existing pipe only. Wastewater shall be new and existing pipe.**						
		Ford / Uni-Flange	Series 1390	Existing Only	Series 1390	Existing Only	Series 1390	
		JCM	Sur-Grip Series 621	Existing Only	Sur-Grip Series 621	Existing Only	Sur-Grip Series 621	
		Sigma	PV-Lok PWP	Existing Only	PV-Lok PWP	Existing Only	PV-Lok PWP	
		Smith Blair	Bell-Lock Series 165	Existing Only	Bell-Lock Series 165	Existing Only	Bell-Lock Series 165	
		Star	Series 1100C	Existing Only	Series 1100C	Existing Only	Series 1100C	
Pipe	PVC C900 DR 18 Bell & Spigot (4" - 12")	**C900 Bell & Spigot PVC Pipe: 4 to 12-inch - AWWA C-900, Minimum DR18 for Water, Reclaimed and Wastewater. DR14 for Fire Lines. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed 4" to 12"	Certa-Lok C900/RJ	Blue	Certa-Lok C900/RJ	Pantone Purple	Certa-Lok C900/RJ	Green
		Diamond Plastics Corp	C-900	Blue	C-900	Pantone Purple	Diamond C900	Green
		Ipex Inc	C-900 Blue Brute	Blue	C-900	Pantone Purple	C900 Blue Brute	Green
		JM Eagle	C-900	Blue	C-900	Pantone Purple	C-900	Green
		National Pipe & Plastics Inc	C-900 Dura- Blue	Blue	C-900	Pantone Purple	C-900 Pipe	Green
		North American Pipe Corp (NAPCO)	C-900	Blue	C-900	Pantone Purple	C-900	Green
		Sanderson Pipe Corp	C-900	Blue	C-900	Pantone Purple	C-900	Green
	PVC C905 DR 18 Bell & Spigot 16" and Larger	**C905 Bell & Spigot PVC Pipe 16" and Larger: AWWA C-905, Minimum DR18 for all Force Mains up to 24". Minimum DR21/DR25 for 30" and greater. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed 16"	NA	NA	NA	NA	Certa-Lok C905/RJ	NA
		Diamond Plastics Corp	NA	NA	NA	NA	Trans-21 DR18	Green
		Ipex Inc	NA	NA	NA	NA	IPEX Centurion	Green
		JM Eagle	NA	NA	NA	NA	C905 Big Blue	Green
		National Pipe & Plastics Inc	NA	NA	NA	NA	C905	Green
		North American Pipe Corp (NAPCO)	NA	NA	NA	NA	C905 Big Blue	Green
	HDPE C906 DR11	**HDPE Pipe DR11 AWWA C906 shall be Ductile Iron Pipe Size, PE 3408/3608/4710 DIPS manufactured in accordance with ASTM F-714 and listed with NSF. Pipe shall be marked in accordance with either AWWA C901,AWWA C906. Compression type connections are not acceptable in new installations. Pipe joints shall be butt fusion or electro-fusion with flange or adapter. All HDPE shall be color coded to the Utility. Color identifications are in accordance with the APWA/ULCC Uniform Color Code. Manufacturers shall be members in good standing with PPI to maintain approval status.**						
		JM Eagle	HDPE	DR11 Blue	HDPE	DR11 Pantone	HDPE	DR11Green
		Performance Pipe(Chevron)	Driscoplex 4000	DR11 Blue	Driscoplex 4000	DR11 Pantone	Driscoplex 4300	DR11 Green
		PolyPipe, Inc.	EHMW Poly Pipe	DR11 Blue	EHMW	DR11 Pantone	EHMW	DR11Green

APPENDIX D **LIST OF APPROVED PRODUCTS - TRANSMISSION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pipe	Ductile Iron Pipe	**Ductile iron/Cast iron: (4" to 12" = Class 350, 16" to 24" - Class 250, 30" to 64" = Class 200). Water and Reclaimed water shall be cement lined. Wastewater Piping shall be Protecto 401 and Holiday Free. Exterior coatings as specified. Wastewater DIP piping shall be for pump station piping only. Manufacturers shall be members in good standing with DIPRA to maintain approval status.**						
		American	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		Griffin	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		McWane Inc. DI Pipe Group	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
		US Pipe	Cement Lined	Blue	Cement Lined	Pantone Purple	Protecto 401	Pump Station
Sample	Sample Station	**Sample Stations - Bacteriological Sample Station with built in flush system, all internal piping to be 2", brass and includes lockable green enclosures.**						
		Safety-Guard	SG-BSS-05 pedestal #77	green enclosure	NA	NA	NA	NA
		Water Plus Corp	Model 5000	green	NA	NA	NA	NA
Services	Brass Service Saddles	**Brass Service Saddles for 1" & 2" water & reclaimed water services on 4" through 12" Mains - Service saddles can be hinge or bolt controlled OD saddles to be used on C-900 and existing IPS OD PVC pipe.**						
		Ford	Series S-70, S-90	4"-12"	Series S-70, S-90	4"-12"	NA	NA
		AY McDonald	Model 3891 / 3895,3801 / 3805	4"-12"	Model 3891 / 3895,3801 / 3805	4"-12"	NA	NA
		Mueller	Series S-13000/H-13000	4"-12"	Series S-13000/H-13000	4"-12"	NA	NA
	Service Saddles	**Service Saddles for 1" (CC) & 2" (Iron pipe threads) Water & Reclaimed Water services on mains greater than 12". Service saddles for 2" taps (iron pipe threads) on 4" mains and greater for Waste Water. : Epoxy or nylon coated stainless steel 18-8-type 304 double straps, controlled O.D. saddles to be used on C-900 / C905 or DI for all 1-in and -2in taps on pipes over 12in.**						
		Ford	Series FC202	16" & greater	Series FC202	16" & greater	Series FC202	4" & greater
		JCM	Series 406	16" & greater	Series 406	16" & greater	Series 406	4" & greater
		Mueller	DR2S	16" & greater	DR2S	16" & greater	DR2S	4" & greater
		Romac	Series 202NS	16" & greater	Series 202NS	16" & greater	Series 202NS	4" & greater
		Smith Blair	Series 317	16" & greater	Series 317	16" & greater	Series 317	4" & greater
	Service Saddles for HDPE	**Service Saddles for 1" (CC) & 2" (Iron Pipe threads) Water and Reclaimed Water Services: Epoxy or nylon coated stainless steel 18-8-type 304 double straps, controlled O.D. saddles to be used on HDPE for all 1-in and -2in taps. Taps to HDPE pipe shall be approved on a case by case basis.**						
		Ford	Series FCP202		Series FCP202		Series FCP202	
		Romac	Series 202N-H		Series 202N-H		Series 202N-H	
		Smith Blair	Series 317-1 for HDPE		Series 317-1 for HDPE		Series 317-1 for HDPE	
	Corporation Stops Ball Type	**Corporation Stops Ball Type (1-inch with AWWA taper C threads only/pack joint outlet for CTS) 2" Corporation Stop Ball Type shall be 2" MIP X FIP threads.**						
		Ford	FB1000, FB1700-7		FB1000, FB1700-7		FB1700-7	2" ARV
		AY McDonald	4701B-22, 3149B2		4701B-22, 3149B2		3149B2	2" ARV
		Mueller	P25008, B-20046		P25008, B-20046		B-20046	2" ARV

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Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Services	Curb Stops	**Curb Stops - Straight Valves: Ball type compression 2" cts O.D. tubing by 2" FIP**						
		Ford	B41-777W		B41-777W		NA	NA
		AY McDonald	6102W-22		6102W-22		NA	NA
		Mueller	P25172		P25172		NA	NA
	Curb Stops	**Curb Stops - Straight Valves: ball type compression x compression**						
		Ford	B44-444W		B44-444W		NA	NA
		AY McDonald	6100W-22		6100W-22		NA	NA
		Mueller	P25146		P25146		NA	NA
	PE tubing	**Polyethylene tubing: AWWA C901. UV protection (SDR-9) 1-inch and 2-inch only. PE 3408 / PE 4710**						
		Charter Plastics	Blue Ice		Lav Ice		NA	NA
		Endot	Endopure Blue		Endocore Lavender		NA	NA
		JM Eagle	Pure-Core		NA	NA	NA	NA
Tapping Sleeves and Valves	Line Stops	**Line Stops**						
		JCM						
		Romac						
		Smith Blair						
	Tapping Sleeves	**Tapping Sleeves: (Mechanical joint for taps on cast iron, ductile iron, PVC & AC pipe, including size on size) with stainless steel nuts and bolts.**						
		American Flow Control	Series 2800		Series 2800		Series 2800	
			Series 1004		Series 1004		Series 1004	
		Clow	Series F-5205	DIP/PVC	Series F-5205	DIP/PVC	Series F-5205	DIP/PVC
			Series F-5207	A/C Pipe	Series F-5207	A/C Pipe	Series F-5207	A/C Pipe
		JCM	Series 414	FBE	Series 414	FBE	Series 414	FBE
		Mueller	Series H-615	DIP/PVC	Series H-615	DIP/PVC	Series H-615	DIP/PVC
			Series H-619	A/C Pipe	Series H-619	A/C Pipe	Series H-619	A/C Pipe
		Smith Blair	Style 623	FBE	Style 623	FBE	Style 623	FBE
	Tapping Valves: 12" and smaller	**Tapping Valves: 12" and smaller - Tapping Valves shall be furnished with an alignment lip and installed in the vertical position for Water and Reclaim Water. Wastewater shall be installed horizontally and abandoned in the open position. Tapping valves shall be resilient seated only and meet the requirements of AWWA C509 or C515**						
		American Flow Control	Series 2500	Alignment Lip	Series 2500	Alignment Lip	Series 2500	Alignment Lip
		Clow	Series F-6114	Alignment Lip	Series F-6114	Alignment Lip	Series F-6114	Alignment Lip
		Mueller	Series T2360 (4"-12")	Alignment Lip	Series T2360 (4"-12")	Alignment Lip	Series T2360 (4"-12")	Alignment Lip

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Tapping Sleeves and Valves	Tapping Valves: 16" and Larger	**Tapping Valves: 16" and Larger - Tapping valves shall be furnished with an alignment lip and be installed in the vertical position for Water and Reclaimed Water. No tapping valve shall be installed horizontally for Water and Reclaim Water unless approved by the engineer. Tapping Valves 16" and larger AWWA C515 resilient seated only (16" and 24" no gearing required) above 24" shall be installed vertically with a spur gear actuator unless noted by the engineer. All tapping valves above 24" shall be furnished with NPT pipe plugs for flushing the tracks when valves are installed horizontally. Tapping valves for Wastewater shall be installed horizontally and abandoned in open position.**						
		American Flow Control	Series 2500	Alignment Lip & flushing port	Series 2500	Alignment Lip & flushing port	Series 2500	Alignment Lip & flushing port
		Clow	Series F-6114	Alignment Lip & flushing port	Series F-6114	Alignment Lip & flushing port	Series F-6114	Alignment Lip & flushing port
		Mueller	Series T2361 (14"&up)	Alignment Lip & flushing port	Series T2361 (14"&up)	Alignment Lip & flushing port	Series T2361 (14"&up)	Alignment Lip & flushing port
Valves	Butterfly Valve 42" and Above	**Butterfly Valves 42"and above. AWWA C504. Actuators input torques based on 150 psi valve pressure and 16 fps velocity with a maximum input of 80 ft-lb on 2" nuts and shall withstand 250 ft-lbs. Valve seats shall be leak-tight in both directions at 150 psi.**						
		Clow	Style #1450		Style #1450		NA	NA
		Dezurik	BAW		BAW		NA	NA
		Mueller / Pratt	LINSEAL III / Groundhog		LINSEAL III / Groundhog		NA	NA
	Check Valves	**Valves (Check) 4-inch and Larger (8 mil epoxy lined)**						
		American Flow Control	NA		NA		Series 600 or 50 line	
		Clow / M&H / Kennedy	NA		NA		106	
		Mueller	NA		NA		Series 2600	
	Gate Valves 4" - 12"	**Gate Valves 12" and smaller - resilient seated only AWWA C509 or C515. Valve seat shall be leak-tight in both directions at 150 psi.**						
		American Flow Control	Series 2500		Series 2500		NA	NA
		Clow	Series F-6100		Series F-6100		NA	NA
		Mueller	Series A-2360		Series A-2360		NA	NA
	Gate Valves (Vertical) 16" and Up	**Gate Valves 16" and larger (Vertical Installation) AWWA C515 resilient seated only (16" and 24" no gearing required) above 24" shall be installed vertically with a gear actuator unless noted by the engineer. Valve seat shall be leak-tight in both directions at 150 psi.**						
		American Flow Control	Series 2500		Series 2500		NA	NA
		Clow	Series F-6100		Series F-6100			
		Mueller	Series A-2361		Series A-2361		NA	NA

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Valves	Plug Valves	**Plug Valves - Bi-directional, MJ & Flanged (min. 8mil fusion bonded epoxy with stainless steel bolts), gear operator to be sized for rated pressure of the valve. Valves 4"-20" shall be 80% Full Port and valves 24" and greater shall be minimum of 70% full port. Valve shall be factory tested to minimium 100 PSI in both directions.**						
		Clow	NA	NA	NA	NA	F-5412 FLG	4" & up
			NA	NA	NA	NA	F-5413 MJ	4" & up
		Dezurik	NA	NA	NA	NA	Series PEF or PEC	4"& up
		Millikan / Pratt	NA	NA	NA	NA	Eccentric / Ballcentric	4"& up
		Val-Matic	NA	NA	NA	NA	5600 or 5800 (FLG)	4" & up
			NA	NA	NA	NA	5700 or 5900 (MJ)	4" & up
Valve Boxes	Valve Boxes with Locking Lids (Cast Iron)	**Two piece standard screw type Heavy Duty Valve Boxes with Locking Lids (Cast Iron) and type of service cast in heavy duty traffic lid (H20 loading) ASTM A48**						
		Bingham/Taylor	Series 4905	Box	NA	NA	Series 4905	Box
			4905-X	Extension	NA	NA	4905-X	Extension
			4904-L	Blue Water Locking Lid	NA	NA	4904-L	Green Sewer locking Lid
		Sigma	Series VB 261X-267X	Box	VB-25031LK-VB-2612	Box	Series VB 261X-267X	Box
			VB 6302	Extension	VB-6302	Extension	VB 6302	Extension
			VB 4650W	Blue Water Locking Lid	VB2503LK	Purple Square Locking Lid	VB 4650S	Green Sewer locking Lid
		Star	Series VB-0002	Box	NA	NA	Series VB-0002	Box
			VBEX 12-24S	Extension	NA	NA	VBEX 12-24S	Extension
			VBLIDLOCK	Blue Water Locking Lid	NA	NA	VBLIDLOCK	Green Sewer locking Lid
		Tyler Union	Series 6850	Box	NA	NA	Series 6850	Box
			58, 59, 60	Extension	NA	NA	58, 59, 60	Extension
			Locking Lid	Blue Water Locking Lid	NA	NA	Locking Lid	Green Sewer locking Lid
	Valve Box	**For mains equal to, or greater than, 16" diameter or equal to greater than 6' feet deep**						
		American Flow Control	# 2A - 9A Retrofit Valve Box Insert	Fit inside std valve boxes	NA		2A - 9A Retrofit Valve Box Insert	Green Sewer locking Lid
		Mueller Company	MVB050C thru MVB130C with Extension Stem MVB875 Guide Plate	Blue Water Locking Lid	MVB050CR thru MVB130CR with Extension Stem MVB875 Guide Plate	Purple Square Locking Reclaim Lid	MVB050C thru MVB130C with Extension Stem MVB875 Guide Plate	Green Sewer locking Lid

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Coatings	Anti-Graffiti Paint	**Block Walls-Anti-Graffiti Paint per Section 3119 Coatings & Linings**						
		American Building Restoration Products	NA	NA	NA	NA	Polyshield Graffiti Preventer for Unpainted Masonry Type B	Super Bio Strip or Strip it all
		Tnemec / Chemprobe	NA	NA	NA	NA	626 DUR A PEL	680 Mark A Way
		Professional Products of Kansas, Inc	NA	NA	NA	NA	Professional Water Seal & Anti-Graffitiant (PWS-15 Super Strength)	Professional Phase II Cleaner
	Coatings for Existing Manholes	**Rehabilitation corrosion protection system per Section 3119 Coatings & Linings. Interior coating for force main connections to existing concrete manholes only. New precast structures and existing pump stations shall be lined.**						
		CCI Spectrum, Inc	NA	NA	NA	NA	Spectrashield	min of 500 mils
		Kerneos Aluminate Technologies	NA	NA	NA	NA	Sewpercoat	1" (1000mil)
		Raven Lining System	NA	NA	NA	NA	Raven 155 Primer Raven 405	min 8 mils min 125 mils
		Sauereisen	NA	NA	NA	NA	210 Series Topcoat Glaze 210G	min 125 mils min 20 mils
		Tnemec	NA	NA	NA	NA	Series 434 Topcoat Glaze 435	min 125 mils 15-20 mils
PVC Pipe and fittings	Pipe SDR 35 Gravity Mains	**PVC Pipe for Gravity SDR26/SDR 35 (Green in color) ASTM-D034. Manufacturers shall be members in good standing with Uni-Bell to maintain approval status.**						
		Certainteed	NA	NA	NA	NA	Gravity Sewer Pipe	
		Diamond Plastics Corp	NA	NA	NA	NA	Sani-21 SDR-35	
		JM Eagle	NA	NA	NA	NA	Gravity Sewer	
		National Pipe & Plastics, Inc.	NA	NA	NA	NA	Ever-Green Sewer Pipe	
		North American Pipe Corp (NAPCO)	NA	NA	NA	NA	Gravity Sewer	
		Sanderson Pipe Corp	NA	NA	NA	NA	Gravity Sewer	
	Locate Balls	**Locating Marker Systems - Wastewater Locator balls placed at all sanitary sewer cleanouts**						
		3M	NA	NA	NA	NA	3M™ EMS 4" Extended Range 5' Ball Marker 1404-XR	
	Fittings SDR 35	**Fittings, Adapters and Plugs - Gravity PVC ASTM-D3034, Min SDR26/ SDR 35**						
		GPK Products, Inc.	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Harrington Corporation (HARCO)	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Multi Fittings Corp.	NA	NA	NA	NA	SDR26/SDR 35 Trench Tough Sewer Fittings	
		JM Eagle	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		Plastic Trends Inc	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	
		TIGRE USA, Inc.	NA	NA	NA	NA	SDR26/SDR35 Gasketed sewer fittings	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
PVC Pipe a	Flexible Pipe Connectors	**Flexible Pipe Connectors and Transitions**						
		Fernco	NA	NA	NA	NA	1002, 1051, 1056 Series	
		Indiana Seal	NA	NA	NA	NA	102, 151, 156 Series	
		Mission Rubber	NA	NA	NA	NA	MR02, MR51, MR 56 Series	
Precast Concrete Structures	MH Lids	**Frame and Cover**						
		USF Fabrication Inc.	NA	NA	NA	NA	USF 225-AS	
	Adj Ring	**Top Adjusting Rings - HDPE with heavy duty loading (H-20)**						
		Ladtech, Inc	NA	NA	NA	NA	24R, 24S with Rope Sealant CS2455	
	Hatches	**Wet Well and Valve Vault Access Frames and Covers (Include the term "Confined Space" etched or cast into the cover with recessed lock & hasp. Frames and covers per manufacturers specifications.**						
		Halliday Products	NA	NA	NA	NA	S1R or S2R Series	
		USF Fabrication Inc.	NA	NA	NA	NA	APS or APD Series	
	Precast Concrete Structures	**Precast Manhole and Wetwell Structures ASTM C478. Precast concrete shall be batched with concrete dyed crystalline waterproofing admixture with corrosion protection. Concrete without admixture or without color tint /tracer shall be rejected.**						
		Allied Precast	NA	NA	NA	NA	Dyed Admix	
		Atlantic Concrete Products, Inc.	NA	NA	NA	NA	Dyed Admix	
		Delzotto Products, Inc.	NA	NA	NA	NA	Dyed Admix	
		Dura Stress Underground Inc.	NA	NA	NA	NA	Dyed Admix	
		Hanson Pipe & Product	NA	NA	NA	NA	Dyed Admix	
		Mack Concrete	NA	NA	NA	NA	Dyed Admix	
		Oldcastle Precast	NA	NA	NA	NA	Dyed Admix	
		Standard Precast Inc.	NA	NA	NA	NA	Dyed Admix	
	Concrete Admix	**Crystalline Waterproofing Concrete Admix with color dye shall be added to all concrete structures (precast and cast-in-place) to provide waterproofing and corrosion resistance. Concrete without admixture or without color tint / tracer shall be rejected. % concentration of admix with colored dye added to the mix shall be based on weight of cement.**						
		Kryton International	NA	NA	NA	NA	KIM K-301R (with red dye)	2%
		Xypex Chemical Corp	NA	NA	NA	NA	Xypex Admix C-1000Red (with red dye)	3.0 - 3.5%
	Liners	**Interior Liner for New or existing Precast Manhole and Precast Wetwell Structures per Section 3119 Coatings & Linings**						
		AFE	NA	NA	NA	NA	Fiberglass Liner	
		AGRU Liner	NA	NA	NA	NA	HDPE Liner (Min 2 mm for Manhole / Min 5 mm for Pump Station)	
		Containment Solutions Inc. (Flowtite)	NA	NA	NA	NA	Fiberglass Liner	
		GSE Studliner	NA	NA	NA	NA	HDPE Liner (Min 2 mm for Manhole / Min 5 mm for Pump Station)	
		GU Liner	NA	NA	NA	NA	Reinforced Plastic Liner	
		L & F Manufacturing	NA	NA	NA	NA	Fiberglass Liner	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Precast Concrete Structures	Heat Shrink Seal	**Heat Shrink Seal - Precast structures shall be primed with manufacturer approved primer prior to application of heat shrunk encapsulation.**						
		Canusa-CPS	NA	NA	NA	NA	Wrapid Seal with WrapidSeal Primer (Canusa G Primer)	
		Pipeline Seal & Insulator, Inc (PSI)	NA	NA	NA	NA	Riser Wrap with Polyken 1027 or 1039 primer	
	Jointing Material	**Jointing Material Min. 2" width for all products to ensure squeeze out with manufacturer approved primer.**						
		Henry Company	NA	NA	NA	NA	Ram-Nek	with Primer
		Martin Asphalt Company	NA	NA	NA	NA	Evergrip 990	with Primer
		Trelleborg Pipe Seals	NA	NA	NA	NA	NPC – Bidco C-56	with Primer
	Pipe Seals Gravity	**Resilient Connector Pipe Seals, Manhole - Gravity less than 12-inch and less than 15-ft deep**						
		Atlantic Concrete	NA	NA	NA	NA	A-Lok (cast-in-place)	
		Hail Mary Rubber	NA	NA	NA	NA	Star Seal (cast-in-place)	
		IPS	NA	NA	NA	NA	Wedge Style	
		NPC	NA	NA	NA	NA	Kor-N-Seal Model WS	
		Press seal gasket	NA	NA	NA	NA	PSX Direct Drive	
	Pipe Seals Gravity	**Cast in Place Pipe Seals, Manhole - Gravity Greater Than or Equal to 12-inch and all pipe sizes greater than 15-ft deep**						
		Atlantic Concrete	NA	NA	NA	NA	A-Lok	cast in place
		Hail Mary Rubber	NA	NA	NA	NA	Star Seal	cast in place
	FM Pipe Seals	**Modular Pipe Seals for Wet Well and Valve Box penetrations and all forcemain connections to existing and new precast concrete structures. EPDM Rubber with 316 SS Hardware**						
		CCI Pipeline Systems	NA	NA	NA	NA	Wrap-It Link WL-SS Series	
		Pipeline Seal & Insulator, Inc / Link Seal	NA	NA	NA	NA	Link-Seal S-316 Modular Seal	
		Proco Products, Inc	NA	NA	NA	NA	PenSeal ES-PS Series	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Generator	Gen	**Generator Systems, Fixed Shall be UL 2200 Certified.**						
		Caterpillar	NA	NA	NA	NA	CAT Diesel Generator Set	
		Cummins Power Generation	NA	NA	NA	NA	Diesel Generator Set	
	Fuel Tanks	**Generator Fuel Tanks. Shall be UL2085 certified.**						
		Convault	NA	NA	NA	NA	CVT-3SF or CVT-3FF	
		Phoenix	NA	NA	NA	NA	Envirovault	
	GR	**Generator Receptacle (GR)**						
		Cooper Crouse-Hinds	NA	NA	NA	NA	AR2042 (230V, 200A, 3P, 4W)	With AJA1 Angle Adaptor
		Cooper Crouse-Hinds	NA	NA	NA	NA	AR2042-S22 (460V, 200A, 3P, 4W)	With AJA1 Angle Adaptor
		Pyle National	NA	NA	NA	NA	JRE-4100 (230V, 100A, 3P, 4W)	
	ATS	**Generator Transfer Switch**						
		Russelectric	NA	NA	NA	NA	RMTD Series with model 2000 controller	NEMA 12/3R 316SS Enclosure
Odor Control Units	Biotrickling Filters	**Biotrickling filters**						
		BioAir	NA	NA	NA	NA		
		Biorem	NA	NA	NA	NA	Biosorbens BTF	
		Envirogen	NA	NA	NA	NA	BTF	
		Siemens	NA	NA	NA	NA	Zabocs BTF	
	Carbon Adsorption Units	**Carbon Adsorption Units**						
		Calgon	NA	NA	NA	NA		
		Pure Air Filtration	NA	NA	NA	NA		
		Siemens	NA	NA	NA	NA		
Pressure Gauges	Pressure Gauges	**Pressure Gauges shall have Diaphragm Seals. Oil filled.**						
		Ashcroft	NA	NA	NA	NA	10 1008SL 02L 60# 25 200SS 02T XYTSE	Gauge Diaphragm Seal
		Trerice	NA	NA	NA	NA	D83LFSS4002LA100 - Gauge M51001SSSS - Diaphragm Seal D99100 Fill and Mount Charge	
		Winter Gauges	NA	NA	NA	NA	PFQ770 0-60 PSI D70950 top D70954 Bottom	
Pumps	Pumps	**Submersible Pumps**						
		ABS	NA	NA	NA	NA		
		Flygt	NA	NA	NA	NA		

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pumps	Floats	**Float Regulator (FR) - Duplex and Triplex Pump Stations**						
		Atlantic Scientific	NA	NA	NA	NA		Roto-Float
	Radar	**Radar - Pulse Burst Radar Transmitter. Input 24 VDC and Output 4-20 mA**						
		Magnetrol	NA	NA	NA	NA		R82-520A-011
Pump Station Main Ser	Main Srvc Disconne	**Main Service Disconnect Breaker**						
		Square D	NA	NA	NA	NA		H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)
	Surge Protector Device	**Surge Protector - UL 1449, 3rd Edition listed and labeled, minimum 10 year warranty, NEMA LS-1 and IEEEC62, 41/45 tested with NEMA 4X enclosure, internal fusing, voltage and phase to match service. Rated 80,000 amps per mode for Duplex & Triplex stations and 150,000 Amperes per mode for Master Stations. All devices shall be provided with a NEMA 4X Plastic enclosure which is approved in lieu of stainless steel.**						
		Current Technology (Power & Systems	NA	NA	NA	NA		XN-80, TG-150 or CurrentGuard 150 Plus Series
		Josyln AKA (Total Protection Solutions)	NA	NA	NA	NA		TSS-ST 160 Series, ST 300 Series or JSP-300 Series
		Surge Suppressors, Inc	NA	NA	NA	NA		LSE Series or SHL Series
Sub Panel	Sub Panel	**Sub-Panel Enclosure - NEMA 12/3R Enclosure 316SS, white polyester Powder coated-finish inside and out, With 3 Point Pad lockable Handle, and Door Stop**						
		Hoffman	NA	NA	NA	NA		
		Schaefer	NA	NA	NA	NA		
		Universal enclosure systems	NA	NA	NA	NA		
Pump Station Control Panel	Control Panel	**Control Panel Supplier**						
		ECS	NA	NA	NA	NA		
		Sta-Con Inc	NA	NA	NA	NA		
	Enclosure	**Enclosure - NEMA 12/3R Enclosure 316SS, white polyester Powder coated finish inside and out, With 3 Point Pad lockable Handle, and Door Stop**						
		Hoffman	NA	NA	NA	NA		
		Schaefer	NA	NA	NA	NA		
		Universal enclosure systems	NA	NA	NA	NA		
	Mnts	**Mounting Channel for Enclosures**						
		Unistrut Stainless Steel	NA	NA	NA	NA		1" 5/8 x 1" 5/8 316 SS
	Seal-off	**Explosion-Proof Sealoff**						
		Cooper Crouse-Hinds	NA	NA	NA	NA		EYSR - 2 Inch Min.
	FL	**Flasher (FL)**						
		MPE	NA	NA	NA	NA		025-120-105
		SSAC	NA	NA	NA	NA		FS-126

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pump Station Control Panel	AL	**Alarm Light / With Base and Globe (AL)**						
		American Electric	NA	NA	NA	NA	F32552	
		Red Dot Globe Red Dot Base	NA	NA	NA	NA	VGLR-01 VA-01	
	AH	**Alarm Horn (AH)**						
		Wheelock	NA	NA	NA	NA	3IT-115-R	
	Fuse	**Fuses (F)**						
		Bussmann	NA	NA	NA	NA	FNQ-R or KTK-R	
	HOA	**Hand-Auto-Off Selector (HOA)**						
		Square D	NA	NA	NA	NA	9001-SKS43B	
	HSS	**Horn Silence Button (HSS)**						
		Square D	NA	NA	NA	NA	9001-SKR1RH5	
	Inter-lock	**Mechanical Interlock**						
		Square D	NA	NA	NA	NA	S29354	
	Breakers	**Control Panel Main Circuit Breaker (MCB) With S29450 Circuit Breaker Auxiliary Switch**						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Emergency Circuit Breaker (ECB) With S29450 Circuit Breaker Auxiliary Switch						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Motor Circuit Breaker (MB)						
		Square D	NA	NA	NA	NA	H or J Frame 3 Pole 600 Volt (HGL or JGL determined by amperage)	
		Control Circuit Breaker/ GFCI Receptacle Breaker/ SCADA Breaker						
		Square D	NA	NA	NA	NA	QOU120	
	MS	**Motor Starter (MS)**						
		Square D	NA	NA	NA	NA	Type S Class 8536	
	OL	**Overload Heater(OL)**						
		Square D	NA	NA	NA	NA	Part number will vary with size needed	
	OR	**Overload Reset**						
		Square D	NA	NA	NA	NA	9066-RA1	
	Transformer	**Control Circuit Transformer (XMFR)**						
		Square D	NA	NA	NA	NA	9070TF75D23	120/24 Volt .075 KVA
		Main Circuit Transformer (MCT)						
		Square D	NA	NA	NA	NA	9070T2000D1	480/120 2KVA
	SPB	**Supplemental Protector Breaker - 3 pole, 1-amp for Phase Monitor**						
		Square D	NA	NA	NA	NA	MG24532	

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pump Station Control Panel	PM	**Phase Monitor (PM)**						
		MPE 240 V.	NA	NA	NA	NA	001-230-118-OVG5	
		MPE 480 V.	NA	NA	NA	NA	002-480-123-OVG5	
	Pump Alternator	**Pump Automatic Alternator (PAA)**						
		Diversified Duplex	NA	NA	NA	NA	ARA-120-ACA	
		Diversified Triplex	NA	NA	NA	NA	ARA-120-AME	
		MPE Duplex	NA	NA	NA	NA	008-120-13SP	
		MPE Triplex	NA	NA	NA	NA	009-120-23P	
		MPE Triplex Socket	NA	NA	NA	NA	SD-12-PC	
	Alt. Test Switch	**Alt. Test Switch**						
		Carling Technologies	NA	NA	NA	NA	6GG5E-78	
		Honeywell	NA	NA	NA	NA	2TL1-50	
	Relay	**Relay**						
		Potter Brumfield 24 Volt	NA	NA	NA	NA	KRPA-11AN-24	
		Potter Brumfield 120 Volt	NA	NA	NA	NA	KRPA-11AN-120	
		Square D 24 Volt	NA	NA	NA	NA	8501KP12P14V14	
		Square D 120Volt	NA	NA	NA	NA	8501KP12P14V20	
	Relay Base	**Relay Base**						
		IEDC 8 Pin Relay Base 600 Volt	NA	NA	NA	NA	SR2P-06	
	Duplex Receptacle / GFCI	**Duplex Receptacle/GFCI (DR) Upgraded to 20 Amp**						
		Hubbell	NA	NA	NA	NA	GFTR20BK	
		Pass & Seymour	NA	NA	NA	NA	2095TRBK	
	ETM	**Elapse Time Meter (ETM)**						
		Reddington	NA	NA	NA	NA	711-0160	
	Grounding	**Grounding System**						
		Marathon	NA	NA	NA	NA	Neutral Isolation Block 1421570	
		Panduit	NA	NA	NA	NA	Ground Lug LAM2A 1/0 - 014 -6Y	
		Square D	NA	NA	NA	NA	Ground Buss PK7GTA	
	TS	**Terminal Strip (TS)**						
		Marathon	NA	NA	NA	NA	Series 200	
		Square D	NA	NA	NA	NA	9080GR6	
	TS	**Terminal Strip End Blocks and End Clamps**						
		Square D	NA	NA	NA	NA	9080GM6B & 9080GH10	

APPENDIX D **LIST OF APPROVED PRODUCTS - PUMP STATION SYSTEMS** **FEBRUARY 11, 2011**

Cat.	Desc	Manufacturer	Water Model #	Water Comments	Reclaimed Water Model #	Reclaimed Water Comments	Wastewater Model #	Wastewater Comments
Pump Station Control Panel	PL	**Pilot Light (PL) 24 Volt with 1819 Bulb**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelight 930507X	
	RL	**Run Indicator Light (RL) 120 Volt**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelites 930507X With 120MB Bulb	
	MT	**Moisture and Temperature Failure Light (MT) 120 Volt with 120MB Bulb**						
		Dialight	NA	NA	NA	NA	803-1710	
		Lighting Components & Design	NA	NA	NA	NA	Littlelites 930507X	
Sluice	Sluice Gate	**Sluice Gate for Wet Well with Motorized Operator**						
		BNW	NA	NA	NA	NA	Model 77 - 316 SS	
		Fontaine	NA	NA	NA	NA	Model 20 - 316 SS	
VFD	VFD	**Variable Frequency Drives**						
		Square D	NA	NA	NA	NA		

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Attachment B – “Geotechnical Engineering Report, Orange County Eastern Regional Water Reclamation Facility, Phase V Improvements”
Nodarse & Associates – A Terracon Company
August 8, 2012

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Geotechnical Engineering Report

Orange County Eastern Regional Water Reclamation Facility
Phase V Improvements
Orlando, Florida

August 8, 2012
Project No. H1115424

Prepared for:
AECOM Technical Services, Inc.
Orlando, Florida

Prepared by:
Nodarse & Associates
A Terracon Company
Winter Park, Florida

August 8, 2012

AECOM
150 N. Orange Avenue, Suite 200
Orlando, FL 32801

Attn: Mr. William D. Marshall, P.E.
P: [407] 513-8233
F: [407] 422-3866
Email: bill.marshall@aecom.com

Re: Geotechnical Engineering Report
Eastern Regional Water Reclamation Facility, Phase V
Orange County, Florida
Terracon Project Number: H1115424

Dear Mr. Marshall:

Nodarse & Associates, a Terracon Company (Nodarse/Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number 01-10-0458-101. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and foundation design and construction of multiple structures and water management facilities for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Nodarse & Associates, a Terracon Company
Certificate of Authorization Number 8830

Kevin C. Martin, E.I
Project Engineer

Amr M. Sallam, Ph.D., P.E.
Principal
Florida PE- #67578

AMR M. SALLAM, PhD
LICENSE
No. 67578
STATE OF
FLORIDA
PROFESSIONAL ENGINEER
08/10/12

Jay W. Casper, P.E.
Senior Associate
Florida PE #36330

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EXECUTIVE SUMMARY

Geotechnical explorations were performed for the proposed Eastern Region Water Reclamation Facility Phase V Improvements planned to be constructed on the Facility located on the south side of Alafaya Trail east of Curry Ford Road in Orlando, Orange County, Florida. Twenty Nine (29) SPT and auger borings were performed to depths of 10 to 100 feet below existing grades within the proposed structure improvement areas and stormwater retention area. Also, six (6) SPT borings were performed and six (6) piezometers were installed to a depth of 15 feet below the berm level between the existing reject pond and Rapid Infiltration Basins Systems (RIBs).

Based on the information obtained from our geotechnical exploration, it appears that the subsoil and groundwater conditions are suitable for the proposed improvements to the facility. The following geotechnical considerations were identified:

- The proposed structures may be supported on shallow foundations bearing on existing site soil or on newly placed engineered fill, if the site preparation recommendations shown in the Earthwork Section of this report are strictly followed.

- Assuming the recommended contact pressures, depths of footings, and proper site preparations are followed for each structure according to the design and construction sections of this report, total and differential settlement should be within tolerable limits.

- The in-place shallow sands appear suitable for re-use as general engineered fill.

- Recommendations for design and recovery analysis of the stormwater management pond located in the southwest corner of the site are included in the stormwater section of the report.

- Based on our field explorations within the berm separating the Reject Pond and the RIBS, shallow subsoil explorations performed within the reject pond, and the reject pond load test, we did not encounter a reject pond bottom clay liner. The reject pond is leaking to the RIBs through the sides and to the surrounding areas through the bottom. Further remediation actions are needed.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
EASTERN REGIONAL WATER RECLAMATION FACILITY
PHASE V IMPROVEMENTS
ORANGE COUNTY, FLORIDA

Project No. H1115424
August 8, 2012

1.0 INTRODUCTION

This geotechnical engineering report was prepared for the proposed Eastern Region Water Reclamation Facility Phase V Improvements located on the south side of Alafaya trail just east of Curry Ford Road in Orlando, Orange County, Florida as shown on the Topographic Vicinity Map included as Exhibit A-1 in Appendix A.

Twenty Nine (29) SPT and auger borings were performed to depths between 10 and 100 feet below the existing ground surface in the proposed structure improvement areas and stormwater retention pond area.

Also, six (6) SPT borings and six (6) temporary monitoring wells were performed to a depth of 15 feet below the berm between the existing reject pond and RIBS. Logs of the borings along with a Boring Location Diagram (Exhibit A-3 and A-4) are included in Appendix A of this report. Laboratory testing procedures are included in Exhibit B-1 in Appendix B.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- foundation design and construction
- stormwater design parameters
- utility pipe design and construction
- reject pond liner conditions

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-3 and A-4: Boring Location Plan

Item	Description
Structures	The project will include new structures including: ■ Clarifier No. 11 ■ Preliminary Treatment Structure and truck loading building ■ Filters & Chlorine Contact Chamber structure ■ Secondary effluent Reject Pump Station ■ RAS/WAS pump stations ■ Supplemental Carbon Feed building ■ Secondary Effluent Reject Diversion structures ■ West electrical building
Building Construction	Assumed shallow foundations, slab on grade, concrete and masonry construction with special considerations for each structure.
Maximum loads	Each proposed structure is independent and will have different loading depending on the application as shown later in the report.
Maximum allowable settlement	Each proposed structure is independent and may have different tolerable settlement requirements depending on the application. Total settlement expectations are assumed to be in the order of 2 to 3 inches and about 1 inch for differential settlement. These assumptions do not include Clarifier No. 11, which typically allows more total and differential settlements.
Grading	Fill – fine grading, estimated at up to approximately 1 foot. Cuts – not anticipated.
Reject water pond	The existing reject water pond is surrounded by RIBS. The pond was reported to have been constructed with a 12 inch clay liner but details about the construction are not available. The effectiveness of the existing clay liner was evaluated.
Stormwater Management	A stormwater management pond is proposed to be constructed on the south west corner of the facility to assist with runoff from the proposed improvements.

2.2 Site Location and Description

Item	Description
Location	The existing plant is located on the south side of Alafaya Trail just east of Curry Ford Road in Orlando, Orange County, Florida.
Current ground cover	Developed with numerous structures, pavements, and ponds.

Item	Description
Existing topography	The USGS topographic quadrangle map Oviedo SW, Florida depicts the undeveloped topography as nearly level with gradual elevation changes, with native ground surface elevations ranging from about elevation +80 feet to +90 feet referencing the National Geodetic Vertical Datum of 1929 (NGVD29).

3.0 SUBSURFACE CONDITIONS

3.1 Regional Geology

The Soil Survey of Orange County, Florida, cites T. M. Scott of the Florida Geological Survey who wrote that Orange County is located in the north-central part of peninsular Florida, east and southeast of the crest of the Ocala Uplift, or the Ocala High. Two major, generalized physiographic divisions occur in Orange County. They are the Central Highlands and the Coastal Lowlands. The Central Highlands form the western one-third of the county, and the Coastal Lowlands (which include the project site) form the eastern two thirds.

Orange County is underlain by Upper Eocene limestone units of the Ocala Group. The surface of the limestone generally dips eastward from the outcrop area west of Orange County under an increasing thickness of younger materials. The sedimentary deposits immediately above the Upper Eocene limestone units are of the Hawthorn Group. The highly variable, diverse, lithologic character of the Hawthorn Group includes interbedded and interfingering sand, clayey sand, sandy clay, phosphatic sediment, dolomite, and limestone. .

Unconsolidated sand blankets the county. This sand consists of medium to fine sand and silt and does not contain clay or shell fragments. They are underlain in some areas by a shelly sand and clay, in other areas by the Hawthorn Group, and in a few scattered areas by limestone of the Eocene age. Shell beds of Miocene age through Pleistocene age occur in portions of the eastern part of the county.

3.2 General Potential for Sinkhole Development

The USGS Geological Survey map “Sinkhole Type, Development, and Distribution in Florida” prepared by the USGS in cooperation with state agencies (1985) divides Florida into four areas that have varying potentials for sinkhole development and type as follows:

- Area I. Bare or thinly covered limestone. Sinkholes are few, shallow and broad, and develop gradually. Solution Sinkholes dominate.

- Area II. Cover is 30 to 200 feet thick and consists mainly of in-cohesive and permeable sand. Sinkholes are few, shallow, of small diameter, and develop gradually. Cover-subsidence Sinkholes dominate.
- Area III. Cover is 30 to 200 feet thick and consists mainly of cohesive clayey sediments of low permeability. Sinkholes are most numerous, of varying size, and develop abruptly. Cover-collapse Sinkholes dominate.
- Area IV. Cover is more than 200 feet thick and consists of cohesive sediments interlayered with discontinuous carbonate beds. Sinkholes are very few, but several large diameter deep sinkholes occur. Cover-collapse Sinkholes dominate.

Review of the map listed above indicates the site is located in Area II. Review of the Florida Geological Survey sinkhole database indicates no reported sinkholes within three miles of the project site. It should be noted that according to the published literature and previous experience, the risk for sinkhole potential at the site general area is low. However, it is prudent to state that no special sinkhole explorations and evaluations were performed for each and every components of the project.

3.3 USDA – Soil Survey

The Soil Survey of Orange County, Florida, (print, CD/floppy disk, and web versions) as prepared by the United States Department of Agriculture (USDA), Soil Conservation Service (SCS; later renamed the Natural Resource Conservation Service - NRCS), originally published in 1975, identifies the soil type at the subject site shown below:

Soil Type No.	Soil Types
3	Basinger Fine Sand, Depressional
34	Pomello Fine Sand, 0 to 5 percent slopes
37	St. Johns Fine Sand
44	Smyrna Fine Sand

It should be noted that the Soil Survey is not intended as a substitute for site-specific geotechnical exploration; rather it is a useful tool in planning a project scope in that it provides information on soil types likely to be encountered. Boundaries between adjacent soil types on the Soil Survey maps are approximate. Descriptions of the mapped soil units are included in Appendix A as Exhibit A-41.

3.4 Typical Profile of the Site

Based on the results of the performed borings within the anticipated improvement areas, subsurface conditions on the project site may be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 13[1]	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	13 to 28	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense
3	28 to 43[2]	Silty fine sand (SM)	Loose to very dense
4	43 to 53[3]	Clayey fine sand to sandy clay (SC/CL)	Very loose to loose
5	53 to 100	Fine sand with silt to silty fine sand (SP-SM/SM)	Medium dense to dense

1. Auger borings AB-1 through AB-5 encountered silty fine sands (SM) ranging from 5 to 10 feet below existing grade.
2. Hardpan (SP-SM/SM) was encountered at borings B-1 and B-4 ranging from 28 to 38 feet below existing grade.
3. Fine sand with silt (SP-SM) and silty fine sand (SM) was encountered in this stratum at borings B-3 and B-4 within the depth range of this stratum.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. Descriptions of our field exploration are included as Exhibit A-40 in Appendix A. Descriptions of our laboratory testing procedures are included as Exhibit B-1 in Appendix B.

3.5 Groundwater

The boreholes for the proposed structures and retention ponds were observed during drilling for the presence and level of groundwater. Groundwater was observed in all the borings between depths of 2 and 6 feet below existing grade. It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the boring was performed. In addition, perched water can develop within higher permeability soils (sands and sands with silt) overlying less permeable

soils (Hardpan). Therefore, groundwater levels during construction or at other times in the future may be higher or lower than the levels indicated on the boring logs.

We estimate that during the wet season, with rainfall and recharge at a maximum, groundwater levels will be at or within few feet below existing grades. Our estimates of the seasonal groundwater conditions are based on the USDA Soil Survey, the encountered soil types, and the encountered water levels. The following table summarizes the water depth and/or elevations of the encountered Groundwater Table (GWT) and the estimated Seasonal High Water Level (SHWL) at location of performed borings.

Boring #	Existing ground elevation, feet	Elevation of the encountered water table, feet	Elevation of the estimated SHWL, feet	Depth to the encountered water table, feet	Depth to the estimated SHWL, feet
AB-1	80.0	76	78	4	2
AB-2	80.05	76.05	78	4	2.05
AB-3	80.03	76.03	78	4	2.03
AB-4	80.37	76.37	78	4	2.37
AB-5	79.24	77.24	78	2	1.24
AB-6	79.6	75.6	78	4	1.6
B-1	---	---	---	2	0.5
B-2	---	---	---	3.5	1
B-3	---	---	---	3.5	1
B-4	---	---	---	3	1
B-5	---	---	---	5	2.5
B-6	---	---	---	5	2.5
B-7	---	---	---	3.5	1.5
B-8	---	---	---	NE @10 feet	1.5
B-9	---	---	---	NE @10 feet	1.5
B-10	---	---	---	3.5	1.5
B-11	---	---	---	NE @10 feet	1
B-12	---	---	---	3.5	1.5
B-13	---	---	---	NE @10 feet	1
B-14	---	---	---	6	2
B-15	---	---	---	4	2
B-16	---	---	---	4	2
B-17	---	---	---	3.5	2

Boring #	Existing ground elevation, feet	Elevation of the encountered water table, feet	Elevation of the estimated SHWL, feet	Depth to the encountered water table, feet	Depth to the estimated SHWL, feet
B-18	---	---	---	3	1.5
B-19	---	---	---	4	2
B-20	---	---	---	5.5	2.5
B-21	---	---	---	3	1.5
B-22	---	---	---	4	2
B-23	---	---	---	4	2

Piezometers were installed in the boreholes that were drilled for the reject pond with surrounding RIBS. The piezometers were installed to the boring termination depth of 15 feet below the existing berm between the reject pond and the RIBS. The following table summarizes the groundwater observed in all the piezometers before, during, and after loading the reject pond (explained later in the report).

Boring # (Piezometer #)	**Groundwater Depth in feet below Ground Surface**				
	Initial Reading	3/27/2012 at 3:30pm	3/28/2012 at 10:19 am	3/29/2012 at 12.48pm	3/30/2012 at 12:30pm
B-24 (1)	6.00	3.67	3.50	3.50	3.42
B-25 (6)	3.00	3.00	2.67	2.67	2.42
B-26 (5)	---	3.00	2.67	2.67	3.00
B-27 (4)	5.00	3.00	5.08	4.42	5.08
B-28 (3)	4.00	3.33	1.42	1.42	1.42
B-29 (2)	7.50	1.58	1.50	1.42	1.42

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The following conclusions and recommendations are based on the project characteristics previously described, the data obtained in our field exploration and our experience with similar subsurface conditions and construction types. If the proposed construction is significantly different from what is previously described in this report, or if subsurface conditions different

from those disclosed by the borings are encountered during construction, we should be notified immediately so that we might review and modify, if necessary, the following recommendations in regards to such changes.

Support of foundations on or above existing fill soils is discussed in this report. However, even with the recommended construction testing services, there is an inherent risk for the owner that compressible fill or unsuitable material within or buried by the original fill may go undetected. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but could be reduced by performing additional testing and/or review of earthwork monitoring and testing reports from the original facility construction.

Our recommendations regarding design and construction of each proposed improvement to the facility is provided in the following sections.

4.2 Clarifier No. 11

Four (4) SPT borings, designated B-1 through B-4, were performed to depths of 75 to 100 feet below the existing ground surface in the proposed Clarifier Tank No. 11 area. Based on the provided construction plans, the proposed clarifier is 125 feet in diameter and about 15 feet in height with a 2.5 feet thick slab embedded about 5 to 6 feet.

Based on the results of the borings, the subsoil conditions at the Clarifier No. 11 can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 13[1]	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	13 to 28	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense
3	28 to 43[2]	Silty fine sand (SM)	Loose to very dense
4	43 to 53[3]	Clayey fine sand to sandy clay (SC/CL)	Very loose to loose
5	53 to 100	Fine sand with silt to silty fine sand (SP-SM/SM)	Medium dense to dense

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density

1. All borings for the Clarifier No. 11 were water jetted from 6 to 12 feet below existing grade to clear deep utilities that may have been encountered while drilling.
2. Hardpan (SP-SM/SM) was encountered in this stratum at borings B-1 and B-4 ranging from 28 to 38 feet below existing grade.
3. Fine sand with silt (SP-SM) and silty fine sand (SM) was encountered at borings B-3 and B-4 within the depth range of this stratum.

In our opinion, the proposed Clarifier No. 11 can be supported by conventional shallow foundation bearing on native soil or newly placed fill extending to native soil. The contractor is responsible to follow all proper site preparations according to the Earthwork and Temporary Dewatering sections of this report before construction of foundations. Design recommendations for shallow foundations for the proposed Clarifier No. 11 are presented in the following table:

Description	Clarifier No. 11
Net allowable bearing pressure [1] ■ **Compacted structural fill or native soils**	2,500 psf
Minimum foundation embedment[2]	3 feet
Estimated or provided average contact pressure below the tank	1200 psf (maximum)
Approximate total settlement from at the center of the tank [3]	About 3 inches[4]
Estimated differential settlement between the center and the perimeter of the tank [3]	About 1 ½ inches[4]
Minimum Compaction Requirements	A minimum of 95% of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes unsuitable existing fill or soft soils, if encountered, will be undercut and replaced with compacted structural fill.
2. Relative to lowest adjacent finished grade, typically exterior grade.
3. The above settlement estimates from foundation loads have assumed that the tank floor diameter is 125 feet.
4. Clarifier Tank will have to be preloaded with water prior to connecting the pipe in order to advance the settlement and minimize post-construction settlement, which might lead to pipe breakage.

4.3 Preliminary Treatment Structure and Truck Loading Building

Three (3) SPT borings, designated B-5 through B-7, were performed to depths of between 15 and 25 feet below the existing ground surface in the proposed Pretreatment Structure area. Based on the given construction plans, the proposed preliminary treatment structure is approximately 27 feet high with multiple concrete chambers throughout the structure. The drawing showed the foundation system to consist of a 2 feet thick continuous slab supporting the entire structure.

Based on the results of the borings, subsurface conditions at the Pretreatment Structure can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 13	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	13 to 25	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense

In our opinion, the proposed Preliminary Treatment Structure can be supported by a shallow foundation system bearing on native soil or newly placed fill extending to native soil. The contractor is responsible to follow all proper site preparations according to the Earthwork and Temporary Dewatering sections of this report before construction of foundations. Design recommendations for shallow foundations for the proposed Preliminary Treatment Structure are presented in the following table:

Description	Preliminary Treatment Structure
Net allowable bearing pressure [1] ■ **Compacted structural fill or native soils**	2,500 psf
Minimum foundation embedment [2]	3 feet
Provided average contact pressure below the foundations	1800 to 2200 psf
Approximate total settlement assuming the pretreatment structure is full of water (1900 psf) [3]	About 2½ to 3½ inches
Estimated differential settlement between the center and the perimeter assuming the pretreatment structure is full of water (2200 psf) [3]	About 1 to 2 inches

Description	Preliminary Treatment Structure
Minimum Compaction Requirements	A minimum 95 percent of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes unsuitable existing fill or soft soils, if encountered, will be undercut and replaced with compacted structural fill.
2. Relative to lowest adjacent finished grade, typically exterior grade.
3. The above settlement estimates from foundation loads assumed that the foundation/slab size is 65 feet in width and 120 feet in length.

4.4 Filters and Chlorine Contact Chamber Structures

Four (4) SPT borings, designated B-8 through B-11, were performed to depths of 30 feet below the existing ground surface in the proposed Filter and Chlorine Contact Chamber Structures area. Based on the given construction plans 60 % submittal (sheets S-580-101 and S-540-301 dated January 2012), the proposed structure is approximately 15.5 feet in height. The proposed foundation system consists of a 1.3 feet thick continuous slab to support the entire weight of the structure loads.

Based on the results of the borings, subsurface conditions at the Filter and Chlorine Contact Chamber Structures can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 13[1]	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	13 to 30	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense

1. Silty fine sand (SM) was encountered in this stratum at boring B-11 between 4 to 6 feet below existing grade.

In our opinion, the proposed Filter and Chlorine Contact Chamber Structures can be supported on a shallow foundation system bearing on native soil or newly placed fill extending to native soil. The contractor is responsible to follow all proper site preparations according to the Earthwork and Temporary Dewatering sections of this report before construction of foundations.

Design recommendations for shallow foundations for the proposed Filter and Chlorine Contact Chamber Structures are presented in the following table:

Description	Filters and Chlorine Contact Chamber Structures
Net allowable bearing pressure [1] ■ **Compacted structural fill or native soils**	2,500 psf
Minimum foundation embedment [2]	2 feet
Estimated or provided average contact pressure below the foundations	975 psf (maximum)
Approximate total settlement from foundation loads [3]	About 2 inches
Estimated differential settlement from foundation loads [3]	About 1 inch
Minimum Compaction Requirements	A minimum of 95 percent of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes unsuitable existing fill or soft soils, if encountered, will be undercut and replaced with compacted structural fill.
2. Relative to lowest adjacent finished grade, typically exterior grade.
3. The above settlement estimates from foundation loads have assumed that the foundation/slab size is 55 feet in width and 106 feet in length.

4.5 Secondary Effluent Reject and RAS/WAS Pump Stations

One (1) SPT boring, designated B-12 was performed to a depth of 30 feet below the existing ground surface in the proposed Secondary Effluent Reject Pump Station areas. Also, two (2) SPT borings, designated B-21 and B-22, have been performed to depths of 30 feet below the existing ground surface in the proposed RAS/WAS Pump Station areas. Based on the given construction plans 60 % submittal (sheet S-560-101 dated January 2012), the proposed structure that will contain the Secondary Effluent Reject Pump station is approximately 28 feet in height with the proposed foundation bottom being 16 feet below final grade. The proposed foundation system consists of a 2.3 feet thick continuous slab to support the entire weight of the pump station. The RAS/WAS Pumps are supported on concrete pads above grade with minimal loading.

Based on the results of the borings, subsurface conditions at the Secondary Effluent Reject and RAS/WAS Pump Stations can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 13[1]	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	13 to 30	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense

1. Silty fine sand (SM) was encountered in this stratum at boring B-12, B-21, and B-22 between 4 to 8 feet below existing grade.

In our opinion, the proposed Secondary Effluent reject and RAS/WAS Pump Stations can be supported by a shallow foundation system bearing on native soil or newly placed fill extending to native soil. The contractor is responsible to follow all proper site preparations according to the Earthwork and Temporary Dewatering sections of this report before construction of foundations. Design recommendations for shallow foundations for the proposed Secondary Effluent reject and RAS/WAS Pump Stations are presented in the following table:

Description	Secondary Effluent Reject Pump Stations	RAS/WAS Pump Stations
Net allowable bearing pressure [1] ■ **Compacted structural fill or native soils**	2,500 psf	1,500 psf
Minimum footing embedment[2]	4 feet	12 inches
Approximate total settlement from foundation loads	about 1 inch	about 1 inch
Estimated differential settlement from foundation loads	about ½ inch	about ½ inch
Minimum Compaction Requirements	A minimum of 95 percent of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom	A minimum of 95 percent of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable existing fill or soft soils, if encountered, will be undercut and replaced with compacted structural fill.
2. Relative to lowest adjacent finished grade, typically exterior grade.

For the Secondary Effluent Reject Pump Stations, the construction should also be sequenced so that a dewatering system, if necessary, is not turned off until the pump station has enough weight to counteract an uplift force equivalent to the amount of water displaced. It may also be prudent to place additional concrete in the structure foundation to provide ballast against such uplift force. This uplift force should account for the head difference from the bottom elevation of the foundation to the seasonal high groundwater level or the groundwater level at the time of construction, whichever is most shallow, plus any possible flooding conditions that may occur at the project site.

For calculations of resistance to the uplift force, 50 pounds per cubic foot may be used for the buoyant unit weight of the soil. The buoyant weight of the concrete and overlying soils below the seasonal high groundwater level should be used in calculating the necessary amount of ballast required.

4.6 Supplemental Carbon Feed Building

Three (3) SPT borings, designated B-15 through B-17, were performed to depths of 25 feet below the existing ground surface in the proposed Supplemental Carbon Feed building area. Based on the given construction plans 60 % submittal (sheet S-520-101 dated January 2012), the proposed Supplemental Carbon Feed building includes four (4) 6100 Gallon IMFO tanks covered by light steel structure. The IMFO tank is 10 feet in diameter and 12 feet in height. The light steel building inclosing the tanks is about 30 feet by 45 feet.

Based on the results of the borings, subsurface conditions at the Supplemental Carbon Feed Building can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 13[1]	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	13 to 30	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense

1- Silty fine sand (SM) was encountered in this stratum at boring B-17 within 4 to 8 feet below existing grade.

In our opinion, the proposed Supplemental Carbon Feed Building can be supported by a shallow foundation system bearing on native soil or newly placed fill extending to native soil. The contractor is responsible to follow all proper site preparations according to the Earthwork and Temporary Dewatering sections of this report before construction of foundations. Design

recommendations for shallow foundations for the proposed Supplemental Carbon Feed Building are presented in the following table:

Description	Supplement Carbon Feed Building
Net allowable bearing pressure [1] ■ **Compacted structural fill or native soils**	2,000 psf
Minimum footing embedment[2]	18 feet
Estimated or provided average contact pressure below the foundations	800 psf (maximum for the tanks)
Approximate total settlement from foundation loads[3]	About 1 ½ inch
Estimated differential settlement from foundation loads	About ½ inch between center and perimeter of the tank
Minimum Compaction Requirements	A minimum of 95 percent of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable existing fill or soft soils, if encountered, will be undercut and replaced with compacted structural fill.
2. Relative to lowest adjacent finished grade, typically exterior grade.
3. The above settlement estimates from foundation loads have assumed that the maximum tank footing size is about 12 feet in diameter (separate footings for each tank).

4.7 Secondary Effluent Reject Diversion Structures

Three (3) SPT borings designated B-18 through B-20, were performed to depths of 25 feet below the existing ground surface in the proposed Secondary Effluent Diversion Structures area. Based on the given construction plans 60% submittal (sheets S-562-101, S-562-101 and, S-563-101 dated January 2012), the proposed diversion structure is 16 feet in height with the proposed foundation bottom being 2 feet and 9 feet below final grade. The proposed foundation system consists of 1.3 to 2 feet thick continuous slab to support the entire weight of the Effluent Diversion Structure.

Based on the results of the borings, subsurface conditions at the Secondary Effluent Diversion Structures can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 13[1]	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	13 to 30	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense

1. Silty fine sand (SM) was encountered in this stratum at boring B-18 between 6 to 13.5 feet below existing grade.

In our opinion, the proposed Secondary Effluent Diversion Structures can be supported by a shallow foundation system bearing on native soil or newly placed fill extending to native soil. The contractor is responsible to follow all proper site preparations according to the Earthwork and Temporary Dewatering sections of this report before construction of foundations. Design recommendations for shallow foundations for the proposed Secondary Effluent Diversion Structures are presented in the following table:

Description	Secondary Effluent Diversion Structures
Net allowable bearing pressure[1] ■ **Compacted structural fill or native soils**	2,500 psf
Minimum footing embedment[2]	2 feet
Estimated or provided average contact pressure below the foundation/slab	1100 psf (maximum)
Approximate total settlement from foundation loads[3]	About 1 ½ inches
Estimated differential settlement from foundation loads[3]	About ½ inch
Minimum Compaction Requirements	A minimum of 95 percent of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable existing fill or soft soils, if encountered, will be undercut and replaced with compacted structural fill.
2. Relative to lowest adjacent finished grade, typically exterior grade.
3. The above settlement estimates from foundation loads have assumed that the footing size is 15 feet by 15 feet supporting the entire weight of the Secondary Effluent Diversion Structure.

4.8 West Electrical Building

Two (2) SPT borings, designated B-13 and B-14, were performed to depths of 25 feet below the existing ground surface in the proposed West Electrical Building area. Based on the given construction plans 60% submittal (sheet S-575-101 dated January 2012), the proposed West Electrical Building is a one-story, cast in place concrete building with a 10" hollow core roofing system. The total area of the West Electrical Building is 1200 square feet and supported on a standard strip footing foundation system.

Based on the results of the borings, subsurface conditions at the West Electrical Building can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	N/A to 6	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense
2	6 to 13	Silty fine sand (SM)	Medium dense
3	13 to 30	Fine sand with silt to silty fine sand (hardpan) (SP-SM/SM)	Medium dense to very dense

In our opinion, the proposed West Electrical Building can be supported by a shallow foundation system bearing on native soil or newly placed fill extending to native soil. The contractor is responsible to follow all proper site preparations according to the Earthwork and Temporary Dewatering sections of this report before construction of foundations. Design recommendations for shallow foundations for the proposed West Electrical Building are presented in the following table:

Description	West Electrical Building
Net allowable bearing pressure[1] ■ **Compacted structural fill or native soils**	2,000 psf
Minimum foundation embedment[2]	2 feet
Estimated or provided average contact pressure below the foundations	4000 pounds per lineal foot
Approximate total settlement from foundation loads[3]	About 1 inch
Estimated differential settlement from foundation loads[3]	about ½ inch per 40 feet

Description	West Electrical Building
Minimum Compaction Requirements	A minimum of 95 percent of the materials maximum Modified Proctor dry density (ASTM D 1557) to a depth of 24 inches below footing bottom

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable existing fill or soft soils, if encountered, will be undercut and replaced with compacted structural fill.
2. Relative to lowest adjacent finished grade, typically exterior grade.
3. The above settlement estimates from foundation loads have assumed that the maximum strip footing size is 2 feet in width.

4.9 Stormwater Management Pond

We anticipate a shallow dry stormwater retention pond will be used. Dry retention ponds generally need to be at least 2 feet above the seasonal high water table to recover within the time required by SJRWMD, although actual recovery performance will vary with pond geometry as well as soil and groundwater conditions.

The auger borings at the proposed stormwater management pond location encountered fine sand to 6 feet and silty fine sand to the termination depth of 10 feet. A somewhat restrictive layer was encountered at 13 feet below existing grade at adjacent boring location B-10.

Laboratory permeability tests were performed on relatively undisturbed samples of the anticipated stormwater pond subgrade soil at Boring locations AB-1 and AB-4 at depths of 3 and 3.5 feet below existing grade. The measured permeability rates were 21 and 38 feet per day for Borings AB-1 and AB-4, respectively. This value is indicative of the saturated vertical permeability. The vertical permeability is on the order of ½ to 2/3 of the horizontal permeability rate for the observed soil types. Recommended design values based on our experience and the potential for pond bottom siltation or hydro-compaction as presented in the table below:

Parameters	Recommended Values
Estimated elevation of the restrictive layer	+74 feet
Estimated elevation of the Seasonal High Water Table Depth	+78 feet

Recommended Unsaturated Vertical Permeability, k_V	15 feet/day
Recommended Horizontal Saturated Hydraulic Conductivity, k_H	25 feet/day
Fillable Porosity, η	25 percent

4.10 Reject Pond and Rapid-Infiltration Basins (RIBs)

Six (6) SPT borings and six (6) piezometers, designated B-24 through B-29, were performed to depths of 15 feet below the existing berm surface in the proposed West Reject Pond and RIBs area. Based on the results of the borings, subsurface conditions at the Reject Pond and RIBs can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	0 to 15	Fine sand to fine sand with silt (SP/SP-SM)	Loose to medium dense

A site visit was conducted by a Senior Geotechnical Engineer and a Senior Geotechnical Technician of Terracon to evaluate the presence or absence of a liner as was shown on the record drawings for the reject pond bottom. A series of hand auger borings were performed at different locations of the reject pond bottom to depths of 3 to 5 feet. The borings encountered clean sands to silty sands. No clays or clayey sands that might be indicative of a pond bottom liner were encountered.

The piezometers were installed at each boring to about a depth of 15 feet below the existing grade of the berm in between the reject pond and the RIBS. The main purpose of the piezometers was to monitor the water depth at the berm between the reject pond and the RIBs prior to loading the pond. The piezometers were then monitored during and after the pond was loaded; it was anticipated that an increase in the water level in the piezometers should be an indication of the deficiency or lack of reject pond liner or cutoff. The results of piezometer readings are summarized in the following table.

Boring # (Piezometer #)	Groundwater Depth in feet below Ground Surface				
	Initial Reading	3/27/2012 at 3:30pm	3/28/2012 at 10:19 am	3/29/2012 at 12.48pm	3/30/2012 at 12:30pm
B-24 (1)	6.00	3.67	3.50	3.50	3.42

Boring # (Piezometer #)	Groundwater Depth in feet below Ground Surface				
	Initial Reading	3/27/2012 at 3:30pm	3/28/2012 at 10:19 am	3/29/2012 at 12.48pm	3/30/2012 at 12:30pm
B-25 (6)	3.00	3.00	2.67	2.67	2.42
B-26 (5)	---	3.00	2.67	2.67	3.00
B-27 (4)	5.00	3.00	5.08	4.42	5.08
B-28 (3)	4.00	3.33	1.42	1.42	1.42
B-29 (2)	7.50	1.58	1.50	1.42	1.42

Given the above as well as the data collected by AECOM during and after the reject pond loading, it is our opinion that the reject pond leaks substantial amount of water either due to the total lack of a liner of a substantially diffident liner. A new liner should be installed in order to control reject water seepage through the side slopes and the bottom of the reject pond. A few options are available such as compacted clay liners, geosynthetic clay liners, or geomembrane liners (HDPE or PVC). The liner will need to be anchored at the top of slope as shown on the typical detail for PVC liner top anchor shown on Exhibit A-41 in Appendix A.

For the selected liner, the effect of uplift force due to seepage through the berm from the RIBs to the reject pond when the RIBs are totally filled or at extreme hydrostatic conditions, were studied. The maximum uplift pressure at bottom of slope and along the reject pond bottom is in the order of 190 psf, which corresponds to about 3 feet of hydrostatic pressure (elevation +99 to +88 feet). Terracon recommend a minimum ballast of two (2) feet of soil compacted to a minimum dry density of 105 on top of the PVC liner to counteract the effect of uplift.

4.11 Utility Pipes

Soils encountered in the borings appear suitable to support the proposed pipelines where applicable, with some limitations. Regarding the pipe subgrade soils, we offer the following recommendations:

- The soils encountered in the borings appear suitable to support the proposed pipeline where applicable.
- Hardpan type soils were encountered at depths of about 10 to 15 feet below ground surface. Hardpan soils are cemented and might need special equipment to excavate and handle. The contractor should anticipate such soil and such equipment need if excavations in the order of 10 to 15 feet are anticipated.

- If unsuitable soils (muck, organics, clayey soils, etc.) are encountered during construction, they should be completely removed below the pipe bottom, replaced with well-draining granular sands with a fines content of 12 percent or less passing the No. 200 U.S. Standard sieve by weight, and compacted to at least 95 percent of the soils' modified Proctor maximum dry density (ASTM D-155), or at least 98 percent of the soils' modified Proctor maximum dry density for paved areas.
- The bedding soil beneath the pipe should be properly shaped to completely support the pipe section and areas should be excavated to accommodate any bells or other raised portions of the pipe to help avoid point loading conditions.
- A minimum separation of 2 feet between the bottom of the compacted subgrade level and the groundwater level is recommended during construction and backfilling operations. A properly designed dewatering system may be required to maintain this minimum separation.
- After the subgrade soils have been prepared as recommended above, the pipe may be installed.

Regarding the pipe backfill soils we offer the following recommendations:

- Compaction of backfilled soils around the pipe should be accomplished in lift thicknesses no thicker than 12 inches.
- Generally, the soils encountered in the borings should be suitable for use as pipe backfill.
- The near surficial site soils appear suitable for use as pipe backfill.
- At least one (1) density test per 300 lineal feet of pipe length per lift, and/or a minimum of two (2) tests, should be performed to verify that the soil has been compacted to at least 95 percent of its modified Proctor maximum dry density (ASTM D-1557), or at least 98 percent of the soils' modified Proctor maximum dry density for paved areas.

If compaction difficulties arise during construction, the Geotechnical Engineer should be consulted to provide further recommendations.

4.12 Earthwork

4.12.1 Site Preparation

We anticipate construction will be initiated by clearing any surface debris that may have accumulated on the site and stripping the topsoil. Stripping depths between our boring locations and across the site could vary and we recommend actual stripping depths be evaluated by a representative of Terracon during construction.

Once stripping is complete, the exposed subgrade should be observed, tested and proofrolled with a minimum of 10 overlapping passes of a medium or heavy weight roller (minimum 10,000

pounds static weight) operating in static mode due to the proximity to existing structures. Proofrolling aids in providing a firm base for compaction of new fill and delineating soft or disturbed areas that may exist at or near the exposed subgrade level as well overall densification of the upper loose sands. Proofrolling should be performed in the presence of a Terracon representative in order to aid in evaluating unstable subgrade areas. Unstable areas observed at this time should be improved as recommended by the engineer based on field conditions and typically includes scarification and recompaction or by undercutting and replacement with suitable compacted fill.

4.12.2 Material Requirements

Compacted structural fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
General [1]	SP to SP-SM (fines content < 10 percent)	All locations and elevations

1. The in-place sands and sands with silt appear to meet this criterion.

4.12.3 Compaction Requirements

Item	Description
Fill Lift Thickness	12 inches or less in loose thickness when heavy compaction equipment is used in vibratory mode. Lift thickness should be decreased if static compaction is being used, typically to no more than 8 inches, and the required compaction must still be achieved. 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used.
Compaction Requirements [1]	A minimum of 95% of the material's maximum modified Proctor dry density (ASTM D 1557)
Moisture Content	Within ±2 percent of optimum moisture content as determined by the Modified Proctor test, at the time of placement and compaction.

1. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

4.12.4 Grading and Drainage

Final surrounding grades should be sloped away from the structure on all sides to prevent ponding of water. Roof drainage should discharge to the stormwater system or a minimum of 10 feet beyond the footprint of the proposed structures.

4.12.5 Temporary Dewatering

Groundwater was observed at depths ranging from about 2 to 6 feet throughout the site area in the open boreholes at the time of drilling. Seasonal high groundwater levels are estimated to be at or just below the ground surface to 3 feet below the existing ground surface at the boring locations. Based on this information and the proposed embedment depths of the foundations and pipes, dewatering will be required to facilitate construction, backfill and compaction in the dry. Regarding dewatering, we offer the following recommendations:

- Dewatering operations at this site for pipe installation should be accomplished with a properly designed dewatering system operating outside the excavation limits.
- The dewatering system should be adequate to lower groundwater levels to at least 2 feet below the lowest compaction surface and keep it there during backfilling to facilitate excavations in the dry and proper compaction of bedding and backfill soils.
- The Contractor should review the boring profiles prior to implementing the dewatering system to be aware of anticipated soils. Wellpoint dewatering may not be effective in all cases, or in hardpan type soils.
- The construction should be sequenced so that the dewatering system is not turned off until pipes have enough weight placed over it to counteract an uplift force equivalent to the height of standing water above the base of the pipe. The resisting weight of soil over the pipe should be calculated using the buoyant unit weight of the soil.

4.12.6 Earthwork Construction Considerations

Although the exposed subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. The use of static compaction and/or light construction equipment would aid in reducing subgrade disturbance.

Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and re-compacted prior to floor slab and pavement construction.

As a minimum, all temporary excavations should be sloped or braced as required to comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom.

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.

4.13 Foundation Construction Consideration

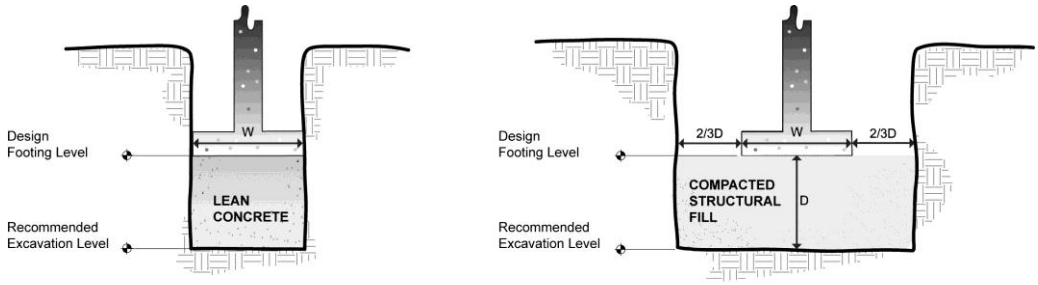
4.13.1 Piping Connection

Due to the sandy subsurface conditions, estimated settlements are expected to be mostly elastic, occurring during and shortly after construction. Also, based on prior experience, we have generally observed settlement of heavy structures to be less than predicted for these soil types. We recommend that the tanks and other structures that include pipe connections to be water-filled and test-loaded, with settlement observations and monitoring, prior to final piping connections, to advance the settlement and minimize post-construction settlement.

4.13.2 Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose soil prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Should the soils at bearing level become excessively dry, disturbed or saturated, the affected soil should be moisture conditioned and recompacted or removed prior to placing concrete. It is recommended that the geotechnical engineer be retained to observe and test the soil foundation bearing materials.

Terracon anticipates hand-operated compaction equipment will be utilized, as necessary, in footing cuts, following any mass grading. It should be noted that footing subgrade preparation requires compaction for a depth of 2 feet below foundation bearing elevations for most structures, which in some cases may require overexcavation to achieve. If unsuitable bearing soils are encountered in footing excavations, the excavation should be extended deeper to suitable soils and the footing could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. As an alternative, the footings could also bear on properly compacted backfill extending down to the suitable soils. Overexcavation for compacted backfill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation. The overexcavation should then be backfilled up to the footing base elevation per the preceding general earthwork specifications, using hand operated compaction equipment in footing cuts. The overexcavation and backfill procedure is described in the following figure.



NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

5.0 GENERAL COMMENTS

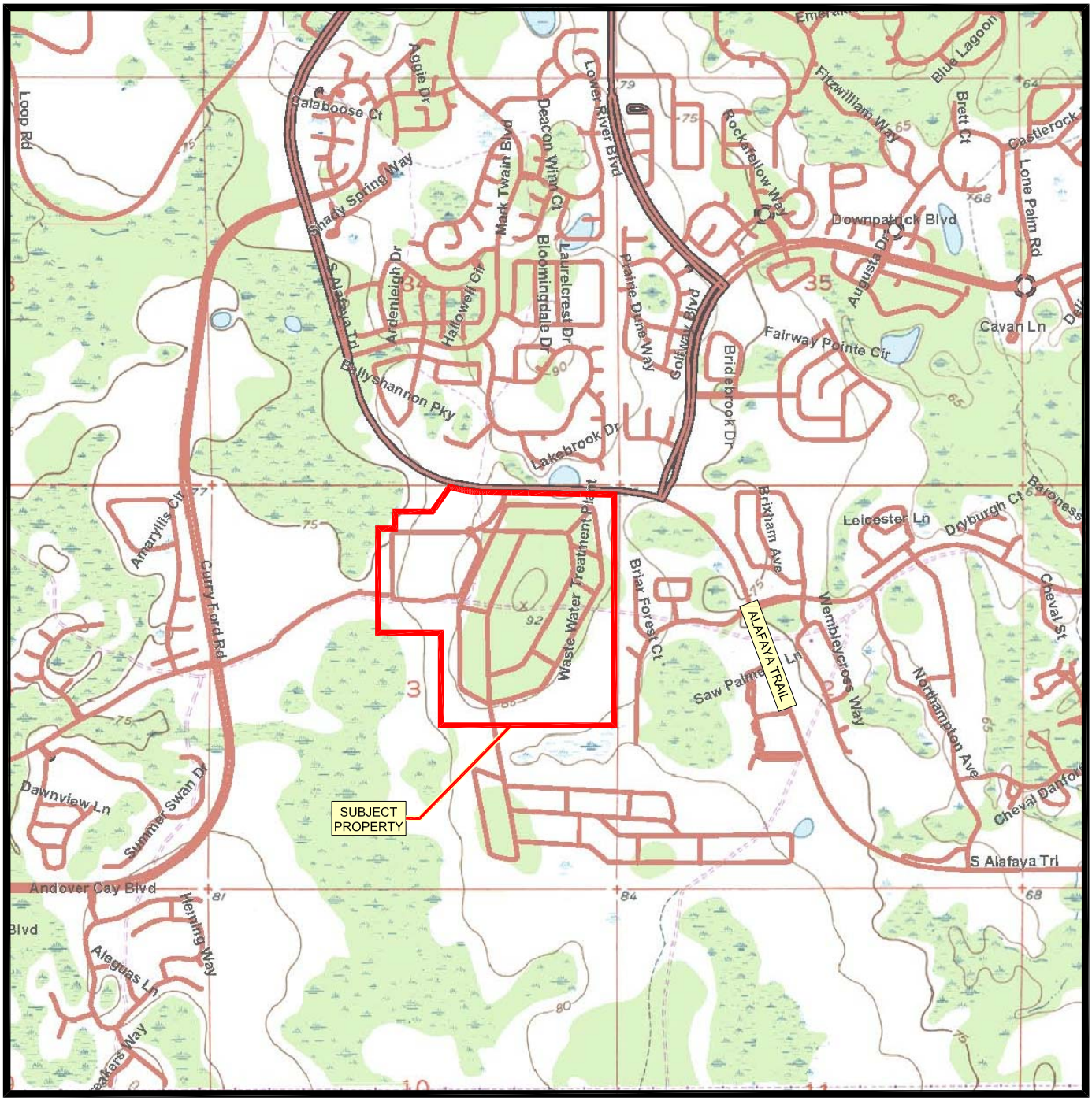
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

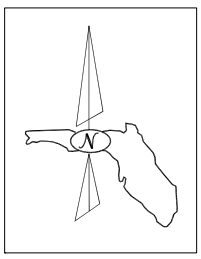
The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

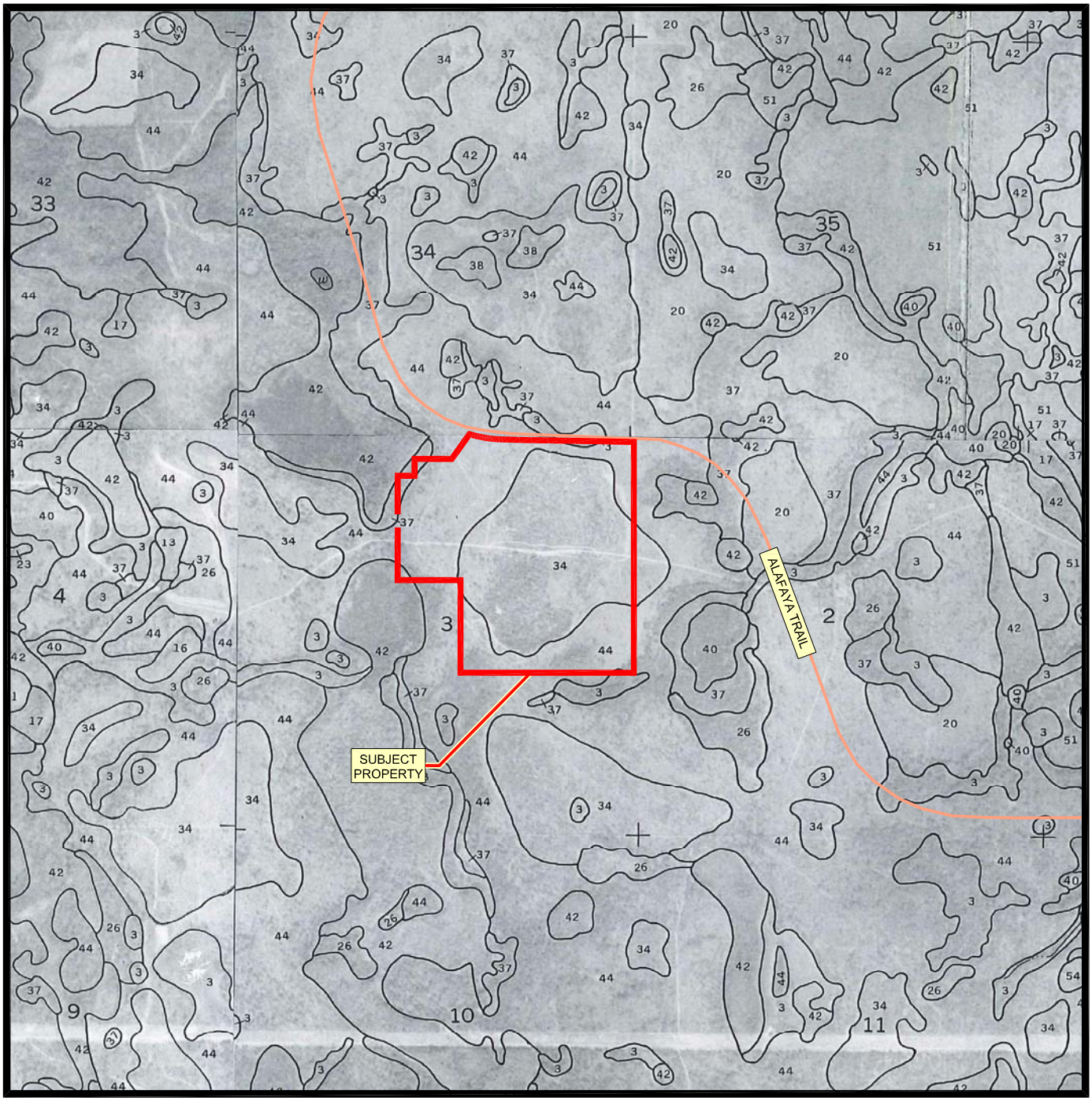


REFERENCE: U.S.G.S. "OVIEDO SW, FLORIDA" QUADRANGLE MAP ISSUED: 1953 REVISED: 1980
SECTION: 3
TOWNSHIP: 23 SOUTH
RANGE: 31 EAST
SCALE: 1" = 2000'

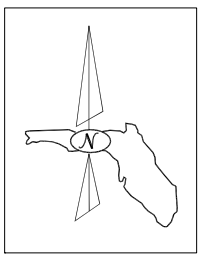


U.S.G.S. QUADRANGLE MAP
EASTERN WATER RECLAMATION FACILITY
PHASE V IMPROVEMENTS
ORANGE COUNTY, FLORIDA

DRAWN: MG	NODARSE A Terracon COMPANY	
CHKD: KCM		
SCALE: 1"=2000'		
DATE: 3-8-12	PROJ. NO: H1115424	EXHIBIT: A-1



REFERENCE: U.S.D.A. ORANGE COUNTY, FLORIDA SOIL SURVEY
ISSUED: AUGUST 1989
SECTION: 3
TOWNSHIP: 23 SOUTH
RANGE: 31 EAST
SCALE: 1" = 2000'



SOIL LEGEND

3	BASINGER FINE SAND, DEPRESSIONAL
34	POMELLO FINE SAND, 0 TO 5 PERCENT SLOPES
37	ST. JOHNS FINE SAND
44	SMYRNA FINE SAND

SOILS MAP
EASTERN WATER RECLAMATION FACILITY
PHASE V IMPROVEMENTS
ORANGE COUNTY, FLORIDA

DRAWN: MG	NODARSE A Terracon COMPANY	
CHKD: KCM		
SCALE: 1"=2000'		
DATE: 3-8-12	PROJ. NO: H1115424	EXHIBIT: A-2

N

SCALE IN FEET

0 200 400

LEGEND

APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

BORING LOCATION PLAN
EASTERN WATER RECLAMATION FACILITY
PHASE V IMPROVEMENTS
ORANGE COUNTY, FLORIDA

DRAWN: MG	NODARSE A Terracon COMPANY		
CHKD: KCM			
SCALE: NOTED			
DATE: 3-8-12	PROJ. NO: H1115424	EXHIBIT: A-3	

N

SCALE IN FEET

0 100 200

LEGEND

APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

APPROXIMATE LOCATION OF AUGER BORING

BORING LOCATION PLAN
EASTERN WATER RECLAMATION FACILITY
PHASE V IMPROVEMENTS
ORANGE COUNTY, FLORIDA

DRAWN: MG	NODARSE A Terracon COMPANY		
CHKD: KCM			
SCALE: NOTED			
DATE: 3-8-12	PROJ. NO: H1115424	EXHIBIT: A-4	

Apr12, 2012-1:25pm N:\Projects\2011\H1115424\PROJECT DOCUMENTS (Reports-Letters-Drafts to Clients)\Cad\H1115424-Exhibit-A-4.dwg

Field Exploration Description

The boring locations were laid out at the project site by Terracon personnel. The locations indicated on the attached diagram are approximate and were measured by pacing distances and estimating right angles, across vegetated/wooded terrain. The locations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The SPT soil borings were drilled with a truck-mounted or mini rig, rotary drilling rig equipped with a rope and cathead-operated safety hammer. The boreholes were advanced with a cutting head and stabilized with the use of bentonite (drillers' mud). Soil samples were obtained by the split spoon sampling procedure in general accordance with the Standard Penetration Test (SPT) procedure. In the split spoon sampling procedure, the number of blows required to advance the sampling spoon the last 12 inches of an 18-inch penetration or the middle 12 inches of a 24-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (N). This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. The sampling depths and penetration distance, plus the standard penetration resistance values, are shown on the boring logs.

Portions of the samples from the borings were sealed in glass jars to reduce moisture loss, and then the jars were taken to our laboratory for further observation and classification. Upon completion, the boreholes were backfilled with the site soil.

Field logs of each boring were prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The boring logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation of the samples.

A CME automatic SPT hammer was used in selected borings to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

LOG OF BORING NO. AB-1

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Storm Drain Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %	Perm. (ft/day)
	FINE SAND WITH SILT gray to brown ▼		SP SM	1	HS						
		5	SP SM	2	HS			14	6		Kv = 21
	8.5										
	10 **SILTY FINE SAND** brown to dark brown	10	SM	3	HS						

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUGER	FOREMAN	MARK
EXHIBIT:	A-6	JOB #	H1115424

LOG OF BORING NO. AB-2

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Storm Drain Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown to brown		SP	1	HS					
	3.5									
	FINE SAND WITH SILT grayish brown to brown	5	SP SM	2	HS			30	11	
	5.5									
	SILTY FINE SAND brown to dark brown		SM	3	HS					
	10	10								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUGER	FOREMAN	MARK
EXHIBIT:	A-7	JOB #	H1115424

LOG OF BORING NO. AB-3

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Storm Drain Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown to brown		SP	1	HS					
			SP	2	HS					
			SP	3	HS					
	4 ▼		SP	4	HS			22	7	
	5 **FINE SAND WITH SILT** brown	5	SM	5	HS					
			SM	6	HS					
	SILTY FINE SAND brown to dark brown		SM	7	HS					
			SM	8	HS					
	10	10	SM	9	HS					
			SM	10	HS					
			SM							

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUGER	FOREMAN	MARK
EXHIBIT:	A-8	JOB #	H1115424

LOG OF BORING NO. AB-4

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Storm Drain Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %	Perm. (ft/day)
	FINE SAND grayish brown to brown		SP	1	HS						
			SP	2	HS						
	4 ▼										
	SILTY FINE SAND brown to dark brown	5	SM	3	HS			15	3		Kv = 38
			SM	4	HS						
	10	10									

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUGER	FOREMAN	MARK
EXHIBIT:	A-9	JOB #	H1115424

LOG OF BORING NO. AB-5

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Storm Drain Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	1 **FINE SAND WITH SILT** gray to brown		SP	1	HS					
	2.5		SM	2	HS					
	3.5 **FINE SAND** grayish brown to brown		SP	3	HS			20	5	
	FINE SAND WITH SILT gray to brown	5	SP SM	4	HS					
	SILTY FINE SAND		SM	5	HS					
	10 brown to dark brown	10								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 2.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUGER	FOREMAN	MARK
EXHIBIT:	A-10	JOB #	H1115424

LOG OF BORING NO. AB-6

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Storm Drain Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND WITH SILT		SP	1	HS					
	gray to dark brown ▼		SM	2	HS					
			SP							
			SM	3	HS					
		5	SP							
			SM	4	HS					
			SP							
			SM	5	HS			23	5	
	10	10	SP							
			SM							

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUGER	FOREMAN	MARK
EXHIBIT:	A-11	JOB #	H1115424

LOG OF BORING NO. B-01

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Clarifier No. 11

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %	
	FINE SAND WITH SILT gray to brown, very loose to loose ▼		SP	1	HA		3*				
			SM								
			SP	2	HA		4*				
		5	SM								
	6		SP	3	HA		5*				
	JETTED FROM 6' TO 12' FOR UTILITIES		SM								
		10									
	12										
	13.5 **FINE SAND WITH SILT** gray to brown, loose		SP	4	SS		9	27	5		
			SM	5	SS		14				
	SILTY FINE SAND brown to dark brown, medium dense	15	SM								
	-hardpan										
		20	SM	6	SS		24				
	23.5										
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, medium dense to very dense	25	SP	7	SS		50/6"				
			SM								
			SP	8	SS		41				
		30	SM								
			SP	9	SS		14				
		35	SM								
	38.5										
	SILTY FINE SAND brown to dark brown, medium dense	40	SM	10	SS		13				
	43.5										
	SILTY FINE SAND gray to greenish gray, very loose	45	SM	11	SS		2				
	47		SM	12	ST			33	37		LL = 33 PI = 9
	FINE SAND WITH SILT gray to brown, loose to dense		SP	13	SS		7				
			SM	14	SS		24				
		50									
	Continued Next Page										

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL ▽	▼ 2	WD	
WL ▼	▼		
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-12	JOB #	H1115424

LOG OF BORING NO. B-01

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND WITH SILT gray to brown, loose to dense	55	SP SM	15	SS		37			
		60	SP SM	16	SS		24			
		65	SP SM	17	SS		29			
		70	SP SM	18	SS		19			
	73.5									
	75 **SILTY FINE SAND** greenish gray, medium dense	75	SM	19	SS		23			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 2	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-12	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-02

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Clarifier No. 11

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %	
	FINE SAND grayish brown to brown, very loose to loose		SP	1	HA		2*				
			SP	2	HA		4*				
	4 ▼										
	SILTY FINE SAND brown to dark brown, loose	5	SM	3	HA		3*				
	6										
	JETTED FROM 6' TO 12' FOR UTILITIES	10									
	12										
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, medium dense to dense	15	SM	4	SS		18				
			SM	5	SS		25				
		20	SM	6	SS		40				
		25	SM	7	SS		36				
	28.5										
	FINE SAND WITH SILT orange-brown, dense	30	SP SM	8	SS		32				
	33.5										
	SILTY FINE SAND brown to dark brown, medium dense	35	SM	9	SS		21				
		40	SM	10	SS		25				
	43.5										
	SILTY CLAY TO CLAYEY SILT tan, loose	45	CH	11	SS		6	60	61		LL = 52 PI = 30
	48.5										
		50	SC	12	SS		9				

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	2-13-12		
BORING COMPLETED	2-13-12		
RIG AUTO HAM.		FOREMAN	DOUG
EXHIBIT:	A-13	JOB #	H1115424

LOG OF BORING NO. B-02

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	CLAYEY FINE SAND tan, loose									
	53.5 **FINE SAND WITH SILT** tan, loose to dense	55	SP SM	13	SS		8	27	10	
		60	SP SM	14	SS		29			
		65	SP SM	15	SS		31			
		70	SP SM	16	SS		20			
	73.5									
	75 **SILTY FINE SAND** tan, medium dense	75	SM	17	SS		28			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	2-13-12		
BORING COMPLETED	2-13-12		
RIG AUTO HAM.		FOREMAN	DOUG
EXHIBIT:	A-13	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-03

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Clarifier No. 11

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown to brown, very loose to loose		SP	1	HA		1*			
			SP	2	HA		4*			
	4 ▼									
	FINE SAND WITH SILT 6 gray to brown, loose	5	SP SM	3	HA		4*			
	JETTED FROM 6' TO 12' FOR UTILITIES	10								
	12									
	13.5 **FINE SAND WITH SILT** gray to brown, medium dense		SP	5	SS		21			
			SM	6	SS		30	27	10	
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, desne to very dense	15	SP SM							
		20	SP SM	7	SS		66			
		25	SP SM	8	SS		61			
	28.5									
	FINE SAND WITH SILT orange-brown, medium dense to dense	30	SP SM	9	SS		28			
		35	SP SM	10	SS		30	31	9	
	38.5									
	SILTY FINE SAND tan, loose to medium dense	40	SM	11	SS		11			
		45	SM	12	SS		7			
		50	SM	13	SS		9			

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL ▽		▼ 3.5	WD
WL ▼		▼	
WL			

NODARSE A Terracon COMPANY

BORING STARTED			2-9-12
BORING COMPLETED			2-9-12
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-14	JOB #	H1115424

LOG OF BORING NO. B-03

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	SILTY FINE SAND tan, loose to medium dense									
		55	SM	14	SS		16			
	58.5 **FINE SAND WITH SILT** gray to brown, medium dense to very dense	60	SP SM	15	SS		21			
		65	SP SM	16	SS		28			
		70	SP SM	17	SS		44			
	75	75	SP SM	18	SS		51			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-9-12
BORING COMPLETED			2-9-12
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-14	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-04

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Clarifier No. 11

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown, very loose ▼		SP	1	HA		1*			
	4		SP	2	HA		3*			
	FINE SAND WITH SILT gray to brown, very loose	5	SP SM	3	HA		3*			
	6 **JETTED FROM 6' TO 12' FOR UTILITIES**	10								
	12									
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, medium dense		SM	5	SS		10			
		15	SM	6	SS		16			
	18.5									
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	20	SP SM	7	SS		72			
		25	SP SM	8	SS		60			
		30	SP SM	9	SS		61			
	33.5									
	SILTY FINE SAND tan, very loose to loose	35	SM	10	SS		WR	31	15	
		40	SM	11	SS		8			
	43.5									
	FINE SAND WITH SILT gray, medium dense	45	SP SM	12	SS		20			
	48.5									
		50	SM	13	SS		24			

Continued Next Page

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-9-12
BORING COMPLETED			2-9-12
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-15	JOB #	H1115424

LOG OF BORING NO. B-04

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %	
	SILTY FINE SAND tan, medium dense	55	SM	14	SS		24				
		60	SM	15	SS		25				
	63.5 **FINE SAND WITH SILT** tan to grayish brown, medium dense	65	SP SM	16	SS		19				
		70	SP SM	17	SS		25				
	73.5 **SILTY FINE SAND** greenish gray, loose	75	SM	18	SS		8	35	26		NP
	78.5 **FINE SAND WITH SILT** gray, trace shell fragments, medium dense to dense	80	SP SM	19	SS		26				
		85	SP SM	20	SS		30				
	88.5 **SILTY FINE SAND** gray, trace shell fragments, dense	90	SM	21	SS		31	38	28		
		95	SM	22	SS		32				
	100	100	SM	23	SS		31				

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-9-12
BORING COMPLETED			2-9-12
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-15	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-05

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Pre-Treatment Structure

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown, loose to medium dense		SP SM	2	HA					
		5	SP	3	SS		5			
			SM SP	4	SS		9			
			SM SP	5	SS		10			
		10	SM							
		13.5								
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	15	SP SM	6	SS		57			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-7-11		
BORING COMPLETED	12-7-11		
RIG	TRUCK	FOREMAN	JOHN C
EXHIBIT:	A-16	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-06

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Pre-Treatment Structure

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown, loose		SP	1	HA					
			SP	2	HA					
		5	SP	3	SS		9			
			SP	4	SS		8			
			SP	5	SS		7			
		10								
	13.5									
	FINE SAND WITH SILT (HARDPAN) reddish brown to dark reddish brown, dense	15	SP SM	6	SS		30			
		20	SP SM	7	SS		39			
	25	25	SP SM	8	SS		38			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			3-28-12
BORING COMPLETED			3-28-12
RIG	MINI	FOREMAN	MARK C
EXHIBIT:	A-17	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-07

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Pre-Treatment Structure

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown, medium dense ▼		SP	1	HA					
			SP	2	HA					
		5	SP	3	SS		18			
			SP	4	SS		11			
	8									
	FINE SAND WITH SILT brown, medium dense		SP SM	5	SS		12			
		10								
	13.5									
	FINE SAND WITH SILT (HARDPAN) dark reddish brown, medium dense to dense		SP SM	6	SS		25			
		15								
			SP SM	7	SS		39			
		20								
	25									
		25	SP SM	8	SS		36			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			3-28-12
BORING COMPLETED			3-28-12
RIG	MINI	FOREMAN	MARK C
EXHIBIT:	A-18	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-08

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Aquadisk Filter

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown	4	SP SM	2	HA					
	FINE SAND light brown, medium dense	5	SP	3	HA					
			SP	4	SS		20			
			SP	5	SS		19			
		10								
		13.5								
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, medium dense to very dense	15	SP SM	6	SS		57	24	6	
		20	SP SM	7	SS		55			
		25	SP SM	8	SS		28			
		30	SP SM	9	SS		27			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-1-11
BORING COMPLETED			12-1-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-19	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-09

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Chlorine Contact Tank

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown, medium dense		SP SM	2	HA					
		5	SP SM	3	HA					
			SP SM	4	SS		19			
			SP SM	5	SS		23			
		10	SP SM							
	13.5									
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, medium dense to very dense		SP SM	6	SS		28			
		15								
			SP SM	7	SS		51			
		20								
			SP SM	8	SS		61			
		25								
	30		SP SM	9	SS		47			
		30								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ N/E	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-1-11
BORING COMPLETED			12-1-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-20	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-10

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Chlorine Contact Tank

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown ▼		SP	1	HA					
			SP	2	HA					
	6	5	SP	3	HA					
	FINE SAND WITH SILT gray to brown, loose		SP SM	4	SS		5			
		10	SP SM	5	SS		6			
	13.5									
	SILTY FINE SAND brown to dark brown, medium dense	15	SM	6	SS		14			
	18.5									
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	20	SP SM	7	SS		61			
		25	SP SM	8	SS		47	24	9	
	28.5									
	30 **FINE SAND WITH SILT** light brown, medium dense	30	SP SM	9	SS		20			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-2-11
BORING COMPLETED			12-2-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-21	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-11

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Chlorine Contact Tank

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown	4	SP SM	2	HA					
	SILTY FINE SAND brown to dark brown	6	SM	3	HA					
	FINE SAND WITH SILT brown, trace root matter, loose	5	SP SM	4	SS		4			
		10	SP SM	5	SS		7			
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, dense to very dense	13.5								
		15	SP SM	6	SS		60			
		20	SP SM	7	SS		43			
		25	SP SM	8	SS		41			
		30	SP SM	9	SS		38			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ N/E	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-2-11
BORING COMPLETED			12-2-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-22	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-12

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Reject Pump Station

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown	4	SP SM	2	HA					
	SILTY FINE SAND brown to dark brown	6	SM	3	HA					
	FINE SAND light brown to brown, loose to medium dense	5	SP	4	SS		10			
			SP	5	SS		9			
		10								
		13.5								
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, dense to very dense	15	SP SM	6	SS		38			
		20	SP SM	7	SS		59			
		25	SP SM	8	SS		41			
		30	SP SM	9	SS		39			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-1-11
BORING COMPLETED			12-1-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-23	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-13

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed West Electrical Building

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown	6	SP SM	2	HA					
		5	SM	3	HA					
	SILTY FINE SAND brown to dark brown, medium dense	13.5	SM	4	SS		14			
		10	SP SM	5	SS		13			
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	15	SP SM	6	SS		50/5"			
		20	SP SM	7	SS		50/6"			
		25	SP SM	8	SS		50/6"			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ N/E	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-2-11
BORING COMPLETED			12-2-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-24	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-14

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed West Electrical Building

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown	6	SP SM	2	HA					
		5	SM	3	HA					
	SILTY FINE SAND brown to dark brown, medium dense	13.5	SM	4	SS		14			
		10	SP SM	5	SS		8			
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	15	SP SM	6	SS		57			
		20	SP SM	7	SS		50/5"			
		25	SP SM	8	SS		50/6"			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 6	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-2-11
BORING COMPLETED			12-2-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-25	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-15

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Supplemental Carbon Building

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown, loose	2	SP	1	SS		6			
	FINE SAND WITH SILT gray to brown, loose ▼		SP SM	2	SS		8			
		5	SP SM	3	SS		7			
			SP SM	4	SS		8			
			SP SM	5	SS		8			
		10	SP SM							
	13.5									
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, desne to very dense	15	SP SM	6	SS		65			
			SP SM	7	SS		47			
		20								
	25	25	SP SM	8	SS		43			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-7-11		
BORING COMPLETED	12-7-11		
RIG	TRUCK	FOREMAN	JOHN C
EXHIBIT:	A-26	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-16

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Supplemental Carbon Building

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown, loose ▼		SP SM	2	HA					
		5	SP	3	SS		6			
			SM SP	4	SS		7			
	FINE SAND brown, medium dense	8	SM SP	5	SS		16			
		10								
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, medium dense to dense	13.5	SM	6	SS		22			
		15								
		20	SM	7	SS		29			
		25	SM	8	SS		38			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-7-11		
BORING COMPLETED	12-7-11		
RIG	TRUCK	FOREMAN	JOHN C
EXHIBIT:	A-27	JOB #	H1115424

LOG OF BORING NO. B-17

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Supplemental Carbon Building

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	4 ▼	SP	1	HA					
			SP	2	HA					
	SILTY FINE SAND brown to dark brown, medium dense	8	SM	3	HA					
			SM	4	SS		12			
	FINE SAND WITH SILT gray to brown, medium dense	13.5	SP SM	5	SS		13			
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, very dense	18.5	SM	6	SS		50/6"			
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	23.5	SP SM	7	SS		50/5"			
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, very dense	25	SM	8	SS		50/6"			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-5-11		
BORING COMPLETED	12-5-11		
RIG AUTO HAM.		FOREMAN	DOUG
EXHIBIT:	A-28	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-18

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Secondary Effluent Diversion Structure

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown, very loose	2	SP	1	HA		3*			
	FINE SAND WITH SILT gray to brown, very loose to medium dense	6	SP SM	2	HA		2*			
	SILTY FINE SAND brown to dark brown, medium dense	13.5	SP SM	3	SS		16			
			SM	4	SS		13			
			SM	5	SS		16			
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, dense	18.5	SM	6	SS		32			
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	25	SP SM	7	SS		76			
			SP SM	8	SS		53			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	MINI	FOREMAN	MARK C
EXHIBIT:	A-29	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-19

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Secondary Effluent Diversion Structure

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown, loose ▼		SP SM	2	HA					
		5	SP SM	3	HA					
			SP	4	SS		6			
		8	SM SP	5	SS		8	17	4	
	FINE SAND brown, loose	10								
		13.5								
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, medium dense to dense	15	SP SM	6	SS		25			
		20	SP SM	7	SS		35			
		25	SP SM	8	SS		36			
		25								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-2-11
BORING COMPLETED			12-2-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-30	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-20

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed Secondary Effluent Diversion Structure

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown	4	SP SM	2	HA					
	FINE SAND light brown, medium dense	5	SP	3	HA					
		8	SP	4	SS		10			
	FINE SAND WITH SILT gray to brown, medium dense	10	SP SM	5	SS		10			
		13.5								
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, dense to very dense	15	SP SM	6	SS		36			
		20	SP SM	7	SS		33			
		25	SP SM	8	SS		66			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 5.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-2-11
BORING COMPLETED			12-2-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-31	JOB #	H1115424

LOG OF BORING NO. B-21

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Proposed RAS/WAS Pump Station

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown, loose	2	SP	1	HA		4*			
	FINE SAND WITH SILT gray to brown, loose	4	SP SM	2	HA		4*			
	SILTY FINE SAND brown to dark brown, medium dense	5	SM	3	SS		8			
		8	SM	4	SS		11			
	FINE SAND WITH SILT gray to brown, medium dense	10	SP SM	5	SS		11			
		13.5								
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, dense	15	SM	6	SS		38			
		20	SM	7	SS		43			
		23.5								
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, very dense	25	SP SM	8	SS		59			
		28.5								
	SILTY FINE SAND orange-brown, trace cemented sands, dense	30	SM	9	SS		34			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	MINI	FOREMAN	MARK C
EXHIBIT:	A-32	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-22

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed RAS/WAS Pump Station

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND WITH SILT gray to brown, very loose to medium dense		SP SM	1	HA		4*			
			SP SM	2	HA		2*			
	6	5	SP	3	SS		14	19	5	
	SILTY FINE SAND brown to dark brown, medium dense 8		SM SM	4	SS		17			
	FINE SAND WITH SILT gray to brown, medium dense		SP SM	5	SS		16			
	13.5	10								
	SILTY FINE SAND (HARD PAN) orange-brown to dark reddish brown, dense	15	SM	6	SS		36			
		20	SM	7	SS		43			
	23.5									
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, medium dense	25	SP SM	8	SS		28			
	28.5									
	30 **SILTY FINE SAND** orange-brown, trace cemented sands, medium dense	30	SM	9	SS		24			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

*Calibrated Hand Penetrometer

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-8-12
BORING COMPLETED			2-8-12
RIG	MINI	FOREMAN	MARK C
EXHIBIT:	A-33	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-23

CLIENT **AECOM Technical Services, Inc**

SITE **Facility Improvements**
Orlando, Florida

PROJECT **Eastern Water Reclamation Facility**

Boring Location: Proposed Secondary Effluent Diversion Structure

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND grayish brown	2	SP	1	HA					
	FINE SAND WITH SILT gray to brown, loose ▼		SP SM	2	HA					
		5	SP SM	3	HA					
			SP SM	4	SS		7			
			SP SM	5	SS		9			
		10	SP SM							
	13.5									
	FINE SAND WITH SILT (HARDPAN) orange-brown to dark reddish brown, dense		SP SM	6	SS		48			
		15								
			SP SM	7	SS		39			
		20								
	25		SP SM	8	SS		45			
		25								

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▼	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			12-1-11
BORING COMPLETED			12-1-11
RIG	MINI	FOREMAN	TRAVIS
EXHIBIT:	A-34	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-24

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Existing Reject Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown, loose to medium dense		SP	1	HA					
			SP	2	HA					
		5	SP	3	HA					
			SP	4	SS		9			
			SP	5	SS		13			
		10								
	15	15	SP	6	SS		21	21	2	

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 6	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-5-11		
BORING COMPLETED	12-5-11		
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-35	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-25

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Existing Reject Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown, loose to medium dense ▼		SP	1	SS		16			
			SP	2	SS		7			
		5	SP	3	SS		19			
			SP	4	SS		17			
			SP	5	SS		19			
		10								
	15	15	SP	6	SS		27			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 3	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			3-28-12
BORING COMPLETED			3-28-12
RIG	MINI	FOREMAN	MARK C
EXHIBIT:	A-36	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

LOG OF BORING NO. B-26

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Existing Reject Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown, loose to medium dense		SP	1	HA					
			SP	2	HA					
		5	SP	3	HA					
			SP	4	SS		7			
			SP	5	SS		10			
		10								
	15	15	SP	6	SS		13			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-5-11		
BORING COMPLETED	12-5-11		
RIG AUTO HAM.		FOREMAN	DOUG
EXHIBIT:	A-37	JOB #	H1115424

LOG OF BORING NO. B-27

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Existing Reject Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown, loose ▼		SP	1	HA					
			SP	2	HA					
		5	SP	3	HA					
			SP	4	SS		5			
			SP	5	SS		4	23	5	
		10								
	13.5									
	15 **FINE SAND WITH SILT** gray to brown, medium dense	15	SP SM	6	SS		10			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL ▽	▼ 5	WD	
WL ▼	▽		
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-5-11		
BORING COMPLETED	12-5-11		
RIG AUTO HAM.		FOREMAN	DOUG
EXHIBIT:	A-38	JOB #	H1115424

LOG OF BORING NO. B-28

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Existing Reject Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown, loose to medium dense ▼		SP	1	SS		4			
			SP	2	SS		5			
		5	SP	3	SS		18			
			SP	4	SS		23			
			SP	5	SS		25			
		10								
	13.5									
	15 **FINE SAND WITH SILT** gray to brown, medium dense	15	SP SM	6	SS		29	16	5	

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 4	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED	12-5-11		
BORING COMPLETED	12-5-11		
RIG AUTO HAM.		FOREMAN	DOUG
EXHIBIT:	A-39	JOB #	H1115424

LOG OF BORING NO. B-29

CLIENT
AECOM Technical Services, Inc

SITE
Facility Improvements
Orlando, Florida

PROJECT
Eastern Water Reclamation Facility

Boring Location: Existing Reject Pond

GRAPHIC LOG	DESCRIPTION	DEPTH, ft.	USCS SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY, in.	SAMPLES SPT - N BLOWS / ft.	TESTS WATER CONTENT, %	TESTS FINES CONTENT %	TESTS ORGANIC CONTENT, %
	FINE SAND light gray to brown		SP	1	HA					
			SP	2	HA					
	4	5	SP SM	3	HA			3	8	
	FINE SAND WITH SILT brown to dark brown, medium dense ▼		SP SM	4	SS		10			
			SP SM	5	SS		13			
		10								
	15	15	SP SM	6	SS		16			

The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft			
WL	▽	▼ 7.5	WD
WL	▼	▽	
WL			

NODARSE
A Terracon COMPANY

BORING STARTED			2-6-12
BORING COMPLETED			2-6-12
RIG	AUTO HAM.	FOREMAN	DOUG
EXHIBIT:	A-40	JOB #	H1115424

BOREHOLE 99 H1115424 - 8-7-12.GPJ TERRACON.GDT 8/7/12

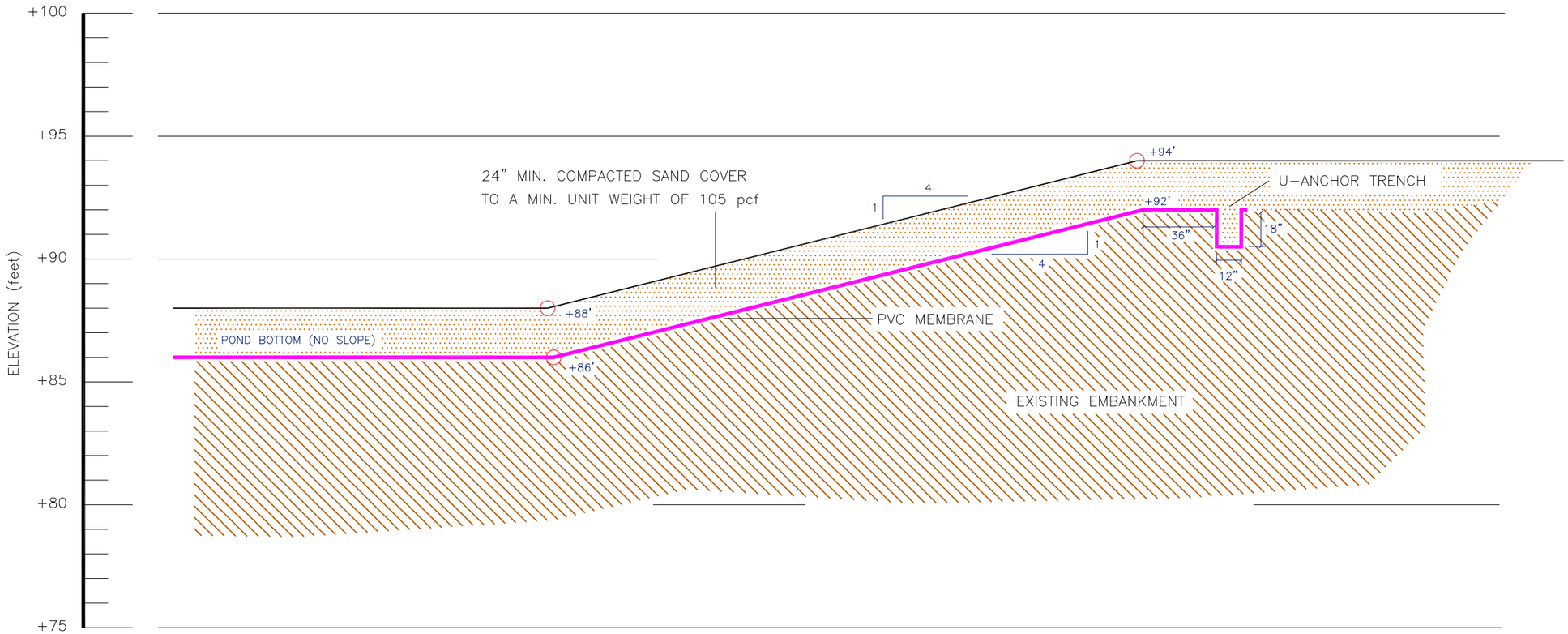
Soil Survey Descriptions

3 – Basinger fine sand, depressional. This soil type is nearly level and poorly drained. It is typically found in shallow depressions and sloughs along edges of freshwater marshes and swamps. In its natural state, water stands on the surface of this soil type for 6 to 9 months during most years and is within 12 inches of the surface for the rest of the year. This soil type is sometimes associated with a surficial organic layer, typical thickness of 7 inches, typical organic contents of between 1 and 8 percent. Typical permeability rates for this soil type generally range from 6 to 20 inches per hour (12 to 40 feet per day) throughout the defined profile of 80 inches (6.7 feet).

34 – Pomello fine sand, 0 to 5 percent slopes. This soil type is nearly level to gently sloping and moderately well drained. It is typically found on low ridges and knolls on the flatwoods. In its natural state and during years of normal rainfall, this soil type has a seasonal high water table at a depth of between 20 and 40 inches (1.7 and 3.3 feet) for 1 to 4 months, receding to a depth of 40 to 60 inches (3.3 to 5.0 feet) during dry periods. Typical permeability rates for this soil type are greater than 20 inches per hour (40 feet per day) between the surface and a typical depth of 40 inches.

37 – St. Johns fine sand. This soil type is nearly level and poorly drained. It is typically found on broad flats on the flatwoods. In its natural state and during years of normal rainfall, this soil type has a seasonal high water table within 10 inches (0.8 feet) of the surface for 6 to 12 months, receding to a depth of 10 to 40 inches (0.8 to 3.3 feet) for more than six months. This soil type is predominantly sandy from the surface to a depth of 24 inches (2.0 feet), and again from a depth of 44 inches (3.7 feet) to the maximum defined depth of 80 inches (6.7 feet). Between depths of 24 and 44 inches (2.0 and 3.7 feet), this soil type exists as fine sand with silt to silty sand. Typical permeability rates for this soil type generally range from 6 to 20 inches per hour (12 to 40 feet per day) throughout the defined profile of 80 inches (6.7 feet), except between depths of 24 and 44 inches where permeability generally ranges from 0.2 to 2 inches per hour (0.4 to 4 feet per day).

44 – Smyrna fine sand. This soil type is nearly level and poorly drained. It is typically found on broad flatwoods. In its natural state and during years of normal rainfall, this soil type has a seasonal high water table within 10 inches (0.8 feet) of the surface, receding to a depth of 10 to 40 inches (0.8 to 3.3 feet) for more than six months. Typical permeability rates for Smyrna fine sand generally range from 6 to 20 inches per hour (12 to 40 feet per day); between typical depths of 17 inches and 27 inches (1.4 and 2.3 feet) the permeability rates range from 0.6 to 6 inches per hour (1.2 to 12 feet per day).



PVC POND LINER DETAIL
EASTERN WATER RECLAMATION FACILITY
PHASE V IMPROVEMENTS
ORANGE COUNTY, FLORIDA

DRAWN: SW	NODARSE A Terracon COMPANY	
CHKD: AMR S.		
SCALE: NOTED		
DATE: 8-9-12	PROJ. No. H1115424	EXHIBIT: A-42

APPENDIX B
SUPPORTING INFORMATION

Laboratory Testing

During the field exploration, a portion of each recovered sample was sealed in a glass jar and transported to our laboratory for further visual observation and laboratory testing. Selected samples retrieved from the borings were tested for moisture (water) content, fines content (soil passing a US standard #200 sieve), Atterberg limits, and laboratory permeability. Those results are included in this report and on the respective boring logs. The visual-manual classifications were modified as appropriate based upon the laboratory testing results.

The soil samples were classified in general accordance with the appended General Notes and the Unified Soil Classification System based on the material's texture and plasticity. The estimated group symbol for the Unified Soil Classification System is shown on the boring logs and a brief description of the Unified Soil Classification System is included in Appendix C. The results of our laboratory testing are presented in the Laboratory Test Results section of this report and on the corresponding borings logs.

Permeability testing was performed on undisturbed samples obtained from adjacent to Boring AB-1 and Boring AB-4, from between depths of 3 and 3.5 feet below existing grade respectively, the presumed subgrade soils for the proposed stormwater management pond. The undisturbed samples were measured for approximate in-place relative density of the sampled soil, and water was allowed to flow into the soil sample until the sample was apparently saturated. Once saturated, water flow was halted and incremental drops in the supply water level were timed.

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-$^3/_8$" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube – 2" O.D., 3" O.D., unless otherwise noted	PA:	Power Auger (Solid Stem)
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB	Wash Boring or Mud Rotary

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	N/E:	Not Encountered
WCI:	Wet Cave in	WD:	While Drilling	ESH:	Estimated Seasonal High Groundwater
DCI:	Dry Cave in	BCR:	Before Casing Removal	ESL:	Estimated Seasonal Low Groundwater
AB:	After Boring	ACR:	After Casing Removal		

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 – 1	Very Soft
500 – 1,000	2 – 4	Soft
1,000 – 2,000	4 – 8	Medium Stiff
2,000 – 4,000	8 – 15	Stiff
4,000 – 8,000	15 – 30	Very Stiff
8,000+	> 30	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 50	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	≥ 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75 to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 – 10
Medium	11 – 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

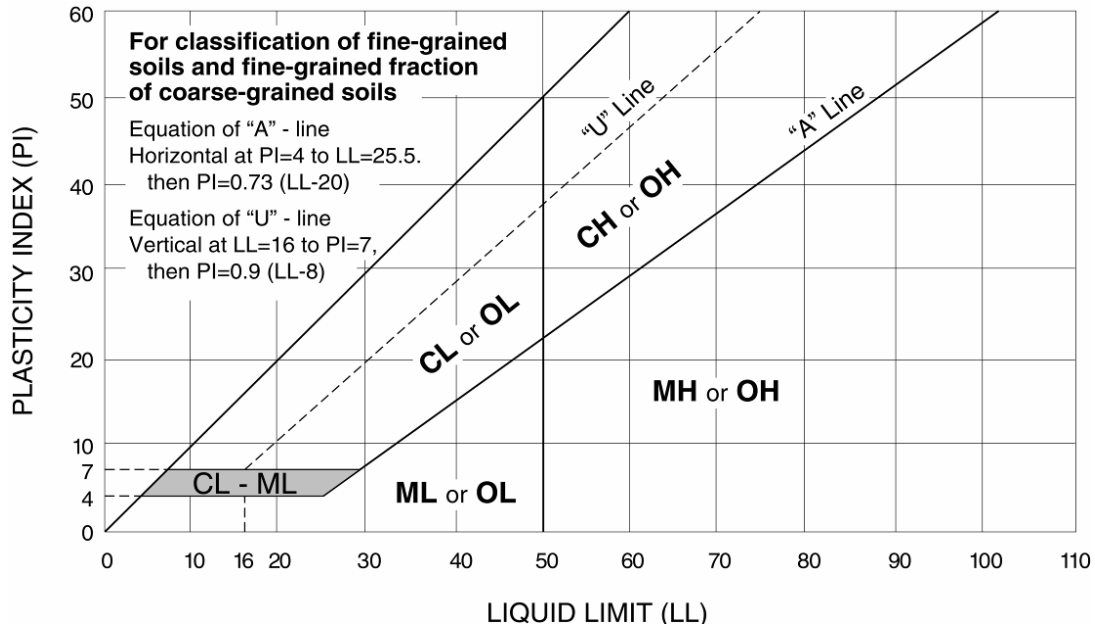
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



NODARSE
A Terracon COMPANY

Exhibit C-2

Attachment C – Hydro-International Inc. Grit Removal System, November 4, 2013

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11/04/13

To: **AECOM**

Re: **Grit Removal, Washing & Dewatering System & Recessed Impeller Grit Pumps**
Sections 11320 & 11314
Eastern WRF
Orange Co., FL
File #01-0390

Hydro International is pleased to present our quote for a Eutek HeadCell® Grit Removal, Classification, Washing, and Dewatering System. The system will meet the requirements described in Sections 11320 & 11314 with comments noted below.

Comments / Exceptions

1. Screening with a 3/4 inch opening or better is necessary prior to the Hydro equipment.
2. Please see the exclusions detailed in the proposal below.

System Components

1. Three (3) 12' 13 tray Eutek HeadCell® Grit Concentrator units shall be supplied. Each Eutek HeadCell® shall consist of a stack of nested trays. The trays shall be fabricated from UV stabilized LDPE and shall be supported by a 316 SS frame integral to the unit. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials. The Eutek HeadCell® trays shall be constructed with a minimum ¼ inch material pans and sidewalls. The Tray Supports shall be fabricated to provide a means to independently support each tray and transfer the weight of each tray to the support structure frame. The Eutek HeadCell® will securely fit into a support structure frame containing the screened raw wastewater inlet connection, necessary hardware, and connections. The Eutek HeadCell® Concentrator shall be equipped with a settled solids underflow connection for collection and removal of settled solids. The settled solids are pumped to the Eutek SlurryCup™ Grit Washing units from each Eutek HeadCell® units.

   Each unit shall remove 95% of all grit (S.G. 2.65) 106 micron and larger at a peak flow of 26.7 mgd. Each unit shall have 12 inches of headloss at the peak flow.

2. Four (4) 32" Eutek SlurryCup™ Solids Classifier units shall be provided. Each Eutek SlurryCup™ unit shall be fabricated from 316 SS and be self-standing and mounted on a support structure above the Eutek Grit Snail® clarifier to provide clearance between the bottom of the grit underflow pipes and the Dewatering Unit clarifier surface. Each unit shall have one (1) 6" flanged inlet connection and one (1) 8" flanged outlet connection. Flanges will be rotatable and conform to ANSI B16.1 bolt patterns. Each unit shall have one (1) - 1.5" grit underflow connection, one (1) - 3" threaded drain connection, and one (1) - 1.5" NPT fluidizing water for the Hydraulic Valve. Exterior surfaces shall be acid washed and bead blasted to a uniform finish.

   Each unit shall remove 95% of all grit (S.G. 2.65) 75 micron and larger at flow of 280-400 gpm and a solids concentration not to exceed 1.0%. Each unit shall have a headloss of 15 ft at a flow rate of 300 gpm.

3. Two (2) 4.0yd^3/hr Eutek Grit Snail® continuous dewatering units shall be supplied. Each unit shall be equipped with a 24" wide rubber belt, 72" square clarifier, and a 1/3 hp inverter duty motor. One (1) 6" flanged overflow discharge connection and one (1) 3" flanged drain connection shall be supplied.

Flanges will be rotatable and conform to ANSI B16.1 bolt patterns. Each unit shall be fabricated from 316 SS. The support structure at the head end shall be an A-frame.

Each unit shall remove 95% of all grit (S.G. 2.65) 75 micron and larger with less than 15% volatile solids and greater than 60% total solids.

4. Five (5) Hayward Gordon TORUS XR3-11 horizontal mount recessed impeller grit pumps shall be supplied for distribution of the Eutek HeadCell® underflow to the Eutek SlurryCup™ unit. Each pump shall have a Ni-hard (650 BHN) impeller, casing and wear plate, John Crane Type 1 single mechanical seal (SC faces). The motor shall be 15 hp, 1800 rpm, TEFC, 3 phase, 60 hertz, 480 volt. The pump uses a fixed speed V-belt and accommodates 0.5 to 2.0% solids concentrations.

5. Two (2) main control panel shall be supplied. Each control panel shall have a NEMA 4X 316 stainless steel enclosure, and shall be rated at three phase, 480 VAC, 60 hz. Each panel shall be relay logic and contain all relays, timers, switches, variable frequency drive, and indicator lights to operate two (2) Eutek SlurryCup™ units, one (1) Eutek Grit Snail® unit and three (3) grit pumps in either fully automated or manual mode. Grit pump starters are to be supplied by others and located remote from Hydro's panels.

    a. Additionally, two (2) NEMA 4X local control stations shall be supplied for the Eutek Grit Snail® units.

Utility Requirements

Clarified NPW or Reuse Water:

Each Eutek HeadCell® unit requires continuous 20 gpm @ 50 +/- 10 psig of clarified water for "fluidizing" to function properly.

Each Eutek SlurryCup™ unit requires continuous 30 gpm @ 50 +/- 10 psig of clarified water to function properly.

Each Eutek Grit Snail® unit requires continuous 20 gpm @ 50 +/- 10 psig of clarified water for tail roll and belt rinse.

Each Eutek SlurryCup™ requires an additional intermittent 47 gpm @ 50 psig of clarified water for fluidizing and backwashing for 1-2 minutes every 2-4 hours.

Appurtenances Per Unit

Eutek HeadCell® Grit Concentrator

DESCRIPTION	QTY
Fluidizing Water Throttling Globe Valve 1” Globe Valve, Stainless Steel	1
Fluidizing Water Shut-off Valve 1” Ball Valve, Stainless Steel	1
Fluidizing Water Flow Meter 1” 4-80 Flow Meter, Stainless Steel	1
Pressure reducing valve, wye-strainer	1

Eutek SlurryCup™ Washing Unit

DESCRIPTION	QTY
Supply Water Flow Meter 1-1/2” Flow Meter, 3.5-35 gpm	1
Manual System Shut-Off Valve 1-1/2” Ball Valve, Stainless Steel	1
Supply Water Throttling Globe Valve 1-1/2” Globe Valve, Stainless Steel	1
Backwash Water Valve and Supply Water Shut-off 1-1/2” Solenoid Valve (NEMA 4X, 120VAC)	2
System Water Supply Pressure Gauge 0-100psi, w/ Diaphragm Seal	1
Inlet Pressure Gauge 0-30psi, w/ Diaphragm Seal	1
Backwash Pressure Gauge 0-30psi, w/ Diaphragm Seal	1
Gauge Isolation Valves ¼” Ball Valve, Stainless Steel	3
Pressure reducing valve, wye-strainer	1

Eutek Grit Snail® Dewatering Unit

DESCRIPTION	QTY
Rinse water Valve 1” Solenoid valve, Stainless Steel (NEMA 4X, 120VAC)	1
Manual Water and Tail Rinse Shut-off Valve 1” Ball Valve, Stainless Steel	2
Tail Rinse Flow Meter 1" Flow Meter, 1-10 gpm, Stainless Steel	1
Tail Rinse Throttling Valve 1” Globe Valve, Stainless Steel	1

Rinse Bar Shutoff Valves ¾" Ball Valve, Stainless Steel	1
Drain Valve 3" Eccentric Plug Valve, Cast Iron	1
Inductive Proximity Sensor	1
Inverter Duty Drive Motor 1/3 hp, 3 phase 230/460 VAC Motor, TENV	1
Gear Reducer	1

Spare Parts

The following control panel spare parts will be supplied:

1. 20% of each fuse size and type used
2. One (1) spare relay and relay socket for every ten (10) used
3. One (1) spare panel mounted lights and switches for every ten (10) used and 10 spare bulbs/colored lenses.
4. 20% of each size of power supply (minimum one).
5. 10 of each type of vapor capsule

Start-up

One (1) man, two (2) trips, for start-up and instruction services as required totaling four (4) days.

Anchorage Analysis

Seismic anchorage and bracing calculations in accordance with specification section 11320.Part 2.J.

Exclusions

Any item(s) not specifically described above are excluded and are not to be supplied by Hydro International including but not limited to the following:

- Erection and installation
- Interconnecting piping and valving not expressly stated above
- Pipe connections and fittings not expressly stated above
- All pipe supports, hangers and braces
- Controls, switches, control panels and instrumentation of any kind not expressly stated above
- Wiring and conduit
- Field or touch-up paint, painting, blasting and touch-up of surface finish
- Spare parts not specifically stated above
- Unloading, hauling and storage charge
- Lubricating oil and greases
- Field performance testing, laboratory testing and sample collection and analysis
- All concrete and grouting work
- Insulation and heat tracing of any kind
- Dumpsters of any kind
- Grit pump motor starters/VFD, associated piping and valving
- Access platforms, walkways, ladders, covers
- Anchor bolts
- Grit Study
- Extended discharge chutes

Limitations

- General Liability is limited to $2,000,000 per each occurrence
- Products Completed & Operations Liability is limited to $2,000,000 per each occurrence
- Worker's Compensation is limited to $1,000,000 per each accident

Warranty
Hydro International's Warranty shall cover a period of 3 years starting from the date of substantial completion.

Delivery
Please allow 4 weeks after receipt of purchase order for approval drawings. Shipment is typically a maximum of 16 weeks after receipt of "Approved" or "Approved As Noted, Resubmittal Not Required" submittal package. The grit removal system shall be delivered to site fully fabricated, subject to size, packaging and transportation constraints. The General Contractor shall inspect equipment prior to unloading and notify Hydro International of any damage to equipment to effect proper remedial action. Failure to notify Hydro International of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.

Terms & Conditions
Hydro International payment terms are detailed in the attached terms and conditions. The pricing submitted herein is based on specification sections and drawings issued to Hydro from PMA Consultants, October 17, 2013. Any changes to the scope of supply required by changes to these specification sections or other sections and drawings not provided to Hydro International as listed above may require the price to change. Hydro International reserves the right to amend the price if changes are required due to changes to the provided specifications or to meet requirements for sections not made available at the time of this quote. Price includes truck freight to jobsite and does not include any state or local taxes if required. The prices quoted are firm based on a receipt of a purchase order by June 30, 2014.

Purchase Price: $1,689,000.00

Purchase Order
Please make purchase orders to:
Hydro International
2925 NW Aloclek Drive
Suite #140
Hillsboro, OR 97124

Local Representative
Mr. Brian Schuette
Moss-Kelley, Inc.
725 Primera Blvd., Suite 155
Lake Mary, FL 32746
Ph: (407) 805-0063
Fx: (407) 805-0062
bks@mosskelley.com

If you have any questions or concerns, do not hesitate to contact me.

Regards,
Hydro International

Sr. Applications Engineer

Standard Terms & Conditions of Sale

1. **DEFINITIONS**. "Hydro" is Hydro International with an address of 2925 NW Aloclek Drive #140 in Hillsboro, Oregon. "Buyer" is the party purchasing the goods from Hydro.

2. **ENTIRE AGREEMENT.** Hydro's agreement is based on these terms and conditions of sale. This document, together with any additional writings signed by Hydro, represents a final, complete, and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained, or waived by parol evidence, Buyer's purchase order, any course of dealing, Buyer's payment or acceptance, or in any other way except in writing signed by Hydro through its authorized representative. These terms and conditions are intended to cover all activity of Hydro and Buyer hereunder, including sales and use of products, parts, and work, and all related matters (references to products include parts and references to work include construction and installation). Hydro's obligations hereunder are expressly conditioned on Buyer's assent to these terms and conditions. Hydro objects to any terms that are different from, or additional to, these terms and conditions. Any applicable detail drawings and specifications are hereby incorporated and made a part of these Terms and Conditions of Sale insofar as they apply to the material supplied hereunder.

3. **SPECIFICATIONS.** Products are supplied in accordance with information received by Hydro, or its duly authorized agent, from Buyer. Hydro shall have no responsibility for products created or sold based upon inaccurate and/or incomplete information supplied to it. Buyer shall ensure that Hydro receives all relevant information in time to enable it to supply the appropriate products.

4. **INSTALLATION AND APPLICATION OF PRODUCTS.** Products supplied hereunder shall be installed and used only in the particular application for which they were specifically designed. Buyer should not presume that any products supplied by Hydro may be utilized for any applications other than those specified; nor shall Hydro's obligations, including, without limitation, any warranty obligations, survive Buyer's transfer of products supplied hereunder to third parties unless the products are transferred with Hydro's consent. In addition, Buyer shall not use any product supplied hereunder at any location other than at the location for which Hydro has previously received notice from Buyer. Any breach of any of the foregoing restrictions may amount to an infringement of the patent for the products in question and will in any event void all express or implied warranties relating to the products supplied hereunder.

5. **PURCHASE PRICE AND PAYMENT TERMS.** All prices are in U.S. dollars and all payments shall be made in U.S. dollars. Payment terms are as follows:

	Incremental Payment	Cumulative Payment
Upon Approval of Shop Drawings	10%	10%
Upon Delivery of Equipment to Site	80%	90%
Upon Final Acceptance or 45 days following completion of equipment start up	10%	100%

If payments are not made in conformance with the terms stated herein, any unpaid balance shall be subject to interest at a rate 1½% per month, but not to exceed the maximum amount permitted by law. If shipment is delayed by Buyer, the previously agreed date of readiness for shipment shall be deemed to be the date of shipment for payment purposes. If manufacture is delayed by Buyer, a payment shall be made based on purchase price and percentage of completion, with the balance payable in accordance with the terms as stated. If at any time in Hydro's judgment Buyer may be or may become unable or unwilling to meet the terms specified, Hydro may require satisfactory assurance or full or partial payment as a condition to commencing, or continuing manufacture, or in advance of shipment.

Until payment in full has been received by Hydro, this Standard Terms and Conditions of Sale shall constitute a security agreement and Buyer hereby grants Hydro a purchase money security interest in and to the products produced by Hydro hereunder, and any products or proceeds thereof. In particular:

(i) Hydro will retain an express purchase money security interest in and to the products and all proceeds thereof.

(ii) Until full payment for the products is received by Hydro, Hydro reserves the right to retake possession of the products at any time and for this purpose Buyer authorizes Hydro or its duly authorized agent to enter upon land or premises where it believes the product may be.

(iii) Proceeds of any disposal of the products shall be held in trust for Hydro pursuant to the terms of the Maine Uniform Commercial Code.

(iv) Buyer grants Hydro a power of attorney for the purpose of filing a UCC-1 financing statement in the name of Buyer to evidence Hydro's security interest in the products.

6. **BACKCHARGES.** In the event that Buyer is required to make repairs, corrections or modifications to the goods supplied by Hydro, it shall only do so upon written approval from Hydro. Backcharges shall be limited to the costs directly associated in making the repairs, corrections or modifications to the goods supplied by Hydro. The costs of such backcharges shall be subject to approval by Hydro and shall be limited to: (1) directly related labor and material costs, (2) directly related equipment and tool rental at prevailing rates in the project location and (3) Buyer's overhead & supervision costs to make repairs, corrections or modifications to the goods

supplied by Hydro. Buyer shall submit complete documentation to Hydro's satisfaction including but not limited to labor time sheets, material lists, and rental fees detailing the nature of the back charges. Backcharges shall be in the form of an adjustment to the contract price or reduction in retained payments and not a direct payment. No incidental or consequential backcharges shall be allowed.

7. **DELIVERY.** The goods are sold F.O.B. manufacturing site, freight prepaid to Buyer at job site. Except as outlined in Paragraph 8 below, the risk of loss passes to Buyer after Hydro delivers the goods to the carrier. Hydro reserves the right to select the method of shipment and carrier. Delivery dates are approximate only and are not a guarantee of delivery on a particular day. Hydro is not liable for failure or delays in deliveries of any cause whatsoever beyond the control of Hydro.

8. **TITLE & INSURANCE:** Title to the product(s) and risk of loss or damage shall pass to Buyer upon delivery to a carrier as outlined in Paragraph 7 above, or, in the event Buyer delays shipment, by the previously agreed date of readiness for shipment, except that a security interest in the product(s) or any replacement shall remain in Hydro's name, regardless of the mode of attachment to realty or other property, until the full price has been paid in cash. Buyer agrees to protect Hydro's interest by adequately insuring the product(s) against loss or damage from any external cause with Hydro named as insured or co-insured.

9. **ERECTION:** Unless otherwise stated in writing, the goods provided hereunder shall be assembled and erected by and at the expense of Buyer.

10. **CANCELLATION & BREACH:** Orders placed cannot be canceled, nor shipments of goods made up, or in process, be deferred beyond the original shipment dates specified, except with Hydro's written consent and upon terms which shall indemnify Hydro against all loss. In the event of cancellation or the substantial breach of Buyer's obligations, as by failing to make any of the payments when due, the parties agree that Hydro will suffer a serious and substantial damage that will be difficult, if not impossible, to measure, both as of the time of entering into this purchase agreement and as of the time of such cancellation or breach. Therefore, the parties agree that, upon such cancellation or breach, Buyer shall pay to Hydro the sums set forth herein below, which sums the parties do hereby agree shall constitute agreed and liquidated damages in such event:

    - If cancellation or breach shall occur after the acceptance of the purchase order but prior to mailing of submittal documents by Hydro to Buyer, liquidated damages shall be 10% of the selling price.
    - If cancellation or breach shall occur within thirty (30) days from the mailing of submittal documents by Hydro to Buyer, the liquidated damages shall be 20% of the selling price.
    - If the cancellation or breach occurs after thirty (30) days from the mailing of submittal documents by Hydro to Buyer, but prior to notification that the order is ready for shipment, the liquidated damages shall be the total of 30% of the selling price plus the expenses incurred, cost of material, and reasonable value of the work expended to fill the order involved herein by Hydro's engineers and other employees, agents and representatives after the mailing of general arrangement drawings by Hydro to Buyer, said sums to be determined at the sole reasonable discretion of Hydro; provided, however, that the total liquidated damages under this provision shall not exceed the total selling price.
    - If cancellation or breach shall occur after Hydro has notified Buyer that the order is ready for shipment, then the liquidated damages shall be the total selling price, less costs associated with startup or field testing.

11. **MATERIALS OF CONSTRUCTION, PAINTS AND COATINGS:** Buyer is responsible for determining the suitability of, and for giving final approval of, the materials of construction, paints, coatings, etc. to be used by Hydro.

12. **WARRANTY:** Any product that proves defective in material, workmanship or design within three (3) years after delivery (or entry into storage) will be, at the discretion of HYDRO, modified, repaired or replaced, or Buyer's payment for the products will be refunded. This shall be Buyer's sole remedy. HYDRO EXPRESSLY EXCLUDES AND DISCLAIMS ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTIES, EXPRESS OR IMPLIED.

    This warranty does not cover any defects or costs caused by: (1) normal wear and tear of equipment from designed operation. (2) modification, alteration, repair or service of the goods by anyone other than Hydro; (3) physical abuse to, or misuse of, the goods, or operation thereof in a manner contrary to Hydro's instructions; (4) any use of the goods other than that for which they were intended; (5) chemicals or components which were not disclosed to Hydro; (6) storage contrary to Hydro's instructions; or (7) failure to maintain the goods in accordance with Hydro's instructions.

    This warranty does not apply to component parts of the goods that were not both originally designed and manufactured by Hydro, including, but not limited to, valves and controls. These component parts do not carry any warranties by Hydro, and only carry the warranties, if any, of their manufacturers.

    In order for Buyer to make a claim under this warranty, Buyer must promptly, and within the warranty period, notify Hydro in writing of any defect(s) in the goods covered by this warranty. If any defect(s) in the goods covered by this warranty are visible at the time of delivery, Buyer must notify Hydro of the defect(s) in writing within five working days. To make any claim under this warranty, Buyer must also fully comply with written authorization and return instructions from Hydro.

13. **FIELD SERVICE:** Startup/Field Service will only be scheduled upon written request. Buyer shall notify Hydro of schedule requirements at least ten (10) working days in advance, or additional charges may be added to cover late-scheduled travel costs. Additional costs will be limited to those arising out of late-scheduled costs. Should Buyer have outstanding balances due Hydro, no startup / field service will be scheduled until such payments are received by Hydro. Hydro will send documents to Buyer defining the service or startup requirements. Buyer assumes all responsibility for the readiness of the system when it requests startup service. Should Hydro's Field Service Engineer arrive at the jobsite and determine that the system cannot be started up within a reasonable

time, Hydro shall have the option to bring the Field Service Engineer home and bill Buyer for time, travel and living expenses. Additional field service is available from Hydro at the prevailing per-diem rate at the time of the request for service plus all travel and living expenses, portal-to-portal. A purchase order or change order will be required prior to scheduling this additional service.

14. **LIMITATION OF HYDRO'S LIABILITY.** Hydro assumes no liability or responsibility for the misuse of its products by Buyer, Buyer's employees, agents or assigns, or other use inconsistent with the use appropriate to the performance specification requirements submitted to Hydro, and Buyer agrees to indemnify and hold harmless Hydro for any loss, costs, expense or liability that it may incur or be put to as a result of misuse or inconsistent use of the products. In addition, Hydro shall have no liability to Buyer for any consequential or incidental damages incurred by Buyer in connection with the contract documents or the products purchased by Buyer. Hydro shall not be liable for any loss which results from delay in delivery caused by any reason beyond its control, including, but not limited to, acts of God, casualty, civil disturbance, labor disputes, strikes, transportation or inability to obtain materials or services, any interruption of its facilities, or act of any governmental authority. The time for delivery shall be extended during the continuance of such conditions. The total liability of Hydro to Buyer in the form of liquidated damages for any loss, indemnity, damage or delay of any kind will not under any circumstances exceed 25% of the Contract Sum.

15. **INTELLECTUAL PROPERTY.** Hydro shall retain sole ownership of all of its intellectual property used or produced in connection with the Project, including but not limited to all drawings, specifications, software, written materials, manuals, marks, business methods, and all other property that is capable of protection by a patent, copyright or trademark (whether or not such protection has actually been sought). Buyer shall not use such intellectual property except for the purpose of confirming the quality of design and/or manufacturing of the products and services set forth in the Proposal. Buyer shall not photocopy, duplicate or in any way copy such intellectual property except for the Buyer's internal purposes only (but not for rendering services or selling products to third persons). Buyer shall not sell, license, assign or transfer the intellectual property protected by this paragraph to anyone. Buyer shall ensure that Owner is in possession of valid licenses for all third-party software (not provided by Hydro) used for the Project, and shall indemnify and hold harmless Hydro against all claims by licensors of such software. Hydro makes no warranty regarding the effect of such third-party software on the performance of the software to be developed by Hydro for the Project and Hydro shall be released from any warranties given to Buyer to the extent that such software causes or contributes to problems. Following acceptance and final payment to Hydro, Hydro will grant to the Owner a non-transferable, non-exclusive license to use the software for the Owner's internal purposes only in the form of the license agreement attached as Exhibit A.

16. **TAXES.** Prices stated herein do not include any tax, excise, duty or levy now or hereafter enacted or imposed, by any governmental authority on the manufacture, sale, delivery and/or use of any item delivered. An additional charge will be made therefore and paid by Buyer unless Hydro is furnished with a proper exemption certificate relieving Hydro of paying or collecting the tax, excise, duty or levy in question.

17. **INTERPRETATION OF CONTRACT.** This contract shall be construed according to the laws of the State of Maine.

18. **CHOICE OF FORUM.** Buyer and Hydro hereby consent and agree that the United States District Court for the District of Maine or the District Court or Superior Court located in the City of Portland, County of Cumberland, Maine will have exclusive jurisdiction over any legal action or proceeding arising out of or relating to the contract documents, and each party consents to the personal jurisdiction of such Courts for the purpose of any such action or proceeding. Buyer and Hydro further hereby consent and agree that the exclusive venue for any legal action or proceeding arising out of or relating to the contract documents will be in the County of Cumberland, Maine. Each party hereby waives all rights it has or which may hereafter arise to contest such exclusive jurisdiction and venue.

19. **ATTORNEYS' FEES.** If any judicial or non-judicial proceeding is initiated for the purpose of enforcing a provision of this contract, the prevailing party shall be awarded reasonable attorneys' fees in addition to all other costs associated with the proceeding, whether or not the proceeding advances to judgment.

20. **SEVERABILITY.** If any provisions of this contract are held invalid by a court of competent jurisdiction, the remainder of this contract shall not be rendered invalid, and such invalid provisions shall be modified, in keeping with the letter and spirit of this contract, to the extent permitted by applicable law so as to be rendered valid.

21. **ANTI-BRIBERY.** Hydro International will not engage in any form of bribery or corruption. The offering, giving or receiving of bribes is contrary to Hydro International's values and can play no part in the way in which it carries out its business. Hydro requires you to support our approach and implement provisions consistent with our policy through your own organization and your supply chain. Please find a copy of our Anti-Bribery and Corruption Policy on our website at http://plc.hydro-intl.com/content/view/296/247/