

Invitation for Bid 37744

TECHNICAL
SPECIFICATIONS
ISSUED FOR BID

Black Creek Water Resource Development Project Intake and Pump Station (Contract II)

St. Johns River Water
Management District

May 2022



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SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.01 OWNER/DISTRICT

- A. Throughout these Contract Documents, the term “District” shall refer to the St. Johns River Water Management District.

1.02 LOCATION OF WORK

- A. The work of this Contract is located in southwest Clay County (Florida) on the north side of State Road (SR) 16 approximately 2.4 miles west of Penny Farms. As shown in the Contract Documents, the work consists of the construction of a raw water intake and pump station to draw water from the South Fork of Black Creek. The intake and pump station are located immediately west of SR 16 crossing of Black Creek.

1.03 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, tools, services and incidentals required and complete all work required by these Specifications and as shown on the Drawings.
- B. The scope of work for this contract includes but is not necessarily limited to, the following:

1. Site Work including, but not limited to:

- a. Erosion and sedimentation control
- b. Clearing and grubbing
- c. Yard piping and valves
- d. Microtunneling (42-inch casing pipe/24-inch carrier pipe) including temporary entry and receiving pits
- e. Site restoration including grassing, and other restoration
- f. Grading and drainage
- g. Asphalt driveway
- h. Chain link fencing and cantilevered slide gate
- i. Segmented block retaining walls
- j. Cast-in-place retaining wall
- k. Precast privacy wall

2. Construction of a raw water intake system including, but not limited to:

- a. Temporary coffer cell
- b. Raw water intake structure and raw water intake screens
- c. Piping, valves, and appurtenances
- d. Intake screens air backwash system

3. Construction of the new pump station including, but not limited to:

- a. Pump station masonry building
- b. Four vertical turbine pumps driven by variable frequency drives

- c. Pump suction cans
 - d. Mechanical piping and valves
 - e. Magnetic flow meter
4. Construction of the new masonry block electrical building.
 5. All instrumentation and electrical components including but not limited to conduit, wire, electric motors, control panels, variable frequency drives, motor control centers, and field instruments
 6. Operational and maintenance manuals for all equipment
 7. Equipment and services for acceptance testing
 8. Warranties and bonds
 9. All testing required during construction and startup
 10. All other work in these contract documents not covered by the items listed above.
- C. Substantial Completion: To satisfy the definition of Substantial Completion, all on-site Work including punch list items required by the Contract have been completed to where the Contractor can vacate the site and only those elements of submittal and closeout nature remain for the attainment of Final Completion and as previously described.
- D. Final Completion: The last stage of construction shall be final construction and shall include the final remaining items subject to Engineer's and District's approval as well as items listed in Section 01700 – Contract Closeout.

1.04 WORK SEQUENCE

- A. Perform Work in a sequence that will allow completion of the Work in the Contract Time. Completion dates of the various stages shall be in accordance with the approved construction schedule submitted by the Contractor.
- B. The Contractor shall submit a written construction schedule including ancillary functions including shop drawing preparation and submittal, off-site and on-site testing, commissioning activities, and performance testing to the Engineer and District for approval prior to commencing work. Completion dates of the various stages shall be in accordance with the approved construction schedule submitted by the Contractor.

1.05 CONTRACTOR'S USE OF PREMISES

- A. Contractor shall have use of the premises for the performance of the Work at the Black Creek intake structure and pump station. Contractor shall coordinate activities with any other Contractor who will be performing work in the same general area.
- B. Contractor shall limit the use of the premises for their Work and for storage to allow for:
 1. Work by other Contractors.
 2. District's occupancy

- C. Contractor shall assume full responsibility for security of all subcontractors' materials and equipment stored on the site.
- D. If directed by the District or Engineer, move any stored items which interfere with operations of District or other Contractors.

1.06 CONTRACTOR'S STAGING, STORAGE AND STOCKPILE AREA

- A. The Contractor's will not be allowed to stage or store materials and equipment beyond the limits of clearings shown on the Drawings, except that the Contractor may obtain (from others) and pay for use of additional storage and staging areas if needed to perform the work.

1.07 DISTRICT OCCUPANCY

- A. Coordinate all construction operations with District or Engineer to minimize conflict and to facilitate District usage.
- B. Contractor's Responsibilities
 - 1. Coordinate delivery date for each pre-purchased item with District, if applicable.
 - 2. Review shop drawings, product data and samples. Notify District and Engineer of any discrepancies or problems anticipated with use of pre-purchased item.
 - 3. Receive and unload items at site.
 - 4. Inspect items jointly with District and record any shortages, damaged or defective items.
 - 5. Assume responsibility for items, including insurance, upon acceptance of items at site.
 - 6. Handle items at site, including uncrating and storage. Protect items from exposure to elements and damage.
 - 7. Assemble, install, connect and finish products and provide warranty for Contractor furnished materials and workmanship as specified.
 - 8. Repair or replace items damaged as a result of Contractor's work.

END OF SECTION

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SECTION 01014
CONSTRUCTION SEQUENCE

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. The construction progress schedule required under Section 01310 shall reflect the conditions presented in this section.
- B. See Sections 01465 and 01730 for additional requirements and Divisions 11 through 16, inclusive, on specific equipment startup and testing requirements.
- C. During Start-Up Testing, make available the manpower, equipment and manufacturer's representatives required to make any necessary adjustments and training.

1.02 NOTIFICATION REQUIREMENTS

- A. The Contractor shall give a minimum of 14 days advance written notice to the Engineer and District of each component proposed for shutdown, tie-in, or disruption, all of which shall be subject to District's approval and limitations. Shutdowns, tie-ins or disruptions specifically mentioned in this Section must conform to this requirement and any others requested by the Engineer or District.
- B. For tie-in piping to be performed in the roadway which will require Maintenance of Traffic and partial or full lane closures, notify the appropriate City, County, or State Agencies as required.

1.03 SUBMITTAL REQUIREMENTS

- A. Contractor shall submit the proposed construction sequence to be approved by Engineer and District prior to beginning work.
- B. Contractor shall submit shop drawings and working drawings in accordance with Section 01300 to show details of all temporary services and connections to existing systems.

1.04 SITE CONDITIONS

- A. Several areas of construction under this Contract shall be coordinated with District Personnel and accomplished in a logical order to allow construction to be completed within the time allowed by Contract Documents. Coordinate the activities with the other contractors, if any, to allow orderly and timely completion of all the work.
- B. When access through construction areas must be disrupted, provide alternate acceptable access for the plant operators or other contractors.
- C. Coordinate the activities in the interface or common areas with these other contractors and the District personnel. Submit to the Engineer and District a description and schedule as to how the common areas will be utilized, recognizing the required coordination with other contractors.
- D. When the work requires an existing facility to be taken out of operation, temporarily or permanently, notify the Engineer and District 7 days in advance.

1.05 CONSTRUCTION CONSTRAINTS

- A. The following is a list of constraints to consider in developing the overall plan of construction. This list is not intended to release the Contractor from the responsibility to coordinate the work in any manner which will ensure project completion within the time allowed. The following areas are not necessarily listed in their required sequence of construction. A suggested sequence within each area, where necessary, is included.
- B. Sitework
1. All erosion control devices and storm drainage piping and inlets shown on the Drawings shall be installed prior to any clearing and grubbing at the project site.
 2. All underground pipes, conduits, cables, duct banks, and structures shall be located by electronic locator equipment and test pits in each area of excavation and flagged and mapped before any excavation is performed for structures, pipes, cables, conduits, duct banks, or removals. Working drawings of existing and proposed new work shall be prepared to scale and submitted to the Engineer in advance of excavation. The Contractor shall be fully responsible for any process outages caused by disruption of underground facilities including responsibility for regulatory fines and the District's costs of dealing with regulatory agencies.
 3. The Contractor's field office shall be set up and fully equipped and all utilities connected within 30 days of the Effective Date of the Agreement. The office shall be removed not earlier than the date of substantial completion and not later than the date of final payment.
 4. All underground pipes, conduits, cables, duct banks, and structures installation work shall be organized and scheduled to accomplish the following:
 - a. The District access to operating facilities shall be maintained at all times.
 - b. All underground work in each area shall be performed concurrently to avoid subsequent trenching through the same areas.
 - c. Yard electrical work and piping work shall be shown on the same working drawings and fully coordinated horizontally and vertically.
 5. New concrete pavement shall not be installed until all piping, cables, conduits, and duct banks under the paved area have been installed. Roads shall be stabilized with crushed stone until that time. The surface pavement course and cap on existing roads shall not be installed until all other construction work is finished. Any weak areas in base course or existing pavement shall be removed and replaced prior to the final surface course installation.
 6. Locations and numbers of sedimentation control facilities shall be adjusted as the work progresses so that all site runoff flows through sedimentation control facilities at all times. Facilities shown are minimums only. At no time shall undesilted water be allowed to leave the site. Maintenance and upgrading of facilities shall be scheduled weekly and after all rain events.

7. Discharges from the Contractor's dewatering operations shall be in accordance with the requirements of the NPDES permit for construction activities obtained by the Contractor from the Florida Department of Environmental Protection (FDEP) or in accordance with a "Generic Permit for Discharge of Groundwater from Dewatering Operations" obtained by the Contractor from the FDEP.
8. All connections to existing facilities shall be scheduled through the Engineer and the District to minimize the impact on existing pump stations and construction progress.
9. All existing trees and vegetation located outside of the limits of clearing shown on the Drawings shall be protected and remain undamaged at all times. If the Contractor anticipates damage to a tree located outside of the limits of clearing due to construction activities within the limits of clearing, the Contractor shall contact the Engineer and the District Project Manager immediately and prior to commencing work in that area.

C. Testing

1. All facilities and systems shall be successfully tested as a condition precedent to substantial completion. See Section 01465 and equipment specifications for additional requirements. Start-up plans for each facility and equipment shall be submitted, reviewed and approved by the Engineer and the District.

1.06 PERMITS

- A. The Contractor shall arrange for all required inspections and shall close out all Contractor-obtained permits at the end of the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01025
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SCOPE

- A. This Section includes specification for the measurement and payment of the various elements of the Work; with provisions applicable to lump sum prices, unit prices, and allowances, if applicable.
- B. In the case of conflict between this Section and the measurement methods specified in the individual technical Sections, the measurement methods in the technical specifications shall govern.
- C. The Contractor shall receive no payment for any portion of the work until it is installed. The only exception to this is payment for stored materials on site if the Contract provides for the payment of stored materials. Partial payment may be requested for items partially installed.

1.02 RELATED WORK

- A. Schedule of Values is included in Section 01370
- B. Applications for Payment are included in Section 01026.
- C. Instructions to Respondents

1.03 LUMP SUM ITEMS

- A. Lump Sum measurement will be for the entire item, unit of work, structure, or combination thereof, as specified and as indicated in the Bid Form. Measurement and payment for all bid items indicated as Lump Sums shall include the cost of all labor, materials and equipment necessary to furnish, install, clean, test, and place each bid item into operation; including permitting, overhead and profit.
- B. Progress payments will be based on the Schedule of Values prepared by the Contractor and approved by the Engineer and District before acceptance of the first Application for Payment.
- C. In order for the Contractor to request progress payments against Lump Sum items, Contractor shall provide a disaggregation or breakdown in sufficient measurable detail that is acceptable to the Engineer and the District.
- D. Measurement
 - 1. Measurement shall be based on the estimated percent complete of each item of the Schedule of Values, as determined by the Engineer and approved by the District.
- E. Payment
 - 1. Payment will be made at the lump sum price proportional to the completion percentages approved by the Engineer and the District.

1.04 UNIT PRICE ITEMS

- A. Quantity and measurement estimates stated in the Bid Proposal Form are estimates for bidding purposes only. Actual payments shall be based on actual quantities installed, in-place, as measured and/or verified by the Engineer and approved by the District.
- B. Unless otherwise provided in the Bid Documents, the bid unit prices shall be in effect throughout the contract duration, regardless of variances between the estimated quantities and the actual installed quantities.
- C. The Contractor shall make no claim, nor receive any compensation, for anticipated profits, loss of profit, damages, or any extra payment due to any difference between the amounts of work actually completed, or materials or equipment furnished, and the estimated quantities.
- D. Unless otherwise approved by the District, any unit quantities exceeded may not be invoiced until the estimated quantity is increased by contract change order.
- E. Contractor shall assist Engineer and District by providing necessary equipment, workers, and survey personnel as required to measure quantities.
- F. Measured quantities shall be rounded to the nearest whole integer, unless the value of the unit price exceeds \$100, in which case measured quantities shall be rounded to the nearest half unit.
- G. Measurement
 - 1. Measurement for progress payment shall be made by, or approved by, the Engineer or District based on the estimated effective quantity installed. The effective quantity installed represents the actual units or quantities installed, adjusted for incomplete elements or components.
 - 2. Unless otherwise provided for in the Bid Form unit price items are all-inclusive of all related work, direct and indirect, to provide a complete and functional item. For example, underground pipe installation would include trenching, shoring, dewatering, bedding, installation, backfill, testing, flushing, disinfection, and commissioning; including all labor, materials and equipment necessary to furnish, install, clean, test, and place into operation; including permitting, overhead and profit.
 - 3. The final measurement shall be based on actual quantities, jointly measured by Contractor Engineer, and District, complete, fully tested and placed into service.
- H. Payment
 - 1. Progress payments shall be in accordance with the contract documents based on estimated effective quantities installed, paid at the bid unit price.
 - 2. The final payment shall be based on actual quantities, fully installed, tested and placed into service, paid at the bid unit price.

1.05 ALLOWANCES

- A. Allowances, if any, specified in the Contract Documents and indicated in the Bid Form are considered provisional amounts to be used only if needed. Allowances are exclusive of work indicated in the Contract Documents for which payment is included under other items in the Bid Form. No work may be performed under an allowance without prior written approval of the District.
- B. Any unused balance of the allowances shall revert to the District upon completion of the project. Prior to final payment, the original amount provided for allowances shall be adjusted to actual costs by deductive Change Order, adjusting the contract price, accordingly.
- C. The Contractor shall make no claim, nor receive any compensation, for anticipated profits, loss of profit, damages, or any extra payment due to any unexpended portion of the allowances.
- D. The Contractor is to include time for allowance work in the construction schedule. No adjustment of Contract Time shall be allowed for any work performed under allowance items.
- E. Allowance items shall be included in the Schedule of Values.
- F. Unless otherwise indicated in the specific measurement and payment provisions under allowance items, the measurable and allowable costs for work performed under an Allowance item shall be limited to the actual, demonstrable, and direct costs associated with that Allowance item. Shipping and sales taxes are allowable costs.
 - 1. No mark-up for overhead or profit shall be included for payment under an Allowance account item. Overhead and profit shall be included in the contract base bid or allocated across other bid items.
 - 2. Work authorized by the District under an allowance may be performed as a lump sum (negotiated before the fact), unit prices (when applicable), or time and material. For work performed under time and material, Contractor shall submit detailed verification (break-down) of all costs, subject to the approval of the Engineer or District.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.01 LUMP SUM ITEMS - BASE BID

- A. Base Bid: Payment shall be full compensation for construction of the Black Creek Intake and Intake Pump Station per the Contract Documents including all Work shown on the Contract Drawings and as specified herein including the raw intake structure and intake screens, raw water intake piping system, new pump station building, electrical building, electrical equipment, pumps, motors, and associated mechanical equipment HVAC, plumbing, and all other appurtenance, yard piping, and site work. The Contractor shall furnish and install all material and equipment and shall furnish all supervision, equipment, labor, overhead and profit required to complete the Work in-place, fully tested, ready for continuous uninterrupted service and Final Acceptance by the District.

1. Measurement shall be in accordance with the accepted Schedule of Values (Section 01370).
2. Progress payments shall be based on the actual percentage of Work satisfactorily completed during the progress payment period in accordance with the approved Schedule of Values. Final Payment shall be the balance of the stated Lump Sum as adjusted by approved Change Orders.

END OF SECTION

SECTION 01026
APPLICATION FOR PAYMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Submit Applications for Payment to the District in accordance with the schedule established by Agreement between District and Contractor.
- B. The accepted Schedule of Values, Section 01370, shall be used as the basis for the Contractor's Application for Payment.

1.02 RELATED WORK

- A. A sample agreement between District and Contractor is included in the Front-End Documents provided by the District.
- B. Instructions to Respondents are included in the Front-End Documents provided by the District.
- C. Schedule of Values are included in Section 01370.
- D. Audio Video Taping and Construction Photographs are included in Section 01380.
- E. Contract Closeout is included in Section 01700.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, applications typed on forms provided by the District, Application for Payment, with itemized data typed on 8-1/2-in by 11-in or 8-1/2-in by 14-in white paper continuation sheets.
- B. Provide itemized data on continuation sheet.
 - 1. Format, schedules, line items and values: Those of the Schedule of Values accepted by the Engineer and the District.
- C. Provide construction photographs in accordance with Section 01380.
- D. As a prerequisite for payment, Contractor shall submit the followings:
 - 1. Updated schedule
 - 2. Man hours
 - 3. Updated record drawings (red-lines)

1.04 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

A. Application Form

1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.
2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.
3. Execute certification with signature of a responsible officer of Contract firm.
4. The Contractor shall provide an example Application for Payment for District's approval at least 30 days prior to submission of first payment request.

B. Continuation Sheets

1. Fill in total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.
2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored.
 - a. Round off values to nearest dollar, or as specified for Schedule of Values.
3. List each Change Order executed prior to date of submission, at the end of the continuation sheets.
 - a. List by Change Order Number and description, as for an original component item of work.
4. To receive approval for payment on component material stored on site, submit copies of the original paid invoices with the application for payment.

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the District requires substantiating data, submit suitable information, with a cover letter identifying.

1. Project.
2. Application number and date.
3. Detailed list of enclosures.
4. For stored products:
 - a. Item number and identification as shown on application.
 - b. Description of specific material.

B. Submit one copy of data and cover letter for each copy of application.

C. Maintain an updated set of red-line drawings to be used as as-build drawings in accordance with Section 01720. As a prerequisite for monthly progress payments, exhibit the updated record

drawings (updated to within seven days of pay application date) for review by the District and the Engineer.

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT

- A. Fill in Application form as specified for progress payments.
- B. Use continuation sheet for presenting the final statement of accounting as specified in Section 01700.
- C. Submit all Project Record Documents in accordance with Section 01050 and 01700.

1.07 SUBMITTAL PROCEDURE

- A. Submit Draft Application for Payment with required documentation to the District at the time stipulated in the Agreement via e-mail.
- B. After approval of the District or after making revisions requested by the District, resubmit approved Application for Payment via email.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01030
SPECIAL PROJECT PROCEDURES

PART 1 GENERAL

1.01 GENERAL

- A. Carefully coordinate and conduct all work in strict accordance with District's requirements and standards.
- B. All other permits and approvals will be the responsibility of the Contractor.

1.02 EQUIPMENT DELIVERY AND STORAGE

- A. Unload and store equipment within the location(s) shown on the Drawings or as approved by Engineer.
- B. Block equipment up, off the ground, protect in accordance with manufacturer recommendations, and store away from drainage ways.

1.03 LINES AND GRADES

- A. The Contractor shall be responsible for establishing all lines and measurements necessary to the proper execution and control of the work.

1.04 ACCESS AND DRAINAGE

- A. The Contractor shall provide and maintain adequate access to and through the site and shall keep all natural and constructed drainage unobstructed or provide equal courses effectively placed.

1.05 LOCATION, PROTECTION AND MAINTENANCE OF EXISTING UTILITIES, STRUCTURES AND PROPERTY

- A. Existing utilities are located and are operating in the construction area. Contractor shall contact the Engineer and ascertain the extent of specific service areas prior to performing any excavation.
- B. The location of existing utilities across or along the line of the proposed work is not necessarily shown on the Drawings and, where shown, is only approximately correct. The Contractor shall locate all underground lines and structures prior to excavation.
- C. The Contractor shall assume full responsibility for the protection and restoration of all structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains, and electric and telephone cables, whether or not they are shown on the Drawings. Contractor shall carefully support and protect all such structures and utilities from injury. Damages resulting from the construction operations shall be repaired by Contractor.
- D. The Contractor shall fully cooperate at all times with the utility owners to maintain the operation of existing utilities with the least amount of interference and interruption possible. Continuous service, public health and safety considerations shall exceed all others and the

Contractor's schedule, plans and work shall at all times be subject to alteration and revision if necessary for these considerations.

- E. Temporary support, adequate protection and maintenance of all underground and surface utility installations and structures, drains, sewers, and other obstructions encountered shall be provided as required by the Contractor. Arrange and pay all costs for required support of utility poles and other structures as required by the utility owners prior to excavation.
- F. Trees, shrubbery, fences, poles, signs, and all other property shall be protected to the extent practicable.

1.06 NOISE LIMITATIONS

- A. All equipment to be furnished under this Contract, unless specified otherwise in the technical specifications, shall be designed to ensure that the sound pressure level does not exceed 85 decibels over a frequency range of 37.8 to 9600 cycles per second at a distance of three ft from any portion of the equipment, under any load condition, when tested using standard equipment and methods. Noise levels shall include the noise from the motor. Mufflers or external baffles shall not be acceptable for the purpose of reducing noise. Data on noise levels shall be included with the shop drawing submittal.

1.07 SPARE PARTS

- A. Where spare parts are specified in the technical Sections, furnish all spare parts recommended by the manufacturer or system supplier for one year of service. In addition, furnish all spare parts itemized in each Section.
- B. Collect and store all spare parts in an area to be designated by the Engineer. Furnish the Engineer with an inventory listing all spare parts, the equipment they are associated with, the name and address of the supplier and the delivered cost of each item. Copies of actual invoices for each item shall be furnished with the inventory to substantiate the delivery cost.
- C. Spare parts shall be packed in cartons, properly labeled with indelible markings with complete descriptive information including manufacturer, part number, part name and equipment for which the part is to be used and shall be properly treated for one year of storage.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01045
CUTTING, CORING, AND PATCHING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the cutting, coring, rough and finished patching of holes and openings. Holes and opening maybe in existing construction, or in parts of new construction. Procedures for cutting and patching will be the same for either condition.
- B. All cutting, coring, and rough patching shall be performed by the Contractor. Finish patching shall be the responsibility of the Contractor and shall be performed by the trade associated with the application of the particular finish.
- C. Provide all cutting, fitting and patching, including attendant excavation and backfill, required to complete the work or to:
 - 1. Make its several parts fit together properly.
 - 2. Uncover portions of the work to provide for installation of ill-timed or improperly scheduled work.
 - 3. Remove and replace defective work.
 - 4. Remove and replace work not conforming to requirements of Contract Documents.
 - 5. Remove samples of installed work as specified for testing.
 - 6. Provide penetrations of structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit.
 - 7. Provide penetrations of non-structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit. The determination of what is a nonstructural surface or material shall be made by the Engineer.
 - 8. Remove, install, or relocate materials or equipment.

1.02 RELATED WORK

- A. Summary of Work is included in Section 01010.
- B. Site work is included in Division 02.
- C. Concrete is included in Division 03.
- D. Masonry is included in Division 04.
- E. Conduit sealing methods is included in Division 16.
- F. Duct penetration assemblies are included in Division 15.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, a written request prior to executing any cutting or alteration which is not shown or detailed on the contract documents which affects or requires:
 - 1. Cutting structural members.
 - 2. Holes drilled in beams or other structural members.
 - 3. Work of the District or any separate contractor.
 - 4. Structural value or integrity of any element of the project.
 - 5. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 6. Efficiency, operational life, maintenance or safety of operational elements.
 - 7. Visual qualities of sight-exposed elements.
- B. Request shall include:
 - 1. Identification of the project.
 - 2. Description of affected work.
 - 3. The reason for cutting, alteration or excavation.
 - 4. Effect on work of District or any separate contractor, or on structural or weatherproof integrity of project.
 - 5. Description of proposed work:
 - a. Method and extent of cutting, patching, alteration, or excavation.
 - b. Trades who will execute the work.
 - c. Products proposed to be used.
 - d. Extent of refinishing to be done.
 - 6. Alternatives to cutting and patching.
 - 7. If the work is considered out of scope, provide a cost proposal.
 - 8. Confirmation of coordination with any separate contractor whose work will be affected.
 - 9. Related shutdown requests if required to do the work.
 - 10. Request for hot work permit if required to do the work.
- C. Submit written notice to the Engineer designating the date and the time the work will be uncovered.
- D. When a written request is required, do not proceed with the work until a written Effective Date of the Agreement is received from the District.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with specifications and standards for each specific product involved. Where there is no equivalent specification, the Contractor shall notify the Engineer who will provide a specification for the materials to be used.
- B. Concrete and grout for rough patching shall be as specified in Divisions 3.
- C. Materials for finish patching shall be equal to those of adjacent construction. Where existing materials are no longer available, use materials with equivalent properties and that will provide the same appearance. The materials are to be approved by the Engineer prior to their use.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect existing conditions of project, including elements subject to damage or to movement during cutting and patching.
- B. After uncovering work, inspect conditions affecting installation of products, or performance of work.
- C. Report unsatisfactory or questionable conditions to the District and Engineer in writing; do not proceed with work until the District and Engineer has provided further instructions.

3.02 PREPARATION

- A. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of work.
- B. Protect surrounding materials and equipment prior to starting work.
- C. Contain and control cooling liquids and slurry produced by the cutting and coring operations.
- D. When the cutting or coring will result in the structure or equipment being exposed to provide adequate weather protection.
- E. Provide dewatering for excavation work in accordance with Division 2.

3.03 PERFORMANCE

- A. Execute cutting and demolition by methods which will prevent damage to other work and will provide proper surfaces to receive installation of repairs.
- B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work. When excavating in close proximity to piping, duct banks or other items subject to damage, use hand excavation.
- C. All equipment and workplace safety shall conform to OSHA standards and specifications pertaining to plugs, noise and fume pollution, wiring and maintenance.

- D. Where possible, employ original installer or fabricator to perform cutting and patching for:
 - 1. Weather-exposed or moisture-resistant elements.
 - 2. Sight-exposed finished surfaces.
- E. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.
- F. Restore work which has been cut or removed; install new products to provide completed work in accordance with requirements of Contract Documents.
- G. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:
 - 1. For continuous surfaces, refinish to nearest intersection.
 - 2. For an assembly, refinish entire unit.
- H. Remove rubble and excess patching materials from the premises.

3.04 CORING

- A. All coring shall be performed in such a manner as to limit the extent of patching. Locate the rebar before coring to minimize cut throughs.
- B. Coring shall be performed with an approved non-impact rotary tool with diamond core drills.
- C. Size of holes shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be installed.
- D. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- E. Fit to pipes and other penetrations in tanks to be water tight using seals or other methods defined in the specifications.
- F. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise approved. All work shall be performed by mechanics skilled in this type of work.
- G. If holes are cored through floor slabs they shall be drilled from below where possible. If holes are drilled from above, provide protection and containment below the area being drilled to catch the plug and contain liquid and slurry.

3.05 CUTTING

- A. All cutting shall be performed in such a manner as to limit the extent of patching.
- B. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
- C. Cutting shall be performed with a concrete saw and diamond saw blades of proper size.

- D. Provide for control of slurry generated by sawing operation on both sides of wall and from below if cutting a floor.
- E. When cutting a reinforced concrete wall or floor, the cutting shall be done so as not to damage the bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.
- F. Adequate bracing of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
- G. Provide equipment of adequate size to remove cut panel.
- H. Saw cut concrete and masonry prior to breaking out sections.
- I. Install work at such time as to require the minimum amount of cutting and patching.
- J. All cutting of structural members shall be done in a manner directed by the Engineer.
- K. Cut opening only large enough to allow easy installation of the equipment, ducting, piping or conduit.
- L. When existing conduits or pipe sleeves are cut off at the floor line or wall line, they shall be filled with grout or suitable patching material.

3.06 PROTECTION

- A. Provide devices and methods to protect other portions of project from damage.
- B. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work.
- C. Maintain excavations free from water.

3.07 PATCHING

- A. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown.
- B. Finish patching shall match existing surfaces as approved.
- C. Patching shall be of the same kind and quality of material as was removed.
- D. The completed patching work shall restore the surface to its original appearance or better.
- E. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed to include the joint between the existing material and the patch.
- F. Equipment damaged during cutting and patching shall be replaced or repaired by the equipment manufacturer, at the Engineer's sole discretion and at the expense of the Contractor doing the work.

- G. Repaint any damage to factory applied paint finishes using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted in accordance with the field painting requirements specified in Section 09902 at the expense of the Contractor doing the work.
- H. Slurry or tailings resulting from coring or cutting operations shall be contained and vacuumed or otherwise removed from the area following drilling or cut.
- I. Equipment shall be protected against mechanical and water damage during cutting and patching. Provide protective covers or use other means such as temporary relocation to protect equipment that is at risk of damage from the cutting and patching
- J. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.

END OF SECTION

SECTION 01046
CONTROL OF WORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor must meet all general requirements of the following general construction requirements outlined in this Section hereinafter.

1.02 PRIVATE LAND

- A. The Contractor shall not enter or occupy private land outside of easements, except by permission of the District.

1.03 PIPE LOCATIONS

- A. The Contractor shall locate pipelines substantially as indicated on the Drawings. The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

1.04 OPEN EXCAVATIONS

- A. The Contractor shall adequately safeguard all open excavations by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. The Contractor shall provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. The Contractor shall remove bridges provided for access during construction when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street and requiring that the trench shall not remain open overnight.
- B. The Contractor shall take precautions to prevent injury to the public due to open trenches. The Contractor shall provide adequate light at all trenches, excavated material, equipment, or other obstacles which could be dangerous to the public at night.

1.05 TEST PITS

- A. The Contractor shall excavate test pits, at the direction of the Engineer, to locate underground pipelines or structures in advance of the construction. The Contractor shall backfill test pits immediately after their purpose has been satisfied and restore and maintain the surface in a manner satisfactory to the Engineer.

1.06 CARE AND PROTECTION OF PROPERTY

- A. The Contractor shall be responsible for the preservation of all public and private property and use every precaution necessary to prevent damage thereto. If any direct or indirect damage is

done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, the Contractor shall restore such property to a condition similar or equal to that existing before the damage was done, or make good the damage in other manner acceptable to the Engineer.

1.07 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

- A. The Contractor shall assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains and electric and telephone cables, whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Immediately repair any damage resulting from the construction operations.
- B. Assistance will be given the Contractor in determining the location of existing services. The Contractor, however, shall bear full responsibility for obtaining all locations of underground structures and utilities (including existing water services, drain lines and sewers). Maintain services to buildings and pay costs or charges resulting from damage thereto.
- C. The Contractor shall notify all utility companies in writing at least 72 hours (excluding Saturdays, Sundays and Legal holidays) before excavating in any public way.
- D. If, in the opinion of the Engineer, permanent relocation of a utility owned by others is required, the District may direct the Contractor, in writing, to perform the work. Any additional work ordered by the District will be processed pursuant to the Change Order provisions of the Agreement. No claim for delay will be allowed due to such relocation.
- E. Along the proposed pipe lines as indicated on the plans, the Contractor shall remove the surface materials only to such widths as will permit a trench to be excavated which will afford sufficient room for proper efficiency and proper construction. All applicable regulations shall be followed. Where sidewalks, driveways, pavements, and curb and gutter are encountered, care shall be taken to protect against fracture or disturbance beyond reasonable working limits. All fractured, broken, or disturbed surfaces shall be restored to their original condition prior to completion of the work.
- F. Restoration of all surfaces including road subbase, soil cement, limerock base, asphaltic concrete surface, portland cement concrete pavement and driveways, sidewalks, and concrete curbs shall be in strict accordance with Drawings. All grassing and mulching shall be done. Sites shall be restored to existing conditions. Any modifications from existing conditions shall require prior approval from District of existing structure, property, or utility.

Lawn areas shall be left in as good or better condition as before starting the work. Where sod is to be removed, it shall be carefully restored with new sod of the same type. Solid sodding shall be placed on all slopes greater than 4:1, within 10 feet of all proposed structures and where existing sod is removed or disturbed by the work. In addition, Contractor shall restore all storm drains, culverts, inlets, and storm manholes to equal or better condition.

Any fence, or part thereof, that is damaged or removed during the course of the work shall be replaced or repaired by the Contractor and shall be left in as good a condition as before the starting of the work. The manner in which the fence is repaired and replaced and the materials used shall be subject to the approval of the Engineer.

All trees and shrubs not shown to be removed on the plans shall be protected by the Contractor at his expense. No excavated materials shall be placed so as to injure such trees and shrubs. Trees or shrubs destroyed by negligence of the Contractor or his employees shall be replaced by him with new stock of similar size and age at the sole expense of the Contractor.

1.08 WATER FOR CONSTRUCTION PURPOSES

- A. Contractor shall provide and install the water meter and backflow preventer for water required for construction services, Coordinate with local utility for the appropriate equipment. Contractor shall pay all fees and water usage charges. All water usage shall be metered.

1.09 MAINTENANCE OF FLOW

- A. The Contractor shall provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and immediately cart away and remove all offensive matter. Discuss the entire procedure of maintaining existing flow with the Engineer at least seven days prior to the interruption of any flow.

1.10 PROTECTION OF CONSTRUCTION AND EQUIPMENT

- A. All newly constructed work shall be carefully protected from injury in any way. No wheeling or walking or placing of heavy loads on it shall be allowed and all portions damaged shall be reconstructed by the Contractor at his own expense.
- B. All structures shall be protected in a suitable manner. Proposed methods of protection shall be submitted to the Engineer. Should any of the floors or other parts of any structures become heaved, cracked or otherwise damaged, all such damaged portions of the work shall be completely repaired and made good by the Contractor at his own expense and to the satisfaction of the District. If, in the final inspection of the work, any defects, faults or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. Further, the Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other work undertaken herein, for at least the guarantee period described in the Contract.

1.11 COOPERATION WITHIN THIS CONTRACT

- A. All firms or persons authorized to perform any work under this Contract shall cooperate with Contractor and Subcontractors or trades and assist in incorporating the work of other trades where necessary or required.
- B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.12 CLEANUP AND DISPOSAL OF EXCESS MATERIAL

- A. During the course of the work, the Contractor shall keep the site of operations as clean and neat as possible. The Contractor shall dispose of all residue resulting from the construction work and, at the conclusion of the work, remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and leave the entire site of the work in a neat and orderly condition.

- B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, the Contractor shall comply with all applicable Federal, State and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and in other related sections.
- C. Disposal of excess excavated material in wetlands, stream corridors and plains is strictly prohibited even if the permission of the property District is obtained. Any violation of this restriction by the Contractor or any person employed by him will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. The Contractor will be required to remove the fill and restore the area impacted at no increase in the Contract Price.

1.13 GRADES, SURVEY LINES, AND PROTECTION OF MONUMENTS

- A. All work shall be constructed in accordance with the lines and grades shown on the drawings. The full responsibility for keeping alignment and grade shall rest upon the Contractor.
- B. Bench marks and base line controlling points shall be established prior to beginning work. Reference marks for lines and grades as the work progresses will be located to cause as little inconvenience to the prosecution of the work as possible. The Contractor shall so place excavation and other materials as to cause no inconvenience in the use of the reference marks provided. Contractor shall remove any obstructions placed contrary to this provision.
- C. The Contractor shall furnish and maintain, at his own expense, stakes and other such materials and give such assistance, including qualified helpers, for setting reference marks to the satisfaction of the Engineer. The Contractor shall check reference marks by such means, as he may deem necessary. The Contractor shall, at his own expense, establish all working or construction lines and grades as required from the reference marks and shall be solely responsible for the accuracy thereof.
- D. Property corners and survey monuments shall be preserved using care not to disturb or destroy them. If a property corner or survey monument is disturbed or destroyed during construction, whether by accident, careless work, or required to be disturbed or destroyed by construction work, said property corner or survey monument shall be restored by a land surveyor registered in the state of Florida. All costs for this work shall be paid for by the Contractor.

END OF SECTION

SECTION 01050
PROJECT CONTROLS (SURVEYING)

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall retain the services of a registered land surveyor currently licensed in the State of Florida to:
 - 1. Perform survey work required for project controls and layout.
 - 2. Provide certified as-built surveys specified herein.
 - 3. Identify existing control points and property line corners indicated on the Drawings.
 - 4. Verify and record all existing structure locations in the vicinity of, or adjacent to, the proposed Work; and the locations of all pro-posed structures and facilities.
 - 5. Maintain an accurate record of locations of all new buried piping and existing buried piping and other buried existing facilities (piping, conduits, and structures) encountered and/or relocated during construction of the new Work.
 - 6. Maintain accurate locations of all new structures and equipment within the project site.

1.02 RELATED WORK

- A. Summary of Work is included in Section 01010.
- B. Contract Closeout is included in Section 01700.
- C. Record Drawings are included in Section 01720.

1.03 SUBMITTALS

- A. The Contractor shall submit, to the Engineer and District, in accordance with Section 01300, the name, address and state registration and license number of proposed registered land surveyor.
- B. On request of the Engineer or District, the Contractor shall submit documentation to verify accuracy of field engineering work.
- C. At the end of the project, as a prerequisite for the final Application for Payment, the Contractor shall submit certified drawing(s) (with the Surveyor's title block) of the items listed below. All surveys shall be tied to the applicable Grid System and shall indicate all pre-existing and new project benchmarks. Vertical Control shall conform to the project elevation datum designated on the plans.
 - 1. Building corners, sidewalks, paved areas and location of all above ground structures within the project site or limits of construction.
 - 2. Locations, lines and grades in plan a of all below-grade lines (piping and concrete-encased electrical ducts) exterior to buildings and other buried facilities. This requirement includes

all utilities installed as a part of the scope of this project, as well as existing lines encountered during the installation of the new Work.

3. Topographical information including spot elevations, finished floor elevations of new buildings, and top of slab elevations for other new structures, retaining walls, and slabs on grade.

1.04 QUALIFICATIONS OF SURVEYOR

- A. Registered land surveyor, licensed in the state of Florida.

1.05 SURVEY REFERENCE POINTS

- A. Existing basic horizontal and vertical control points for the project are those designated on Drawings.
- B. The Contractor shall locate and protect control points prior to starting site work and preserve all permanent reference points during construction.
 1. The Contractor shall make no changes or relocations without prior written notice to and approval by the Engineer.
 2. The Contractor shall report to the Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
 3. The Contractor shall require the surveyor to correctly replace project control points which may be lost or destroyed. Establish replacements based on original survey control.

1.06 PROJECT SURVEY REQUIREMENTS

- A. The Contractor shall establish a minimum of two permanent bench marks on site, referenced to data established by survey control points.
 1. Record locations, with horizontal and vertical data, on the as-built Survey.
 2. Permanent benchmarks shall be installed and spaced for convenient reference and use at locations along the pipeline route and/or on the project site.
 3. Benchmarks shall be installed to National Geodetic Survey standards and shall include horizontal and vertical data, as well as the installation date.
- B. The Contractor shall establish lines and levels; locate and lay out:
 1. Site improvements.
 - a. Stakes for grading, fill and topsoil placement.
 - b. Utility slopes and invert elevations.
 - c. Sidewalks, pavement, fencing, storm drainage facilities, and other finish surface work.
 - d. Locations, sizes and depths of manholes, valves and fittings.
 2. Batter boards for structures.

3. Building foundation, column locations and floor levels.
 4. Controlling lines and levels required for mechanical and electrical trades.
- C. If lines, levels or layouts are lost or destroyed, or if required by the District or Engineer, the Contractor shall verify layouts by same methods.
- D. The Surveyor shall provide all elevation in North American Vertical Datum of 1988 (NAVD 88).
- E. The Contractor shall establish all lines and grades prior to construction of line work for all force mains, transmission mains, storm drainage piping, gravity sewers and other new utility lines at 100-ft increments, at defined breaks in grade, and at manholes.
- F. The following dimensional references must be depicted on the As-Built drawings.
1. Depths of various elements of foundation in relation to finish first floor datum.
 2. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of all underground utilities and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc. All pipes and valves shall be labeled using the method as per the contract drawings.
 3. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.
 4. Field changes of dimension and detail.
 5. Changes made by District Supplemental Instruction or by Change Order.
 6. Details not on original contract drawings.
 7. Equipment and piping relocations.
 8. All underground duct banks with elevations and dimensions, horizontal and vertical locations of underground duct banks, and manholes along duct banks.
 9. All underground cable elevations and horizontal locations of underground cables.
 10. All existing and new structures clearly indicated.
 11. All elevations of new structures clearly indicated.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 RECORDS

- A. The Contractor shall maintain a complete, accurate log of all control and survey work as it progresses.

- B. The Contractor shall update the project as-built survey on a monthly basis, based on the work performed during the month. The Contractor shall submit one copy of up to date as-built documentation with Contractor's monthly applications for payment.
- C. The Contractor shall maintain an accurate record of new and existing piping, conduit and structure changes, revisions, relocations, and modifications.
- D. At the end of the project, the Contractor shall submit the following:
 - 1. Four signed and sealed prints of all required as-built survey information
 - 2. Copy of all AutoCAD files of documents specified in Article 1.03.C, above on a CD or DVD.

END OF SECTION

SECTION 01065
PERMITS AND FEES

PART 1 GENERAL

1.01 GENERAL REQUIREMENTS

- A. The Contractor shall: Obtain and pay for any and all permits and licenses as provided for in the Bid Documents, except as otherwise provided herein, and in effect at the time of bidding.
- B. Schedule all inspections and obtain all written approvals of the agencies required by the permits and licenses.
- C. Comply with all construction related conditions specified in each of the permits and licenses.
- D. A copy of the permits obtained by the District will be furnished to the Contractor.

1.02 PERMITS BY DISTRICT

- A. The District has acquired (or will acquire) the following permits:
 - 1. USACOE – Standard Permit Authorization under Section 10 of the Rivers and Harbors Act (33 USC 403) and Section 404 of the Clean Water Act (33 USC 1344).
 - 2. FDEP – Consumptive Use Permit.
 - 3. FDEP – Environmental Resource Permit.
 - 4. FDOT – Utility Permit.
 - 5. Clay County – Site Development Plan Approval.

1.03 PERMITS BY CONTRACTOR

- A. The Contractor shall be responsible for acquiring building permits (Clay County), NPDES General Permit for Stormwater Discharge from Construction Activities (FDEP) and, if applicable, Generic Permit for Discharge of Groundwater from Dewatering Activities (FDEP)..
- B. The dewatering plan shall include sequence of excavation, discharge locations, sediment sump, turbidity control, erosion control, and turbidity monitoring.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01110
ENVIRONMENTAL PROTECTION PROCEDURES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials and equipment and perform all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this Section, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid waste, as well as other pollutants.
- C. The Contractor shall schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. The Contractor shall provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, staked hay bales, seeding, mulching or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to construction activity in that area. Specific requirements for erosion and sedimentation controls are specified in Division 2.
- D. This Section is intended to provide that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the District. The Contractor shall prepare a sedimentation and erosion control plan meeting the requirements all applicable Federal, State, and Local regulatory agencies. After approval of the plan is provided by the District the Contractor can initiate construction. It shall be the responsibility of the Contractor to modify the plan as needed to address changing site conditions to comply with applicable regulations. No additional compensation shall be provided or contract time added for the Contractor's environmental protection procedures.

1.02 APPLICABLE REGULATIONS

- A. The Contractor shall comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

1.03 NOTIFICATIONS

- A. The Engineer or the District will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the

Engineer, of any non-compliance with state or local requirements. After receipt of such notice from the Engineer or from the regulatory agency through the Engineer, immediately take corrective action. Such notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the District may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

1.04 IMPLEMENTATION

- A. Prior to commencement of the work, the Contractor shall meet with the Engineer and the District to develop mutual understandings relative to compliance with these provisions and administration of the environmental pollution control program.
- B. The Contractor shall remove temporary environmental control features, when approved by the Engineer and incorporate permanent control features into the project at the earliest practicable time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EROSION CONTROL

- A. The Contractor shall provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures, such as siltation basins, check dams, mulching, jute netting and other equivalent techniques, shall be used as appropriate. Offsite surface water shall be diverted around the site, to a downstream channel ahead of siltation barriers. Flow of surface water into excavated areas shall be prevented. Ditches around construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled and the ground surface restored to original condition.

3.02 PROTECTION OF STREAMS AND SURFACE WATERS

- A. The Contractor shall take all precautions to prevent, or reduce to a minimum, any damage to any stream or surface water from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Divert such waters through a settling basin or filter before being directed into streams or surface waters.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.
- C. The Contractor shall take all preventative measures to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken.

- D. Water being flushed from structures or pipelines after disinfection, with a Cl₂ residue of 2 mg/l or greater shall be treated with a dechlorination solution, in a method approved by the Engineer, prior to discharge.

3.03 PROTECTION OF LAND RESOURCES

- A. The Contractor shall restore land resources within the project boundaries and outside the limits of permanent work to a condition, after completion of construction that will appear to be natural and not detract from the appearance of the project. The Contractor shall confine all construction activities to areas shown on the Drawings.
- B. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C. Before beginning operations near them, the Contractor shall protect trees that may possibly be defaced, bruised, injured, or otherwise damaged by the construction equipment, dumping or other operations, by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly.
- D. Any trees or other landscape features scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to their original condition. The Engineer will decide the method of restoration to be used and whether damaged trees shall be treated and healed or removed and disposed of.
 - 1. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than one-in. in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.
 - 2. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer, shall be immediately removed or replaced.
- E. The locations of the Contractor's storage and other construction buildings required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Drawings and approved by the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Drawings showing storage facilities shall be submitted for approval of the Engineer.
- F. If the Contractor proposes to construct temporary roads or embankments and excavations for plant and/or work areas, he shall submit the following for approval at least 10 days prior to scheduled start of such temporary work.

1. A layout of all temporary roads, excavations, embankments and drainage to be constructed within the work area.
 2. Details of temporary road construction.
 3. Drawings and cross sections of proposed embankments and their foundations, including a description of proposed materials.
 4. A landscaping drawing showing the proposed restoration of the area. Indicate the proposed removal of any trees and shrubs outside the limits of existing clearing area. Indicate locations of guard posts or barriers required to control vehicular traffic and protect trees and shrubs to be maintained undamaged. The Drawing shall provide for the obliteration of construction scars as such and shall provide for a natural appearing final condition of the area. Modification of the Contractor's approved drawings shall be made only with the written approval of the Engineer. No unauthorized road construction, excavation or embankment construction including disposal areas will be permitted.
- G. The Contractor shall remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess of waste materials, or any other vestiges of construction as directed by the Engineer. It is anticipated that excavation, filling and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and sodded as described in Section 02932, or as approved by the Engineer.
- H. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

3.04 PROTECTION OF AIR QUALITY

- A. Burning - The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- B. Dust Control - Maintain all excavations, embankment, stockpiles, access roads, plant sites, waste areas, borrow areas and all other work areas within or without the project boundaries free from dust which could cause the standards for air pollution to be exceeded and which would cause a hazard or nuisance to others.
- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer.
- D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor shall have sufficient competent equipment on the job to accomplish this. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer.

3.05 NOISE CONTROL

- A. The Contractor shall make every effort to minimize noises caused by the construction operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with Federal and State regulations.

3.06 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

- A. The Contractor shall maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created and approval for removal is provided by the Engineer.

END OF SECTION

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SECTION 01172
PIPE PENETRATIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install pipe penetration assemblies as shown. This Section covers materials for the various pipe penetration configurations. Refer to Drawings for details of assembly and location.

1.02 SUBMITTALS

- A. Submit manufacturers' literature, installation instructions, and where applicable, fire rating and certified test results of the various components on all items to be furnished in accordance with Section 01300.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Unless otherwise shown all pipe sleeves shall be Schedule 40 galvanized steel pipe conforming to ASTM A53. The inside diameter of the sleeve shall be larger than the outside diameter of the flanges of process water piping that will pass through the wall. Ends of sleeves shall be cut and ground smooth and shall be flush with the wall or ceiling and extend two in. above finished floors. Sleeves to be sealed with mechanical seals shall be sized in accordance with the seal manufacturer's recommendations. Sleeves to be sealed by caulking and sleeves for insulated piping shall be sized as required.

2.02 WALL CASTINGS

- A. Unless otherwise shown, wall castings shall be ductile iron conforming to ANSI/AWWA A21.51/C151, thickness Class 53, diameter as required. Flanges and/or mechanical joint bells shall be drilled and tapped for studs where flush with the wall. Castings shall be provided with an intermediate two-in. minimum circumferential thrust collar type waterstop integrally cast with or welded to the casting, located as follows: for castings set flush with walls located at the center of the overall length of the casting; for castings which extend through wall located such that it falls within the middle third of the wall.

2.03 SEALING MATERIALS

- A. Mechanical seals shall be modular, adjustable, bolted, mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve. The seal shall be rated by the manufacturer for 40-ft of head or 20 psig. Mechanical seals shall be Link-Seal Model S-316 and sized appropriately, depending on pipe size, manufactured by PSI Thunderline/Link-Seal, Houston, TX or equal.
- B. Caulking for iron, steel and copper piping shall consist of braided oakum packing or fire retardant pliable material, Fig. 310 by Sealite Co.; White Oakum W.S. - 600 by American Manufacturing Co., or equal, followed by poured molten soft virgin lead. Minimum length of lead segment shall

be one half of pipe diameter, or six inches, whichever is less. Lead shall be flush with end of sleeve. Cooled lead shall be expanded with a caulking iron to form a water seal.

- C. Caulking for PVC pipe shall meet all the requirements in Paragraph B above except that lead wool, compacted to form a watertight seal, shall be used in place of molten lead.
- D. Sealant shall be a two part foamed silicone elastomer as manufactured by Dow Corning Co., Product No. 3-6548 silicone R.T.V.; 3M brand fire barrier products caulk C.P. 25 and 3M brand putty 303; or Flame-Safe fire stop systems Fig. No. FS-500 by Thomas & Betts Corp. Sealant bead configuration, depth and width shall be in accordance with manufacturer's recommendations.

2.04 MISCELLANEOUS MATERIALS

- A. Bonding compound shall be Sikadur Hi-Mod epoxy by Sika Corp.; equal by Euclid Chemical Corp.; Master Builders Company or equal.
- B. Non-shrink grout shall be Masterflow 713 by Master Builders Co.; Euco N-S by Euclid Chemical Co.; Five Star Grout by U.S. Grout Corp. or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Assemble and install components of pipe penetration assemblies as detailed on the Drawings.

END OF SECTION

SECTION 01200
PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The District shall schedule and administer pre-construction meeting, periodic progress meetings and specially called meetings throughout progress of the work.
 - 1. Make physical arrangements for meetings.
- B. The Engineer or District shall
 - 1. Preside at meetings.
 - 2. Record the minutes; include significant proceedings and decisions.
 - 3. Reproduce and distribute copies of minutes within 10 working days after each meeting.
 - a. To participants in the meeting.
 - b. To parties affected by decisions made at the meeting.
- C. Representatives of the Contractor, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
- D. Attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.
- E. Contractor to prepare agenda for meetings.

1.02 RELATED REQUIREMENTS

- A. Construction Schedules are included in Section 01310.
- B. Shop Drawings, Working Drawings and Samples are included in Section 01300.
- C. Project Record Documents are included in Section 01720.
- D. Operating and Maintenance Data is included in Section 01730.

1.03 PRE-CONSTRUCTION MEETING

- A. Schedule a preconstruction meeting no later than 10 days after date of Effective Date of the Agreement.
- B. Location: A central site, convenient for all parties, designated by the District.
- C. Attendance
 - 1. District's Representative.
 - 2. Engineer and their professional consultants.

3. Resident Project Representative.
4. Contractor's Superintendent.
5. Major Subcontractors.
6. Major suppliers.
7. Utilities
8. Others as appropriate.

D. Suggested Agenda

1. Distribution and discussion of:
 - a. List of major subcontractors and suppliers.
 - b. Projected Construction Schedules.
2. Critical work sequencing.
3. Major equipment deliveries and priorities.
4. Project Coordination.
 - a. Designation of responsible personnel.
5. Procedures and processing of:
 - a. Field decisions.
 - b. Proposal requests.
 - c. Submittals.
 - d. Change Orders.
 - e. Applications for Payment.
6. Adequacy of distribution of Contract Documents.
7. Procedures for maintaining Record Documents.
8. Use of premises:
 - a. Office, work and storage areas.
 - b. District's requirements.
9. Construction facilities, controls and construction aids.
10. Temporary utilities.
11. Housekeeping procedures.

1.04 PROGRESS MEETINGS

- A. Schedule regular periodic meetings. The progress meetings will be held every 30 days with the first meeting 30 days after the pre-construction meeting or 30 days after the date of Effective Date of the Agreement.

- B. Hold called meetings as required by progress of the work.
- C. Location of the meetings: Project field office of Contractor or District, or virtual meetings.
- D. Attendance
 - 1. Engineer and their professional consultants as needed.
 - 2. Contractor's superintendent and key staff as appropriate to the agenda.
 - 3. Subcontractors as appropriate to the agenda.
 - 4. Suppliers as appropriate to the agenda.
 - 5. Others as appropriate.
- E. Suggested Agenda
 - 1. Review, approval of minutes of previous meeting.
 - 2. Review of work progress since previous meeting.
 - 3. Field observations, problems and conflicts.
 - 4. Problems which impede Construction Schedule.
 - 5. Review of off-site fabrication, delivery schedules.
 - 6. Corrective measures and procedures to regain projected schedule.
 - 7. Revisions to Construction Schedule.
 - 8. Progress, schedule, during succeeding work period.
 - 9. Coordination of schedules.
 - 10. Review submittal schedules; expedite as required.
 - 11. Maintenance of quality standards.
 - 12. Pending changes and substitutions.
 - 13. Review proposed changes for:
 - a. Effect on Construction Schedule and on completion date.
 - b. Effect on other contracts of the project.
 - 14. Other business.
 - a. Asset management update
 - 15. Construction schedule.
 - 16. Critical/long lead items.

- F. Attend progress meetings and is to study previous meeting minutes and current agenda items, in order to be prepared to discuss pertinent topics such as deliveries of materials and equipment, progress of the work, etc.
- G. Provide a current submittal log at each progress meeting in accordance with Section 01300.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes the requirements for compiling, processing and transmitting submittals required for execution of the project.
- B. Submittals are categorized into two types: Action Submittals and Informational Submittals, as follows:
 - 1. Action Submittal: Written and graphic information submitted by the Contractor that requires the Engineer's approval. The following are examples of action submittals:
 - a. Shop drawings (including working drawings, valve schedule in accordance with Section 01170, and product data)
 - b. Samples
 - c. Operation & maintenance manuals
 - d. Site Usage Plan (Contractor's staging - including trailer siting and material laydown area)
 - e. Schedule of values
 - f. Payment application format
 - 2. Informational Submittal: Information submitted by the Contractor that does not require the Engineer's approval. The following are examples of informational submittals:
 - a. Shop Drawing Schedule
 - b. Construction Schedule
 - c. Statements of Qualifications
 - d. Health and Safety Plans
 - e. Construction Photography and Videography
 - f. Asset Management
 - g. Work Plans
 - h. Maintenance of Traffic Plans
 - i. Outage Requests
 - j. Proposed Testing Procedures
 - k. Test Records and Reports
 - l. Vendor Training Outlines/Plans
 - m. Test and Start-Up Reports
 - n. Certifications
 - o. Record Drawings
 - p. Record Shop Drawings
 - q. Submittals required by laws, regulations and governing agencies
 - r. Submittals required by funding agencies
 - s. Other requirements found within the technical specifications
 - t. Warranties and Bonds
 - u. As-Built Surveys
 - v. Contract Close-out Documents

1.02 RELATED WORK

- A. Additional requirements may be specified in the Agreement.
- B. Additional submittal requirements may be specified in the respective technical Specification Sections.
- C. Operation and Maintenance manuals are included in Section 01730.
- D. Contract closeout submittals are included in Section 01700.
- E. Warranties and Bonds are included in Section 01740.
- F. Construction Photos are included in Section 01380.
- G. Applications for Payment are included in Section 01026.
- H. Construction Schedules are included in Section 01310.
- I. Project Controls (Surveying) 01050.
- J. Project Record Documents are included in Section 01720.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. All submittals shall be clearly identified as follows:
 - 1. Date of Submission.
 - 2. Project Number.
 - 3. Project Name.
 - 4. Contractor Identification.
 - a. Contractor.
 - b. Supplier.
 - c. Manufacturer.
 - d. Manufacturer or supplier representative.
 - 5. Identification of the Product.
 - 6. Reference to Contract Drawing.
 - 7. Reference to specification section number, page and paragraph(s).
 - 8. Reference to applicable standards, such as ASTM or Federal Standards numbers.
 - 9. Indication of Contractor's approval.
 - 10. Contractor's Certification statement.
 - 11. Identification of deviations from the Contract Documents, if any.

12. Reference to previous submittal (for resubmittals).
 13. Made in America (when required by the Contract).
- B. Submittals shall be clear and legible, and of sufficient size for legibility and clarity of the presented data.
- C. Maintain a log of all submittals. The submittal log shall be kept accurate and up to date. This log should include the following items (as applicable):
1. Description.
 2. Submittal Number.
 3. Date transmitted to the Engineer.
 4. Date returned to Contractor (from Engineer).
 5. Status of Submittal (Approved/Not Approved/etc.).
 6. Date of Resubmittal to Engineer and Return from Engineer (if applicable and repeat as necessary).
 7. Date material released for fabrication.
 8. Projected (or actual) delivery date .
- D. Numbering System. Utilize the following submittal identification numbering system:
1. The first character shall be a D, S, M or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.
 2. The next five digits shall be the applicable Section Number.
 3. The next three digits shall be the sequential number of each separate item or drawing submitted under each Specification Section, in the chronological order submitted, starting at 001.
 4. The last character shall be a letter, A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc. A typical submittal number would be as follows:
 - a. D-03300-008-B.
 - b. D = Shop Drawing03300 = Section for Concrete.
 - c. 008 = the eighth different submittal under this Section.
 - d. B = the second submission (first resubmission) of that particular shop drawing.

E. Variances

1. Notify the Engineer in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
2. Notify the Engineer in writing, at the time of re-submittal (resubmission), of all deviations from previous submissions of that particular shop drawing, except those deviations which are the specific result of prior comments from the Engineer.

F. Action Submittals

1. Shop Drawings, Working Drawings, Product Data and Samples.
 - a. Shop Drawings.
 - 1) Shop drawings as defined in the Bid Documents, and as specified in individual Sections may include, but are not necessarily limited to, custom prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, valve schedules, wiring diagrams, coordination drawings, equipment inspection and test reports, and performance curves and certifications, as applicable to the work.
 - 2) Contractor shall verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and coordinate each item with other related shop drawings and the Contract requirements.
 - 3) All details on shop drawings shall clearly show the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.
 - 4) All shop drawings submitted by subcontractors and vendors shall be reviewed by the Contractor. Contractor shall confirm, materials, dimensions, catalog numbers, technical data and performance criteria; and shall coordinate with other related shop drawings and the Contract requirements. In addition, Contractor shall confirm existing field conditions and dimensions and assure that the submittal is coordinated and compatible with existing conditions. Submittals directly from subcontractors or vendors will not be accepted by the Engineer.
 - 5) The Contractor shall be responsible the accuracy of the subcontractor's or vendor's submittal; and, for their submission in a timely manner to support the requirements of the Contractor's construction schedule. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractor or vendor to correct, before submission to the Engineer. All shop Drawings shall be approved by the Contractor.
 - 6) Delays to construction due to the untimely submission of submittals will constitute inexcusable delays, for which Contractor shall not be eligible for additional cost nor additional contract time. Inexcusable delays consist of any delay within the Contractor's control.
 - 7) Submittals for equipment specified under Divisions 11, 13, 14, 15 and 16 shall include a listing of installations where identical or similar equipment manufactured by that manufacturer has been installed and in operation for a period of at least five years.

- b. Working Drawings
 - 1) Detailed installation drawings (sewers, equipment, piping, electrical conduits and controls, HVAC work, and plumbing, etc.) shall be prepared and submitted for review and approval by the Engineer prior to installing such work. Installation drawings shall be to-scale and shall be fully dimensioned.
 - 2) Piping working drawings shall show the laying dimensions of all pipes, fittings, valves, as well as the equipment to which it is being connected. In addition, all pipe supports shall be shown.
 - 3) Equipment working drawings shall show all equipment dimensions, anchor bolts, support pads, piping connections and electrical connections. In addition, show clearances required around such equipment for maintenance of the equipment.
 - 4) Electrical working drawings shall show conduits, junction boxes, disconnects, control devices, lighting fixtures, support details, control panels, lighting and power panels, and Motor Control Centers. Coordinate all locations with the Contract Documents and the Contractor's other working drawings.

- c. Product Data
 - 1) Product data, as specified in individual Specification Sections, include, but are not limited to, the manufacturer's standard prepared data for manufactured products (catalog data), such as the product specifications, installation instructions, availability of colors and patterns, rough-in diagrams and templates, product photographs (or diagrams), wiring diagrams, performance curves, quality control inspection and reports, certifications of compliance (as specified or otherwise required), mill reports, product operating and maintenance instructions, recommended spare parts and product warranties, as applicable.

- d. Samples
 - 1) Furnish, samples required by the Contract Documents for the Engineer's approval. Samples shall be delivered to the Engineer as specified or directed. Unless specified otherwise, provide at least two samples of each required item. Materials or equipment for which samples are required shall not be used in the work unless and until approved by the Engineer.
 - 2) Samples specified in individual Specification Sections, include, but are not limited to: physical examples of the work (such as sections of manufactured or fabricated work), small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and other specified units of work.
 - 3) Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify and Contract Requirements.
 - 4) Approved samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Approved samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the approved samples. Samples which fail testing or are not approved will be returned to the Contractor at his expense, if so requested at time of submission.

- e. Professional Engineer (P.E.) Certification Form
 - 1) If specifically required in any of the technical Specification Sections, submit a Professional Engineer (P.E.) Certification for each item required, using the form appended to this Section.
2. Contractor's Certification
 - a. Each shop drawing, working drawings, product data, and sample shall have affixed to it the following Certification Statement:
 - 1) "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."
 - b. Shop drawings, working drawings, and product data sheets 11-in x 17-in and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The transmittal cover sheet for each identified shop drawing shall fully describe the packaged data and include a listing of all items within the package.
3. The review and approval of shop drawings, working drawings, product data, or samples by the Engineer shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will have no responsibility therefor.
4. Project work, materials, fabrication, and installation shall conform to approved shop drawings (including working drawings and product data) and applicable samples.
5. No portion of the work requiring a shop drawing (including working drawings and product data) or sample shall be started, nor shall any materials be fabricated or installed before approval of such item. Procurement, fabrication, delivery or installation of products or materials that do not conform to approved shop drawings shall be at the Contractor's risk. Furthermore, such products or materials delivered or installed without approved shop drawings, or in non-conformance with the approved shop drawings will not be eligible for progress payment until such time as the product or material is approved or brought into compliance with approved shop drawings. Neither the District nor Engineer will be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
6. Operation and Maintenance Data
 - a. Operation and maintenance data shall be submitted in assembled manuals as specified. Such manuals shall include detailed instructions for District personnel on safe operation procedures, controls, start-up, shut-down, emergency procedures, storage, protection, lubrication, testing, trouble-shooting, adjustments, repair procedures, and other maintenance requirements.
7. Schedule of Values
 - a. On projects consisting of lump sums (in whole or in part) submit a proposed schedule of values providing a breakdown of lump sum items in to reasonably small components – generally disaggregated by building, area, and/or discipline. The purpose of the schedule of values is for processing partial payment applications. If requested by the Engineer and District, provide sufficient substantiation for all or

some items as necessary to determine the proposed schedule of values is a reasonable representation of the true cost breakdown of the Work. The schedule of values shall not be unbalanced to achieve early payment or over-payment in excess of the value of work or any other mis-distribution of the costs. If, in the opinion of the Engineer, the schedule of values is unbalanced, Contractor shall reallocate components to achieve a balanced schedule acceptable to Engineer and District.

8. Payment Application Format
 - a. If an application form is included in the Contract Documents, use that form unless otherwise approved by the Engineer and District. If an application form is not included in the Contract Documents, Contractor may propose a form for approval.
9. Site Usage
 - a. Submit a proposed site staging plan, including but not limited to the location of office trailers, storage trailers and material laydown. Such plan shall be a graphic presentation (drawing) of the proposed locations; and, shall include on-site traffic modifications, and temporary utilities, as may be applicable.

G. Informational Submittals

1. Shop Drawing Schedule
 - a. Prepare and submit a schedule indicating when shop drawings are required to be submitted to support the as-planned construction schedule. The submittal schedule shall allow sufficient time for preparation and submittal, review and approval, and fabrication and delivery to support the construction schedule.
2. Construction Schedule
 - a. Prepare and submit construction schedules and monthly status reports as specified.
3. Statements of Qualifications
 - a. Provide evidence of qualification, certification, or registration, as required in the Contract Documents, to verify qualifications of licensed land surveyor, professional engineer, materials testing laboratory, specialty subcontractor, technical specialist, consultant, specialty installer, and other professionals.
 - b. Health and Safety Plans
 - 1) When specified, prepare and submit a general company Health and Safety Plan (HSP), modified or supplemented to include job-specific considerations.
4. Construction Photography and Videography
 - a. Provide periodic construction photographs and videography as specified – including but not limited to preconstruction photographs and/or video, monthly progress photos and/or video and post-construction photographs and/or video.
5. Work Plans
 - a. Prepare and submit copies of all work plans needed to demonstrate to the District that Contractor has adequately thought-out the means and methods of construction and their interface with existing facilities.
6. Maintenance of Traffic Plans
 - a. Prepare maintenance of traffic plans where and when required by the Contract Documents and by local ordinances or regulations. If Contractor is not already

knowledgeable about local ordinances and regulations regarding maintenance of traffic requirements, become familiar with such requirements and include all costs for preparation and submittal of traffic management plans and all associated costs for permits and fees to implement the traffic management plan, in the bid amount. In addition, unless a supplemental payment provision is provided in the bid form, include the cost of police attendance, when required.

7. Outage Requests
 - a. Provide sufficient notification of any outages required (electrical, flow processes, etc.) as may be required to tie-in new work into existing facilities. Unless specified otherwise elsewhere, a minimum of seven calendar days' notice shall be provided.
8. Proposed Testing Procedures
 - a. Prepare and submit testing procedures it proposes to use to perform testing required by the various technical specifications.
9. Test Records and Reports
 - a. Provide copies of all test records and reports as specified in the various technical specifications.
10. Vendor Training Outlines/Plans
 - a. At least two weeks before scheduled training of District's personnel, provide lesson plans for vendor training in accordance with the specification for O&M manuals.
11. Test and Start-up Reports
 - a. Manufacture shall perform all pre-start-up installation inspection, calibrations, alignments, and performance testing as specified in the respective Specification Section. Provide copies of all such test and start-up reports.
12. Certifications
 - a. Provide various certifications as required by the technical specifications. Such certifications shall be signed by an officer (of the firm) or other individual authorized to sign documents on behalf of that entity.
 - b. Certifications may include, but are not limited to:
 - 1) Welding certifications and welders' qualifications
 - 2) Certifications of Installation, Testing and Training for all equipment
 - 3) Material Testing reports furnished by an independent testing firm
 - 4) Certifications from manufacturer(s) for specified factory testing
 - 5) Certifications required to indicate compliance with any sustainability or LEEDS accreditation requirements indicated in the Contract Documents
13. Record Drawings
 - a. No later than Substantial Completion, submit a record of all changes during construction not already incorporated into drawings – in accordance with specification on Project Record Documents.
14. Record Shop Drawings
 - a. Before final payment is made, furnish one set of record shop drawings to the Engineer. These record shop drawings shall be in conformance with the approved documents and should show any field conditions which may affect their accuracy.
 - b. Submittals required by laws, regulations and governing agencies

- 1) Prepare and submit all documentation required by state or local law, regulation or government agency directly to the applicable agency. This includes, but is not limited to, notifications, reports, certifications, certified payroll (for projects subject to wage requirements) and other documentation required to satisfy all requirements. Provide to Engineer one copy of each submittal made in accordance with this paragraph.
 - c. Submittals required by funding agencies
 - 1) Prepare and submit all documentation required by funding agencies. This includes, but is not limited to segregated pay applications and change orders when required to properly allocate funds to different funding sources; and certified payrolls for projects subject to wage requirements. Provide one copy of each submittal made in accordance with this paragraph to the Engineer.
15. Other requirements of the technical Specification Sections
 - a. Comply with all other requirements of the technical specifications.
16. Warranties and Bonds
 - a. Assemble a booklet or binder of all warranties and bonds as specified in the various technical specifications and in accordance with the specification on Warranties and Bonds; and provide two originals to the Engineer or District.
17. As-Built Surveys
 - a. Engage the services of a licensed land surveyor in accordance with the Project Controls (Surveying) specification. Prior to Final Completion, provide an as-built survey of the constructed facility, as specified.
18. Contract Close-Out Documents
 - a. Submit Contract documentation as indicated in the specification for Contract Close-out.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTAL SCHEDULE

- A. Provide an initial submittal schedule at the pre-construction meeting for review by District and Engineer. Incorporate comments from District or Engineer into a revised submittal schedule.
- B. Maintain the submittal schedule and provide sufficient copies for review by District and Engineer. An up-to-date submittal schedule shall be provided at each project progress meeting.

3.02 TRANSMITTALS

- A. Prepare separate transmittal sheets for each submittal. Each transmittal sheet shall include at least the following: the Contractor's name and address, District's name, project name, project number, submittal number, description of submittal and number of copies submitted.
- B. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or as otherwise directed by the Engineer.

- C. Provide copies of transmittals forms or cover letters (without attachments) directly to the Resident Project Representative.

3.03 PROCEDURES

A. Action Submittals

1. Contractor's Responsibilities

- a. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required). Coordinate with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. Extensions to the Contract Time will not be approved for the Contractor's failure to transmit submittals sufficiently in advance of the Work.
- b. The submittals of all shop drawings (including working drawings and product data) shall be sufficiently in advance of construction requirements to allow for possible need of re-submittals, including the specified review time for the Engineer.
- c. No less than 30 calendar days will be required for Engineer's review time for shop drawings and O&M manuals involving only one engineering discipline. No less than 45 calendar days will be required for Engineer's review time for shop drawings and O&M manuals that require review by more than one engineering discipline. Resubmittals will be subject to the same review time.
- d. Submittals of operation and maintenance data shall be provided within 30 days of approval of the related shop drawing(s).
- e. Before submission to the Engineer, review shop drawings as follows:
 - 1) make corrections and add field measurements, as required
 - 2) use any color for its notations except red (reserved for the Engineer's notations) and black (to be able to distinguish notations on black and white documents)
 - 3) identify and describe each and every deviation or variation from Contract documents or from previous submissions, except those specifically resulting from a comment from the Engineer on a previous submission
 - 4) include the required Contractor's Certification statement
 - 5) provide field measurements (as needed)
 - 6) coordinate with other submittals
 - 7) indicate relationships to other features of the Work
 - 8) highlight information applicable to the Work and/or delete information not applicable to the Work
- f. Submit the following number of copies:
 - 1) Shop drawings (including working drawings and product data) – Submit no fewer than six, and no more than nine; five of which will be retained by the Engineer.
 - 2) Samples – three
 - 3) Site Usage Plan – three copies
 - 4) Schedule of values – four copies
 - 5) Payment application format – four copies
- g. If Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, provide written notice thereof to the Engineer immediately; and do not release for manufacture before such notice has been received by the Engineer.

final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

- 4) "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the entire package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 30 calendar days of the date of the Engineer's transmittal requiring the resubmittal.
 - 5) "NOT APPROVED" – This code is assigned when the submittal does not meet the intent of the contract documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the contract documents.
 - 6) "COMMENTS ATTACHED" – This code is assigned where there are comments attached to the returned submittal, which provide additional data to aid the Contractor.
 - 7) "RECEIPT ACKNOWLEDGED (Not subject to Engineer's Review or Approval)" – This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval, and is being filed for informational purposes only. This code is generally used in acknowledging receipt of means and methods of construction work plans, field conformance test reports, and health and safety plans.
- f. Repetitive Reviews: Shop drawings, O&M manuals and other submittals will be reviewed no more than twice at the District's expense. All subsequent reviews will be performed at the Contractor's expense. Reimburse the District for all costs invoiced by Engineer for the third and subsequent reviews.

4. Electronic Transmission

- a. Action Submittals may be transmitted by electronic means provided the following conditions are met:
 - 1) The above-specified transmittal form is included.
 - 2) All other requirements specified above have been met including, but not limited to, coordination by the Contractor, review and approval by the Contractor, and the Contractor's Certification.
 - 3) The submittal contains no pages or sheets large than 11 x 17 inches.
 - 4) With the exception of the transmittal sheet, the entire submittal is included in a single file.
 - 5) The electronic files are PDF format (with printing enabled).
 - 6) In addition, transmit three hard-copy (paper) originals to the Engineer.
 - 7) The Engineer's review time will commence upon receipt of the hard copies of the submittal.
 - 8) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit at least two hard-copy originals to the Engineer. In addition, provide additional photocopied or scanned copies, as specified above, showing the required certification, corporate seal, or professional seal.

B. Informational Submittals

1. Contractor's Responsibilities
 - a. Number of copies: Submit three copies, unless otherwise indicated in individual Specification sections
 - b. Refer to individual technical Specification Sections for specific submittal requirements.
2. Engineer's Responsibilities
 - a. The Engineer will review each informational submittal within 15 days. If the informational submittal complies with the Contract requirements, Engineer will file for the project record and transmit a copy to the District. Engineer may elect not to respond to Contractor regarding informational submittals meeting the Contract requirements.
 - b. If an informational submittal does not comply with the Contract requirements, Engineer will respond accordingly to the Contractor within 15 days. Thereafter, the Contractor shall perform the required corrective action, including retesting, if needed, until the submittal, in the opinion of the Engineer, is in conformance with the Contract Documents.
3. Electronic Transmission
 - a. Informational submittals may be transmitted by electronic means providing all of the following conditions are met:
 - 1) The above-specified transmittal form is included.
 - 2) The submittal contains no pages or sheets large than 11 x 17 inches.
 - 3) With the exception of the transmittal sheet, the entire submittal is included in a single file.
 - 4) The electronic files are PDF format (with printing enabled).
 - 5) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit two hard-copy originals to the Engineer.

END OF SECTION

P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional engineer registered in the [State]
[Commonwealth] of _____ and that he/she has been employed by

_____ to design
(Company Name)

(Insert P.E. Responsibilities)

In accordance with Specification Section _____ for the

_____.
(Name of Project)

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state and federal codes, rules and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the

(Insert Name of District)

or District's representative within seven days following written request therefor by the District.

P.E. Name

Company Name

Signature

Signature

P.E. Registration Number

Title

Address

Address

SECTION 01310
CONSTRUCTION SCHEDULING

PART 1 GENERAL

1.01 PROGRAM DESCRIPTION

- A. A Critical Path Method (CPM) construction schedule shall be used to control the Work and to provide a basis for determining job progress. The construction schedule shall be prepared and maintained by the Contractor. All work shall be done in accordance with the established CPM schedule. The Contractor and all subcontractors shall cooperate fully in developing the construction schedule and in executing the work in accordance with the CPM schedule.
- B. The construction schedule shall consist of a computerized CPM network (diagram of activities) presented in a time-scaled graphic (print-out) with reports, as specified herein.

1.02 QUALIFICATIONS

- A. The Contractor shall have the capability of preparing and utilizing the specified CPM schedule, or engage the services of a specialized scheduling professional to do so. Within seven days of the award of contract, provide a résumé or qualifications statement for the individual within the Contractor's organization, or the outside consultant, who is being proposed as the responsible party for development and maintenance of the CPM schedule. The résumé or qualifications statement shall demonstrate that the proposed responsible party has successfully developed and maintained CPM schedules for at least three construction projects of the same size or greater than this project. The proposed responsible party for the CPM schedule is subject to approval by the Engineer and District. If the proposed responsible party for the CPM schedule is not approved by the Engineer and/or District, Contractor shall resubmit a more-appropriate candidate for approval.

1.03 SUBMITTALS

- A. Submit Interim, Preliminary, Baseline (also known as "as-planned") CPM schedules, revisions, and Monthly Status Reports, all including graphics, reports, and narratives, and an as-built schedule, as specified herein.

PART 2 PRODUCTS

2.01 SOFTWARE

- A. Unless otherwise approved by the Engineer, the computer-based schedule shall be generated using Oracle-Primavera Contractor, or P6 Professional Project Management Software.
- B. Provide two copies of the scheduling software program (with licenses) being used by the Contractor, for use by the Engineer and/or District, during construction. Pay for annual license renewals for the duration of the construction project. Provide and pay for technical support for the software provided to the Engineer and District. The licenses shall be registered in the names of the Engineer and District. At the end of construction, the Software will be retained by the Engineer and District.

2.02 NETWORK REQUIREMENTS

- A. Each schedule submittal shall contain the following identifying information:
1. Project Title, District's Contract Number, and the Engineer's Project Number
 2. Contractor's name
 3. All Contract milestones, as specified
 4. The project calendar(s) (including work week and holidays)
 5. Type of submittal (e.g., Interim, Preliminary, Baseline or Monthly Status Report)
 6. A summary contract milestones
 7. Data date and run (print) date
- B. The network of activities shall show the order and inter-dependence of activities; and, show the sequence in which the work is to be accomplished, as planned by the Contractor. The basic concept of a network analysis diagram shall be followed to show how each activity is dependent on preceding activities (predecessors) and following activities (successors).
- C. Detailed network activities shall include, but are not limited to,:
1. mobilization activities,
 2. procurement activities (submittals, review and approval, fabrication, and delivery),
 3. permitting and regulatory activities,
 4. right-of-way activities (including utility agreements that require others to relocate existing utilities that affect the project),
 5. construction activities (including demolition, rehabilitation, new construction and testing),
 6. maintenance of existing facilities,
 7. test and start-up activities (including testing, start-up, training, performance testing, and commissioning),
 8. contract milestones (fixed and floating),
 9. specified sequences, outages and coordination activities, and
 10. any other activities needed to properly identify the scope of work and contract requirements.
- D. All activities shall be sufficiently identified and/or described so that the scope of work of each activity is clear. All work tasks shall be broken down into appropriate scopes and durations to facilitate monitoring progress. Unless otherwise approved by the Engineer, no activities shall have durations of more than one month; except for off-site activities such as procurement and

delivery of materials and equipment - or administrative or management activities that span the project duration that do not reflect earned progress.

- E. Network activities shall be organized (grouped) by phases (or stages), physical areas, buildings, elevations, or other portions of the project.
- F. Separate network activities shall be provided for each significant identifiable function in each trade area in each facility. Separate network activities shall be provided for subcontractors.
- G. The number of network activities, sufficiency of description, and level of breakdown shall be subject to the Engineer's review and approval to confirm conformance with the specified requirements.
- H. The format of the schedule network graphic shall be a time-scaled logic diagram - with a list of network activities and the specified data fields presented adjacent to the graphic display.
- I. The following general requirements also apply to the network diagram.
 - 1. The Critical Path (the sequence of project network activities that add up to the longest overall duration and thereby determines the shortest time possible to complete the project) shall be identified - preferably in 'red'.
 - 2. Unless otherwise approved by the District the Contractor's work schedule shall be based on 'normal work week' as defined in the Contract Documents – (typically 40 hours per week, consisting of five 8-hour days).
 - 3. The graphics shall indicate the calendar(s) on which activity durations are based (i.e., 5-day workweek or 7 calendar day week). When multiple calendars or work weeks are used, the graphics shall clearly indicate which calendars are used where.
 - 4. The project calendar shall include exclusions for holidays observed by the Contractor and those indicated in the Contract Documents.
- J. Each network activity shall have the following information (fields) listed alongside the activity on the graphic display.
 - 1. Activity ID – a manually assigned designation (numeric or alphanumeric). The Contractor should use a logical approach to assigning identification to network activities to facilitate grouping (sorting) of activities.
 - 2. Activity Description
 - 3. Original Duration – including allowances for adverse weather interruptions – normal for the project location. Normal weather shall mean seasonally average weather conditions, as recorded by NOAA.
 - 4. Percent complete – the Contractor's estimated percent complete for each network activity as of the data date for the respective report.
 - 5. Remaining Duration - a calculated value based on Original Duration of each network activity and the estimated percent of completion for each activity.

6. Early Start Date
7. Early Finish Date
8. Late Start Date
9. Latest Finish Date
10. Total Float
11. Cost – an estimated value representing the Contractor's estimate of the accumulated cost of all components of each network activity, including indirect costs and allocated profit and overhead (bid documents, permits, insurance, etc.)

2.03 SUBMITTAL REQUIREMENTS

A. Each schedule submittal shall include the following elements:

1. Graphics – unless otherwise approved by the Engineer, the network graphics shall be printed on 24-inch by 36-inch sheets; including a list of activities and the specified data fields.
2. Narrative
 - a. The Narrative shall consist of a written report by the Contractor providing an overview of the schedule – specific to each submittal.
 - b. The Narratives for developmental submittals, i.e., Interim and Preliminary, shall describe the Contractor's approach to executing the project Work.
 - c. The Narrative for the Baseline Schedule shall:
 - 1) explain key activities and assumptions on which the schedule is based;
 - 2) describe the Critical Path;
 - 3) discuss key deliveries that might adversely affect the project schedule; and,
 - 4) explain the Contractor's approach to adverse weather interruptions – normal for the project location. Normal weather shall mean seasonally average weather conditions, as recorded by NOAA.
 - d. The Narratives provided with Monthly Status Reports (updates) shall also identify:
 - 1) any changes the Contractor has made to the CPM logic (including any added, modified or deleted activities,
 - 2) any delays that have been encountered, and
 - 3) remedial actions or recovery steps the Contractor will employ to arrest and/or recover from such delays.

B. Reports

1. The following reports are required to be submitted with Baseline Schedule, when a major revision is made to the schedule, and when requested by the Engineer or District.
 - a. Activity – a report listing all network activities, sorted by activity ID
 - b. Early Start – a report listing all network activities, sorted by Early Start date
 - c. Total Float – a report listing all network activities, sorted by Total Float (ascending from low to high).

- d. Predecessor/Successor – a report of all activities, sorted by Activity ID that lists all predecessor and successor activities for each network activity.

2.04 ACCEPTABILITY

- A. Submit the CPM schedule submittals, as specified, and resubmit as needed, until they are in compliance with Contract requirements.
- B. The Engineer's review of the Contractor's construction schedule submittals will only be for conformance with the Contract requirements – including but not limited to contract time and work sequences specified in the contract documents. The Engineer's review of the schedule shall not include the Contractor's means and methods of construction or safety. The Engineer's concurrence, acceptance, or approval of the Contractor's schedule submittals will not relieve the Contractor from responsibility for complying with the Contract Scope, Contract Time or any other contract requirement. Any indication of concurrence, acceptance, or approval of the Contractor's schedule will only indicate a general conformance with the Contract Requirements.
- C. Engineer's review of the Contractor's construction schedule submittals shall not relieve the Contractor from responsibility for any deviations from the Contract Documents unless the Contractor has in writing called Engineer's attention to such deviations at the time of submission and Engineer has given written concurrence to the specific deviations, nor shall any concurrence by the Engineer relieve Contractor from responsibility for errors and omissions in the submittals. Concurrence of the CPM Activity Network by the Engineer is advisory only and shall not relieve the Contractor of responsibility for accomplishing the Work within the Contract completion date(s).
- D. Concurrence, acceptance, or approval of the Contractor's CPM schedule by the Engineer in no way makes the Engineer an insurer of the CPM schedule's success, nor liable for time or cost overruns resulting therefrom.
- E. Failure to include any element of work required for the performance of this Contract will not excuse the Contractor from completing all Work required within the Contract completion date(s), notwithstanding the review of the network by the Engineer.
- F. CPM schedules that contain activities with negative float, or which extend beyond the contract completion date, will not be acceptable.
- G. Except where earlier completions are specified, CPM schedules which show completion of all work prior to the contract completion date may be indicated; however, in no event shall they constitute a basis for claim for delay by the Contractor.

PART 3 EXECUTION

3.01 IMPLEMENTATION SCHEDULE

- A. Interim Schedule
 - 1. Within 15 days following the receipt of the Effective Date of the Agreement, submit an Interim Schedule indicating the planned operations during the first 60 calendar days after Effective Date of the Agreement. In addition, the Contractor shall indicate its general approach for the balance of the project.

2. Within 15 days following the receipt of the Effective Date of the Agreement, meet with the Engineer and District to discuss and agree on the proposed standards for the CPM schedule. At this conference submit to the Engineer a preliminary network defining the planned operations during the first 60 calendar days after Effective Date of the Agreement. In addition, the Contractor shall indicate its general approach for the balance of the project.
3. While the Preliminary schedule is being developed, the Contractor shall update the Interim schedule on a monthly basis – indicating actual progress - until the Preliminary schedule is submitted.

B. Preliminary Schedule

1. Within 45 days following the receipt of Effective Date of the Agreement, submit a proposed Preliminary Schedule to the Engineer. The Preliminary Schedule shall consist of a draft computer-generated CPM-schedule showing the entire Scope of Work. The Preliminary Schedule shall not include any actual progress earned during development of the schedule (i.e., stated as of the Effective Date of the Agreement).
2. Within 15 days of submittal of the Preliminary Schedule (i.e., within 60 days of receipt of the Effective Date of the Agreement), meet with the Engineer and District to discuss the review comments.
3. Once the Preliminary Schedule is submitted, Contractor shall discontinue updating the Interim Schedule. Provide monthly updates of the Preliminary Schedule until concurrence, acceptance, or approval of the Baseline Schedule.

C. Baseline (as-planned) Schedule

1. With 10 days of the review meeting on the Preliminary Schedule submittal, the Contractor shall incorporate the Engineer's comments into the network and submit a Baseline Schedule. Resubmit the Baseline Schedule, as required until it is deemed acceptable as stated in Paragraph 2.04, above.
2. Upon concurrence, acceptance, or approval of the Contractor's initial Baseline Schedule, stated as of the Effective Date of the Agreement date, it shall be recognized as the basis against which the Contractor's progress shall be measured.

D. Monthly Status Reports

1. Monthly Status Reports shall include updated graphics and a narrative. In addition, if requested by the Engineer or District, Contractor shall provide copies of one or more of the standard reports listed in Paragraph 2.03.B.
2. Provide Monthly Status Reports (schedule updates) commencing approximately 30 days after submission of the Interim Schedule. Unless approved otherwise by the Engineer or District, the Monthly Status Reports shall be stated as of the end of each calendar month.
3. While the Preliminary Schedule is being developed, the Contractor shall update the Interim schedule on a monthly basis – indicating actual progress - until the Preliminary Schedule is submitted.

4. While the Baseline Schedule is being developed, the Contractor shall update the Preliminary Schedule on a monthly basis – indicating actual progress - until concurrence, acceptance, or approval of the Baseline Schedule.
5. Once the initial Baseline Schedule is complete, Monthly Status Reports shall be based on the Baseline Schedule.

E. As-Built Schedule

1. Upon achieving Substantial Completion, the Contractor shall submit an as-built schedule, showing all activities from the Effective Date of the Agreement through Substantial Completion. In addition, provide the reports listed in Paragraph 2.03.B. A Narrative is not required.

3.02 DELIVERABLES

- A. Unless approved otherwise by the Engineer, all schedule submittals shall be printed in color on sheets 24-in by 36-in and may be divided into as many separate sheets as required.
- B. Interim Schedule: Submit three copies to the Engineer.
- C. Preliminary Schedule: Submit three hard (paper) copies to the Engineer.
- D. Baseline Schedule: Submit three hard (paper) copies, one electronic copy (PDF), and a copy of the program files to the Engineer.
- E. Monthly Status Reports: Submit three copies and one electronic copy on CD to the Engineer; and if requested, an electronic copy of the program files for the respective update.
- F. As-Built Schedule: Submit one hard copy; one electronic (PDF), and, if requested, an electronic copy of the program files.

3.03 PROGRESS REPORTING

- A. Progress under the approved CPM schedule shall be reported monthly by the Contractor by submitting a Monthly Status Report. Unless otherwise approved by the Engineer, not less than seven days prior to the due date of the Monthly Status Report, the Contractor shall meet with the Engineer's and District's representative to jointly evaluate the status of each network activity. Each activity shall be updated to reflect the actual progress (percent complete) and the actual dates activities were started and completed, as applicable.
- B. The Monthly Status Report shall include an update of the computer-generated network graphics and a Narrative report. The Narrative shall include:
 1. A description of the progress during the reporting period in terms of completed activities
 2. A summary of the Critical Path
 3. An description or explanation of each delays to network activities
 4. A description of problem areas, current and anticipated delaying factors and their anticipated effect on the performance of other activities and completion dates

5. An explanation of corrective action taken or proposed.
6. This report, as well as the CPM Status Report, will be discussed at each progress meeting.

3.04 RESPONSIBILITY FOR SCHEDULE COMPLIANCE

- A. Whenever it becomes apparent from the current CPM schedule and CPM Status Report that delays to the critical path have resulted and the contract completion date will not be met, or when so directed by the District, take some or all of the following actions at no additional cost to the District. Submit to the District and Engineer for approval, a written statement of the steps intended to take to remove or arrest the delay to the critical path in the approved schedule.
 1. Increase construction manpower in such quantities and crafts,
 2. Increase the number of working hours per shift, shifts per day, working days per week,
 3. Increase the amount of construction equipment, and/or
 4. Reschedule activities to maximize the concurrence of activities and comply with the revised schedule.
- B. If when so requested by the District, failure to submit a written statement of the steps intended to take or should fail to take such steps as approved by the District, the District may direct the Contractor to increase the level of effort in man-power (trades), equipment and work schedule (overtime, weekend and holiday work, etc.) to be employed by the Contractor in order to remove or arrest the delay to the critical path in the approved schedule and the Contractor shall promptly provide such level of effort at no additional cost to the District.

3.05 ADJUSTMENT OF CONTRACT SCHEDULE AND COMPLETION TIME

- A. If the Contractor wants or needs to make changes in his/her execution of the construction schedule that would affect the approved CPM schedule, he/she shall notify the District and Engineer in writing stating what changes are proposed and the reasons for the changes. If the District approves such changes, the Contractor shall revise and submit a revised schedule for approval - without additional cost to the District. The CPM schedule shall be adjusted by the Contractor only after prior approval of his/her proposed changes. Adjustments may consist of changing portions of the activity sequence, activity durations, division of approved activities, or other adjustments as may be approved by the District and Engineer; however, the addition of extraneous, non-working activities and activities that add unapproved restraints to the CPM schedule will not be allowed.
- B. Shop drawings that are not approved on the first submittal will require the addition of network activities for the resubmittals.
- C. Equipment that does not pass the specified tests will require the addition of network activities for the retesting.
- D. The contract completion time will be adjusted only for causes specified in this Contract. In the event the Contractor requests an extension of any contract completion date, he/she shall furnish such justification and supporting evidence as the District may deem necessary to determine whether the Contractor is entitled to an extension of time under the provisions of this Contract.

After receipt of such justification and supporting evidence, the Construction Manager's shall perform an assessment or evaluation of the appropriate change in contract time based upon the currently approved CPM schedule and on all data relevant to the extension. Inexcusable delays (attributable to the Contractor) and non-critical delays (delays to activities which, according to the CPM schedule, do not affect any contract completion date shown by the Critical Path) shall not be the basis for a change in contract time. The Engineer will provide a written recommendation to the District based on its assessment, with a copy to the Contractor. The Contractor shall not change any fixed contract milestones or required completion dates without the approval of the District, evidenced by the execution of a contract change order. However, the Contractor should make note of such requests for changes in contract time in the narrative of monthly schedule status reports.

- E. Each request for change in any contract completion date shall be submitted by the Contractor to the District and Engineer in accordance with the notification requirements stipulated in the form of contract or Bid Documents. No time extension will be granted for requests that are not submitted in accordance with the Contract requirements.
- F. Total float in the approved CPM network belongs to the project; i.e., either the District or Contractor may take advantage of available total float on a first-come, first-served basis. Therefore, without obligation to extend either the overall completion date, or any intermediate completion dates set out in the CPM network, the District may initiate changes to the work or delay work that absorb available total float existing at the time of the change or delay. District initiated changes or delays that affect the Critical Path on the approved CPM network shall be the sole grounds for extending (or contracting) contract completion dates or fixed milestones.

3.06 COORDINATING SCHEDULES WITH OTHER CONTRACT SCHEDULES

- A. Coordinate this contract with the construction of the raw water transmission main, under a separate contract.

END OF SECTION

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SECTION 01370
SCHEDULE OF VALUES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Submit a Schedule of Values allocated to the various portions of the work, within 15 days after the effective date of the Agreement.
- B. Upon request of the Engineer, support the values with data which will substantiate their correctness.
- C. The accepted Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.02 RELATED REQUIREMENTS

- A. Application for Payment is included in Section 01026.
- B. Instructions to Respondents of the Construction Contract are included in the Front-End Documents provided by District.

1.03 FORM AND CONTENT OF SCHEDULE OF VALUES

- A. Type schedule on an 8-1/2-in by 11-in or 8-1/2-in by 14-in white paper. Contractor's standard forms and automated printout will be considered for approval by the Engineer and the District upon Contractor's request. Identify schedule with:
 - 1. Title of Project and location.
 - 2. Engineer and Project number.
 - 3. Name and Address of Contractor.
 - 4. Contract designation.
 - 5. Date of submission.
- B. Schedule shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.
- C. Identify each line item with the number and title of the respective Section.
- D. For each major line item list sub-values of major products or operations under the item.
- E. For the various portions of the work:
 - 1. Each item shall include a directly proportional amount of the Contractor's overhead and profit.

2. For items on which progress payments will be requested for stored materials, break down the value into:
 - a. The cost of the materials, delivered and unloaded, with taxes paid. Paid invoices are required for materials upon request by the Engineer or District.
 - b. The total installed value.

F. The sum of all values listed in the schedule shall equal the total Contract Sum.

1.04 SUBSCHEDULE OF UNIT MATERIAL VALUES

A. Submit a sub-schedule of unit costs and quantities for:

1. Products on which progress payments will be requested for stored products.

B. The form of submittal shall parallel that of the Schedule of Values, with each item identified the same as the line item in the Schedule of Values.

C. The unit quantity for bulk materials shall include an allowance for normal waste.

D. The unit values for the materials shall be broken down into:

1. Cost of the material, delivered and unloaded at the site, with taxes paid.
2. Copies of invoices for component material shall be included with the payment request in which the material first appears.
3. Paid invoices shall be provided with the second payment request in which the material appears or no payment shall be allowed and/or may be deleted from the request.

E. The installed unit value multiplied by the quantity listed shall equal the cost of that item in the Schedule of Values.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01380
PRE- AND POST-CONSTRUCTION VIDEO PHOTOGRAPHY

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required to videotape all construction areas within the project area, as shown in the Drawings and as specified herein, prior to any construction work and after all construction work is finished.

1.02 QUALIFICATIONS

- A. The photography shall be done by a competent camera operator who is fully experienced and qualified with the specified equipment.
- B. The audio shall be recorded in the presence of the District or Engineer in a clear and easily understood manner.

1.03 COST OF PHOTOGRAPHY

- A. The cost of the photography shall be a subsidiary obligation of the Contractor, and no separate payment will be made. Parties requiring additional copies will pay photographer directly.

1.04 AUDIO-VISUAL VIDEOS (DVDs)

- A. DVD recordings shall not be made more than 60 days prior to construction or after substantial completion. No construction shall begin prior to review and approval of the videos covering the construction area by the Engineer. The Engineer shall have the authority to reject all or any portion of a DVD not conforming to specifications and order that it be redone at no additional charge. The Contractor shall reschedule unacceptable coverage within five days after being notified. The Engineer shall designate those areas, if any, to be omitted from or added to the audio-visual coverage. All DVDs and written records shall be immediately submitted to and become the property of the District.
- B. The Contractor shall produce professional-grade videos (DVDs). The color audio-visual DVDs shall be reproduced by a responsible commercial firm regularly engaged in the business of color audio-video tape documentation.

PART 2 PRODUCTS

2.01 DVDs

- A. The DVD shall be of professional quality.

2.02 AUDIO-VISUAL RECORDING

- A. The audio-visual system and the procedures employed in its use shall be such as to produce a finished product that will meet professional standards. The video portion of the recording shall produce bright, sharp, clear pictures with accurate colors and shall be free from distortion or 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 time and date

information must be continuously and simultaneously generated with the actual recording. The audio portion of the recording shall be of high clarity and be free from distortion.

PART 3 EXECUTION

3.01 VIDEO RECORDING

- A. The recordings shall contain coverage of all visible features within the construction zone of influence. These features shall include, but not be limited to, all roadways, pavement, retention ponds, railroad tracks, curbs, driveways, sidewalks, culverts, head-walls, retaining walls, landscaping, trees, fences, visible utilities, structures and all buildings. Of particular concern shall be the condition of existing vegetation, terrain, and structures and the existence or non-existence of any faults, fractures or defects. Panning, zoom-in and zoom-out rates shall be sufficiently controlled to maintain a clear view of the subjects.

3.02 FINAL PRODUCT

- A. The final product shall be two sets of fully edited audio/video DVDs, one set pre-construction and one set post-substantial completion.
- B. Three copies of each set shall be delivered to the Engineer.

END OF SECTION

SECTION 01390
CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.01 REQUIREMENTS

- A. Furnish a competent photographer to take construction record photographs monthly during the course of the Work.

1.02 PHOTOGRAPHY REQUIRED

- A. Provide color photographs taken immediately prior to the cutoff date for each scheduled Application for Payment. Submit photographs within 14 days of the photograph dates.
- B. For pipelines, duct banks, and other utilities, provide initial photographs of the entire pipeline route prior to any construction. Photographs shall be spaced at approximately 300-foot intervals along the route.
- C. For cast-in-place structures, untrenched road crossings, and stream crossings, provide two photographs each month of each structure and crossing taken at each major stage of construction for each scheduled Application for Payment.
- D. Views and quantities required:
 - 1. Photography locations to be approved in advance by the Engineer.
 - 2. Provide photos in digital format.
 - 3. Provide at least 10 views of periodic construction photographs per week.
 - 4. Provide aerial photography of the entire project site. Do not extend limits past the project boundary in order to provide the greatest level of detail of the entire work area. Provide three different views at the following periods of the Project.
 - a. Prior to commencement of the Work.
 - b. Each month of construction.
 - c. At project completion.
- E. Negatives:
 - 1. Photographs shall be taken with a digital camera.
 - 2. The Contractor shall convey images to the Engineer on a thumb drive and electronic transmission as designated in Section 01300 Submittals.

1.03 COST OF PHOTOGRAPHY

- A. The cost of the photography shall be a subsidiary obligation of the Contractor and no separate payment will be made. Parties requiring additional photography will pay photographer directly.

PART 2 PRODUCTS

2.01 FORMAT

- A. Photos shall be submitted electronically in a PDF format.
- B. Identify for each photo:
 - 1. Name of Project.
 - 2. Orientation of View.
 - 3. Date and time of exposure.
 - 4. Name and address of photographer.
 - 5. Photographer's numbered identification of exposure.

PART 3 EXECUTION

3.01 TECHNIQUE

- A. Use 8.0 megapixel or higher digital camera.

3.02 VIEWS REQUIRED

- A. Photograph from locations to adequately illustrate condition of construction and state of progress.
 - 1. At successive periods of photography, take at least one photograph from the same overall views of work under way as previously photographed, as directed by Engineer.
 - 2. Consult with the Engineer at each period of photography for instructions concerning views required.

3.03 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to District for unlimited reproduction of photographic documentation.

3.04 DELIVERY OF IMAGES

- A. Deliver images of the previous month photos to the Engineer to accompany the subsequent Application for Payment.
- B. No construction shall start until pre-construction photographs are completed and submitted to Engineer in accordance with Section 01380.

3.05 DURATION AND PAYMENT

- A. Monthly photos are required to the date of substantial completion of the project regardless of time overruns or extensions. No additional total payment will be made for the additional photos except where the scope of work has been increased with a corresponding time increase. See Section 01025 for specifics on payment.

END OF SECTION

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SECTION 01400
QUALITY CONTROL

PART 1 GENERAL

1.01 QUALITY CONTROL PLAN

- A. General: The Contractor shall furnish for approval by the District, the Contractor Quality Control (CQC) plan within 10 calendar days after award of contract. The plan shall identify personnel, procedures, instructions, records, and forms to be used. If the Contractor fails to submit an acceptable CQC plan within the time herein prescribed, the District may refuse to allow construction to start until such time as the Contractor submits an acceptable final plan. No progress payments will be made by the District until the CQC plan is accepted by the District.
- B. The Contractor Quality Control Plan: This plan shall include, as a minimum, the following:
1. A description of the quality control organization, including chart showing lines of authority and acknowledgment that the Contractor's quality control staff shall report to the Project Manager or someone higher in the Contractor's organization.
 2. The name, qualifications, duties, responsibilities, and authorities of each person assigned a quality control function.
 3. A copy of a statement signed by an authorized official of the Contractor's firm, which describes the responsibilities and delegates the authorities of the CQC System Manager.
 4. Procedures for scheduling and managing submittals, including those of subcontractors, off-site fabricators, suppliers and purchasing agents.
 5. Control testing procedures for each specific test.
 6. Reporting procedures including proposed reporting formats.
- C. Acceptance of Plan: Acceptance of the plan by the District is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction.
- D. Notification of Changes: After acceptance of the CQC plan, the Contractor shall notify the District in writing of any proposed change. Proposed changes are subject to acceptance by the District.

1.02 QUALITY CONTROL ORGANIZATION

- A. CQC System Manager: CQC System Manager shall be responsible for overall management of the CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager for this Contract shall be fully qualified by experience and technical training, to ensure compliance with contract plans and specifications. This person shall demonstrate his/her ability to perform correctly the duties required of him/her to the satisfaction of the District, shall be physically at the project site whenever work is in progress, and shall be in charge of the Contractor's Quality Control program for this project. All the Contractor's submittals for approval shall be reviewed and modified or corrected as needed by the CQC System Manager

or his/her authorized assistants and approved correct prior to forwarding of such submittals to the District. The CQC System Manager may be a qualified employee, as described herein, of the Contractor. If the CQC System Manager is also the Contractor's superintendent, then the superintendent may also perform as the Contractor's Site Safety Representative but will not be allowed to perform more than these three roles on this project.

1.03 SUBMITTALS

- A. Submittals shall be as specified in Section 01300. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CONTROL

- A. Contractor Quality Control is the means by which the Contractor assures himself that the construction complies with the requirements of the Contract Plans and Specifications. The controls shall be adequate to cover all construction operations, including both onsite and offsite operations and will be keyed to the proposed construction sequence. The controls shall include at least three phases of inspection for all definitive features of work as follows:
 - 1. Preparatory Inspection: This shall be performed prior to beginning any definable feature of work. It shall include a review of Contract requirements; a check to assure that all materials and/or equipment have been tested, submitted, and approved; a check to assure that provisions have been made to provide required control testing; examination of the work area to ascertain that all preliminary work has been completed, and a physical examination of materials, equipment, and sample work to assure that they conform to approved shop drawings or submittal data and that all materials and/or equipment are on hand.
 - 2. Initial Inspection: This shall be performed as soon as a representative portion of the particular feature of work has been accomplished and shall include examination of the quality of workmanship and a review of control testing for compliance with contract requirements, use of defective or damaged materials, omissions, and dimensional requirements.
 - 3. Follow-up Inspections: These shall be performed daily to assure continuing compliance with Contract requirements, including control testing, until completion of the particular feature of work. Such inspection shall be made a matter of record in the CQC documentation as required below. Final follow-up inspections shall be conducted and deficiencies corrected prior to the addition of new features of work.

3.02 TESTS

- A. Test Procedures: The Contractor shall perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. The Contractor shall procure the services of an industry recognized testing laboratory. A list of tests which the Contractor understands are to be performed shall be furnished as a part of the CQC plan to the District. The list shall give the test name, specification paragraph containing the test

requirements, and the personnel and laboratory responsible for each type of test. The Contractor shall perform the following activities and record and provide the following data:

1. Verify that testing procedures comply with Contract requirements.
2. Verify that facilities and testing equipment are available and comply with testing standards.
3. Verify that test instrument calibration data are checked against certified standards.
4. Verify that recording forms, including all of the test documentation requirements, have been prepared.

3.03 COMPLETION INSPECTION

- A. At the completion of all work or any increment thereof established by a specified completion time, the CQC System Manager shall conduct a completion inspection of the work and develop a "punch list" of items which do not conform to the approved plans and specifications. Such a list shall be included in the CQC documentation and shall include the estimated date by which the deficiencies will be corrected. The CQC System Manager or his/her staff shall make a second completion inspection to ascertain that all deficiencies have been corrected and so notify the District. The completion inspection and any deficiency corrections required by this paragraph will be accomplished within the time stated for completion of the entire work or any particular increment thereof, if the project is divided into increments by separate completion dates.

3.04 DOCUMENTATION

- A. The Contractor shall maintain current records of quality control operations, activities, and tests performed including the work of suppliers and subcontractors. These records shall be maintained on an acceptable form (sample form attached) and indicate a description of trades working on the project, the number of personnel working, the weather conditions encountered, any delays encountered, and acknowledgment of deficiencies noted along with the corrective actions taken on current and previous deficiencies. In addition, these records shall include factual evidence that required activities or tests have been performed including, but not limited to, the following:
 1. Type and number of control activities and tests involved.
 2. Results of control activities or tests.
 3. Nature of defects, causes for rejection, etc.
 4. Proposed remedial action.
 5. Corrective actions taken.
- B. These records shall cover both conforming and defective or deficient features and shall include a statement that supplies and materials incorporated in the work comply with the requirements of the Contract. Legible copies of these records shall be furnished to the District daily and not later than the day following the previous day.

3.05 NOTIFICATION OF NONCOMPLIANCE

- A. The District or Engineer will notify the Contractor of any noncompliance with the foregoing requirements. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor or the Contractor's representative at the site of the work, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the District may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

END OF SECTION

(FORM FOLLOWS)

CONTRACTOR QUALITY CONTROL DAILY REPORT

REPORT NO. _____ CONTROL NO. _____ DATE _____

LOCATION OF WORK: _____

DESCRIPTION: _____

WEATHER _____; RAINFALL _____ INCHES; TEMP - MIN _____ MAX _____

1. Work Performed Today by Prime Contractor (Include Plant and Labor Breakdown): _____

2. Work Performed Today by Subcontractors (Include Plant and Labor Breakdown):

3. List Specific Inspection Performed and Results of these Inspections.
(Include Corrective Actions):

4. List Type and Location of Tests Performed and Results of these Tests:

5. Verbal Instructions Received from District or Engineer on Construction Deficiencies or Re-testing Required: _

6. Equipment on Site: _____

7. Personnel on Site: _____

General: _____

Electric: _____

Paving: _____

Other (Specify): _____

8. Remarks: _____

9. CERTIFICATION: I certify that the above report is complete and correct and that I, or my authorized representative, have inspected the work performed this day by the Prime Contractor and each subcontractor and have determined that all materials, equipment and workmanship are in strict compliance with the plans and specifications except as may be noted above.

Contractor's Designated Quality Control System Manager

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SECTION 01410
TESTING AND TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. The Contractor shall employ and pay for the services of an Independent Testing Laboratory to perform testing specifically indicated on the Contract Documents and may at any other time elect to have materials and equipment tested for conformity with the Contract Documents. Soil and concrete testing shall be scheduled by the Contractor
 - 1. Cooperate with the laboratory to facilitate the execution of its required services.
 - 2. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the work of the Contract.
 - 3. The Contractor shall submit the qualifications and experience of the proposed testing laboratory to the District and Engineer for approval prior to beginning any testing related work.

1.02 RELATED REQUIREMENTS

- A. Conditions of the Contract: Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities.
- B. Respective Sections: Certification of products.
- C. Each Section listed: Laboratory tests required and standards for testing.
- D. Testing Laboratory inspection, sampling and testing is required for but not limited to the following:
 - 1. Earthwork (included in Section 02200).
 - 2. Trenching, Backfilling and Compaction (included in Section 02221).
 - 3. Concrete and reinforcement (included in Section 03300).
 - 4. Grout (included in Section 03600).

1.03 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

- A. Laboratory is not authorized to:
 - 1. Release, revoke, alter or enlarge on requirements of Contract Documents.
 - 2. Approve or accept any portion of the work.
 - 3. Perform any duties of the Contractor.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. Cooperate with laboratory personnel, provide access to work, to manufacturer's operations.
- B. Secure and deliver to the laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.
- C. Provide to the laboratory the preliminary design mix proposed to be used for concrete and other materials mixes which require control by the testing laboratory.
- D. Materials and equipment used in the performance of work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard requirements for quality and workmanship are indicated in the Contract Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor, and no extra charge to the District shall be allowed on account of such testing and certification.
- E. Furnish incidental labor and facilities:
 - 1. To provide access to work to be tested.
 - 2. To obtain and handle samples at the project site or at the source of the product to be tested.
 - 3. To facilitate inspections and tests.
 - 4. For storage and curing of test samples.
- F. Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
 - 1. When tests or inspections cannot be performed after such notice, reimburse District for laboratory personnel and travel expenses incurred due to Contractor's negligence.
- G. Employ and pay for the services of the same or a separate, equally qualified independent testing laboratory to perform additional inspections, sampling and testing required for the Contractor's convenience.
- H. If the test results indicate the material or equipment complies with the Contract Documents, the District shall pay for the cost of the testing laboratory via the testing allowance. If the tests and any subsequent retests indicate the materials and equipment fail to meet the requirements of the Contract Documents, the Contractor shall pay for the laboratory costs directly to the testing firm or the total of such costs shall be deducted from any payments due the Contractor. Failed tests shall not be assessed to the testing allowance.
- I. Provide District and Engineer with all testing reports.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 01445
PIPELINE TESTING AND CLEANING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and test and clean all new pipelines installed under this Contract as specified herein.

1.02 RELATED WORK

- A. Buried pipelines are included in Division 2.
- B. Above grade, chemical piping and exposed pipelines are included in Division 15.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Furnish all necessary equipment and labor for cleaning and testing and chlorinating the pipelines. The procedures and methods shall be approved by the Engineer.
- B. Make any taps and furnish all necessary caps, plugs, etc., as required in conjunction with testing pipelines. Furnish a test pump, gauges and any other equipment required in conjunction with carrying out the hydrostatic tests.

3.02 CLEANING PIPELINES

- A. As pipe laying progresses and at the conclusion of the work, thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

3.03 TESTING PRESSURE PIPELINES

- A. All pressure pipelines shall be pressure and leakage tested. Pipelines shall be subjected to a hydrostatic pressure of 200 psi on the discharge side of the intake pump station. Pipelines shall be subjected to a hydrostatic pressure of 150 psi on the suction side of the intake pump station. The leakage test shall be conducted at the test pressure shall be maintained for at least two hours. The test pump and water supply shall be arranged to allow accurate measurement of the water required to maintain the test pressure. The amount of leakage which will be permitted shall be in accordance with AWWA C600.

END OF SECTION

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SECTION 01465
EQUIPMENT TESTING AND STARTUP

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide a competent field services technician of the manufacturers of all equipment furnished under Divisions 11, 13, 15 and 16 to supervise installation, adjustment, initial operation and testing, performance testing, final acceptance testing and startup of the equipment.
- B. Perform specified equipment field performance tests, final acceptance tests and startup services.

1.02 RELATED WORK

- A. Operation and Maintenance Data is included in Section 01730.
- B. Performance and acceptance testing and startup requirements are included in the respective sections of Divisions 11, 13, 15 and 16.

1.03 SUBMITTALS

- A. Submit name, address and resume of proposed field services technicians at least 30 days in advance of the need for such services.
- B. Submit, in accordance with Section 01300, detailed testing procedures for shop tests, field performance tests and final acceptance tests as specified in the various equipment sections. Submittals shall include the following:
 - 1. Test procedures shall be submitted at least 30 days in advance of the proposed test dates and shall include at least the following information:
 - a. Name, classification, model and serial number of equipment to be tested, including reference to specifications section number and title.
 - b. Testing schedule of proposed dates and times for testing.
 - c. Summary of power, lighting, water, etc., needs and identification of who will provide them.
 - d. Outline specific assignment of the responsibilities of the Contractor and manufacturers' factory representatives or field service personnel.
 - e. Detailed description of step-by-step testing requirements, with reference to appropriate standardized testing procedures and laboratory analyses by established technical organizations (e.g., ASTM, WPCF Standard Methods, etc.).
 - f. Samples of forms to be used to collect and record test data and to present tabulated test results.
 - 2. Copies of test reports upon completion of specified shop, performance and acceptance tests. Test reports shall incorporate the information provided in the test procedures submittals and modified to reflect actual conduct of the tests and the following additional information:
 - a. Copy of all test data sheets and results of lab analyses.
 - b. Summary comparison of specified test and performance requirements vs actual test results.

- c. Should actual test results fail to meet specified test and performance requirements, describe action to be taken prior to re-testing the equipment.
 3. Copies of the manufacturer's field service technician's report summarizing the results of their initial inspection, operation, adjustment and pre-tests. The report shall include detailed descriptions and tabulations of the points inspected, tests and adjustments made, quantitative results obtained, suggestions for precautions to be taken to ensure proper maintenance, and the equipment supplier's Certificate of Installation in the format specified herein.

1.04 REFERENCE STANDARDS

- A. American Water Works Association (AWWA)
- B. ASTM International
- C. Water Environment Federation (WEF)
- D. Standard Methods for the Examination of Water and Wastewater (Latest Revision)
- 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. Field service technicians shall be competent and experienced in the proper installation, adjustment, operation, testing and startup of the equipment and systems being installed.
- B. Manufacturers' sales and marketing personnel will not be accepted as field service technicians unless they can prove their qualifications.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PRELIMINARY REQUIREMENTS

- A. After installation of the equipment has been completed and the equipment is presumably ready for operation, before it is operated by others, the manufacturer's field service technician shall inspect, operate, test and adjust the equipment. The inspection shall include at least the following points where applicable:
 1. Soundness (without crack or otherwise damaged parts).
 2. Completeness in all details, as specified and required.
 3. Correctness of setting, alignment and relative arrangement of various parts.
 4. Adequacy and correctness of packing, sealing and lubricants.
- B. The operation, testing and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.

- C. Upon completion of this work, the manufacturer's field service technician shall submit a signed report of the results of their inspection, operation, adjustments and tests.

3.02 WITNESS REQUIREMENTS

- A. Shop tests or factory tests may be witnessed by the District and/or District's representatives, as required by the various equipment specifications.
- B. Field performance and acceptance tests shall be performed in the presence of the District, the District's designed personnel and/or District's representatives.

3.03 STARTUP AND ACCEPTANCE OF THE TREATMENT PLANT AND RELATED SYSTEMS

A. General Requirements

1. Successfully execute the step-by-step procedure of startup, normal operation, shutdown, and performance demonstration specified herein.
2. The startup and performance demonstration shall be successfully executed prior to Substantial Completion and acceptance by the District of the facility and its related systems.
3. All performance tests and inspections shall be scheduled at least 10 working days in advance or as otherwise specified with the District and the Engineer. All performance tests and inspections shall be conducted during the work week of Monday through Friday, unless otherwise specified.

B. Preparation for Startup

1. All mechanical and electrical equipment shall be checked to ensure that it is in good working order and properly connected. Preliminary run-ins of the pumps, and other remaining equipment shall be made. All systems shall be cleaned and purged as required. All pipes and equipment which are hydraulically checked shall be drained and returned to their original condition once the water testing is complete.
2. All instruments and controls shall be calibrated through their full range. All other adjustments required for proper operation of all instrumentation and control equipment shall be made.
3. Perform all other tasks needed for preparing and conditioning the facility for proper operation.
4. No testing or equipment operation shall take place until it has been verified by the Engineer that all specified safety equipment has been installed and is in good working order.
5. No testing or equipment operation shall take place until it has been verified by the Engineer that all lubricants, tools, maintenance equipment, spare parts and approved equipment operation and maintenance manuals have been furnished as specified.

C. Facilities Startup

1. Startup period shall not begin until all new treatment facilities and equipment have been tested as specified and are ready for operation. The District shall receive spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data and the specified operation and maintenance instruction prior to the startup with raw wastewater. All valve tagging shall also be complete prior to this startup.
2. Demonstrate a seven consecutive 24-hour day period of successful operation of the facility as a prerequisite of Substantial Completion and Acceptance. This testing will be the responsibility of the Contractor.
3. In the event of failure to demonstrate satisfactory performance of the facility on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. When the facility is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the facility has operated continuously to the satisfaction of the District and Engineer, for the specified duration.
4. The District will furnish all operating personnel (other than manufacturer's or subcontractor's service personnel) needed to operate equipment during the final test period after substantial completion; however, said personnel will perform their duties under Contractor's direct supervision. Until performance tests are completed and units and systems are accepted by the District as substantially complete, the Contractor shall be fully responsible for the operation and maintenance of all new facilities.
5. The District will provide all necessary electricity for startup. However, the Contractor shall provide all necessary personnel of the various construction trades, i.e., electricians, plumbers, etc, and field service personnel of the major equipment suppliers on an 8 hour per day basis at the facilities and on a 24 hour per day basis locally during the startup period. Major equipment suppliers shall include, but not be limited to, the following:
 - a. Instrumentation and Control Equipment: unwitnessed and witnessed factory testing
 - b. All Pumping Equipment
 - c. Electrical Control Systems
 - d. Generator Equipment
 - e. HVAC and Plumbing
6. Do not, at any time, allow the facility to be operated in a manner which subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

EQUIPMENT SUPPLIER'S CERTIFICATE OF INSTALLATION

District _____

Project _____

Contract No. _____

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial no.)

installed for the subject project has (have) been installed in a satisfactory manner, has (have) been tested and adjusted, and is (are) ready for final acceptance testing and operation on :

Date _____

Time _____

CERTIFIED BY: _____
(Signature of Manufacturer's Representative)

Date: _____

END OF SECTION

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SECTION 01500
TEMPORARY FACILITIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, equipment, materials, and incidentals necessary and provide separate temporary facilities for the Contractor's use as specified herein and as shown on the drawings. Temporary offices shall be established on the job site where approved or directed by the District, adequately furnished and maintained in a clean, orderly conditions by the Contractor. The Contractor or an authorized representative shall be present in the field office at all times while work is in progress
- B. Operate and maintain temporary facilities for the duration of the project and as directed by the District. All cost and use charges for temporary facilities shall be included in the Contract Price.

1.02 RELATED WORK

- A. Control of Work is included in Section 01046.
- B. Special Provisions is included in Section 01170.

1.03 SUBMITTALS

- A. Submit shop drawings and product data, in accordance with Section 01300, showing materials of construction and details of installation for:
 - 1. Site Plan: Show the proposed locations for temporary facilities including offices, temporary utilities, storage containers/buildings, vehicle access and parking areas, material laydown and staging areas, temporary fencing, and other security measures.
 - 2. Temporary Fence: Layout drawings which indicate dimensions, access to fire hydrants, gate locations and opening sizes, and other site-specific requirements.
 - 3. Project Sign: Layout, graphics, and wording.
- B. Submittals shall be received by the Engineer no later than the date of the Preconstruction Meeting.

1.04 QUALITY ASSURANCE

- A. Temporary facilities shall comply with all applicable state and local ordinances, codes and regulations.
- B. Coordinate with authorities having jurisdiction to inspect (and test if required) temporary facilities.
- C. Obtain all required permits for temporary facilities.

1.05 DEFINITIONS

- A. Duration of the project: The period of time from the date of the Effective Date of the Agreement to the date of Final Completion, inclusive.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Temporary Fence: Fabric shall be No. 9 gauge galvanized wire woven in two-in diamond mesh with top and bottom twisted selvage. Intermediate and terminal posts shall be galvanized steel H or pipe, minimum 2-3/8-in OD line posts, 2-7/8-in OD corner and pull posts, and 1-5/8-in OD top rails.
- B. Project Sign: Plywood shall be A-A EXT-APA grade, 1-in thick. Posts and braces shall be pressure treated lumber.

2.02 EQUIPMENT

- A. Fire Extinguishers: Provide portable, UL-rated with class and extinguishing agent required by locations and classes of fire exposure. Provide at least one for each trailer/office.
- B. Temporary Heat: Provide vented, self-contained, liquid propane gas or fuel oil heaters with individual space thermostatic control. Equipment shall be listed and labeled for type of fuel consumed and marked for intended use.

2.03 CONTRACTOR'S FIELD OFFICE

- A. Provide a temporary field office(s) for the Contractor's use for the duration of the project. An authorized representative of the Contractor shall be present at all times while the Work is in progress. Instructions received at the Contractors field office from the Engineer or District shall be considered delivered to the Contractor.
- B. Locate field office(s) in accordance with approved shop drawings and as directed by the District.
- C. Establish and occupy field office within 30 days of the Effective Date of the Agreement, unless otherwise approved by the Engineer or District.

2.04 TEMPORARY POWER AND LIGHT

- A. Contractor shall be responsible for providing temporary power until such time that permanent service can be installed. Power service for bypass pumping activities, if required, will not be provided and shall be provided by the Contractor.
- B. The Contractor shall provide connections to existing facilities sized to provide service required for power and lighting. The Contractor shall pay the costs of fuel for heating.
- C. The Contractor shall provide properly configured NEMA polarized outlets to prevent insertion of 110-120 Volt plugs into higher voltage outlets. For connection of power tools and equipment, provide outlets equipped with ground-fault circuit interrupters, reset button and pilot light.

- D. The Contractor shall provide grounded extension cords. Use heavy duty cords where exposed to abrasion and traffic. The Contractor shall provide waterproof connectors to connect separate lengths of electric cords if more than one length is required.
- E. The Contractor shall provide general service incandescent lamps as required for adequate illumination. The Contractor shall provide guard cages or tempered glass enclosures where exposed to breakage. The Contractor shall provide exterior fixtures where exposed to moisture.

2.05 WEATHER PROTECTION

- A. Contractor shall furnish, install and maintain temporary heat and enclosures to provide adequate working areas for personnel during the cold weather months.
- B. The Contractor shall furnish temporary heating units (UL or FM listed) to maintain reasonable temperatures within temporary enclosures.
- C. Weather protection shall comply with M.G.L. Chapter 149 Section 44G.

2.06 TEMPORARY AIR, STEAM AND WATER

- A. Provide all air, steam and water, including temporary piping and appurtenances required for cleaning and testing pipelines and equipment. Remove temporary piping and appurtenances upon approval of equipment being tested.

2.07 SANITARY FACILITIES

- A. Provide self-contained, single occupant toilet units of the chemical, aerated recirculation, or combustion type, properly vented and fully enclosed in a fiberglass or other approved non-absorbent shell.

2.08 CONSTRUCTION AIDS

- A. Provide temporary elevators, hoists, cranes, scaffolding and platforms as necessary to perform the Work. Provide temporary stairs where ladders are not adequate. Protect permanent stairs from damage from construction operations.

2.09 TEMPORARY FENCE

- A. Provide temporary fence as shown on the Drawings, as specified herein, and as the Contractor requires for site security.
 - 1. Provide six-ft high chain link fence with at least two vehicle and two pedestrian access gates. Gates shall be equipped with locking hardware and padlocks. Furnish two sets of keys to Engineer and District. Coordinate with local first responders for access during non-work hours.
 - 2. Fence installation shall comply with ASTM F567. Post spacing shall not exceed 8-ft on center. Posts shall be set plumb in concrete footings.
 - 3. Perform daily inspections of fence and immediately repair or replace damaged or compromised sections and as directed by the Engineer.

4. A temporary fence shall be installed prior to the removal of the existing fence. At no time shall the site note have complete fencing around the site.

2.10 WASTE MANAGEMENT

- A. Provide covered dumpster, minimum four-cubic yards, dedicated for field office waste. Provide separate covered dumpster of adequate size for construction debris. Empty dumpsters on a regular basis and as directed by the Engineer. Dumpsters shall not exceed their capacities at any time.

2.11 PROJECT SIGNS

- A. Furnish and install the project signs indicated in Specification 01580. Signs shall be placed as directed by the District; and, shall remain maintained in good condition for the life of the construction period.
- B. Remove signs at final acceptance, unless otherwise directed.

2.12 REMOVAL AND RESTORATION

- A. Remove each temporary facility complete when need for its service has ended and as approved by the District. Coordinate removal of temporary facilities with authorities having jurisdiction.
- B. Restore all improvements damaged by the installation, operation, and removal of the temporary facilities. Obtain prior approval from District and Engineer for restoration work. Comply with the restoration requirements of Section 01046.

END OF SECTION

SECTION 01520
CONSTRUCTION AIDS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. Furnish, install and maintain required construction aids, and remove on completion of the Work.

1.02 RELATED REQUIREMENTS

- A. Summary of Work is included in Section 01010.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials may be new or used, suitable for the intended purpose, but must not violate requirements of applicable codes and standards.

2.02 CONSTRUCTION AIDS

- A. Provide construction aids and equipment required by personnel and to facilitate execution of the Work; Scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes and other such facilities and equipment.

- 1. Refer to respective sections for particular requirements for each trade.

- B. When permanent stair framing is in place, provide temporary treads, platforms and railings, for use by construction personnel.

- C. Maintain facilities and equipment in first-class condition.

2.03 TEMPORARY ENCLOSURES

- A. Provide temporary weather-tight enclosure of exterior walls for successive areas of building as work progresses, as necessary to provide acceptable working conditions, provide weather protection for materials, allow for effective temporary heating and to prevent entry of unauthorized persons.

- 1. Provide temporary exterior doors with self-closing hardware and padlocks.

- 2. Other enclosures shall be removable as necessary for work and for handling of materials.

PART 3 EXECUTION

3.01 PREPARATION

- A. Consult with the Engineer, review site conditions and factors which affect construction procedures and construction aids, including adjacent properties and public facilities which may be affected by execution of the Work.

3.02 GENERAL

- A. Comply with applicable requirements specified in sections of Divisions 2 through 16.
- B. Relocate construction aids as required by progress of construction, by storage or work requirements and to accommodate legitimate requirements of District and other Contractors employed at the site.

3.03 REMOVAL

- A. Completely remove temporary materials, equipment and services:
 - 1. When construction needs can be met by use of permanent construction.
 - 2. At completion of work.
- B. Clean and repair damage caused by installation of or by use of temporary facilities.
 - 1. Remove foundations and underground installations for construction aids.
 - 2. Grade areas of site affected by temporary installations to required elevations and slopes and clean the area.
- C. Restore permanent facilities used for temporary purposes to specified condition or in kind if not specified.

END OF SECTION

SECTION 01562
DUST CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Perform dust control operations, in an approved manner, whenever necessary or when directed by the Engineer and District, even though other work on the project may be suspended. Dust control shall be generally accomplished by the use of water; however, the use of calcium chloride may be used when necessary to control dust nuisance. Cost of dust control shall be included in base bid price.
- B. Calcium chloride shall conform to AASHTO M144, Type I except the requirements for "total alkali chlorides" and other impurities shall not apply.
- C. Methods of controlling dust shall meet all air pollutant standards as set forth by Federal and State regulatory agencies.

END OF SECTION

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SECTION 01580
PROJECT IDENTIFICATION AND INFORMATIONAL SIGNS

PART 1 GENERAL

1.01 REQUIREMENTS

- A. Furnish, install and maintain project identification and informational signs.
- B. Remove sign on completion of construction.
- C. Allow no other signs to be displayed.

1.02 RELATED WORK

- A. Finishes are provided in Division 9.

1.03 SUBMITTALS

- A. Submit in accordance with the requirements of Section 01300.

1.04 INFORMATIONAL SIGNS

- A. Painted signs with painted lettering, or standard products.
 - 1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.
 - 2. Colors: as required by regulatory agencies, otherwise of uniform colors throughout Project.
- B. Erect at appropriate location to provide required information.

1.05 QUALITY ASSURANCE

- A. Sign Painter: Professional Experience in type of work required.
- B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

PART 2 PRODUCTS

2.01 SIGN MATERIALS

- A. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.
- B. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.
 - 1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.
- C. Rough Hardware: Galvanized

- D. Paint: Exterior quality, as specified in Division 9.
 - 1. Use Bulletin colors for graphics.
 - 2. Colors for structure, framing, sign surfaces and graphics: As selected by the Engineer.

PART 3 EXECUTION

3.01 MAINTENANCE

- A. Maintain signs and supports in a neat, clean condition; repair damages to structure, framing or sign.

3.02 REMOVAL

- A. Remove signs, framing, supports and foundations at completion of project.

END OF SECTION

SECTION 01600
DELIVERY, STORAGE, AND HANDLING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.02 TRANSPORTATION AND DELIVERY

- A. Transport and handle items in accordance with manufacturer's instructions.
- B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.
- C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.
- D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.
- E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- F. Provide necessary equipment and personnel to unload all items delivered to the site.
- G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct and items are undamaged. For items furnished by others (i.e., District, other contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems.
- H. If any item has been damaged, such damage shall be repaired at no additional cost to the District.

1.03 STORAGE AND PROTECTION

- A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and shall be their responsibility. Instruction shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.
- B. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- C. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground

or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in a manner to reduce breakage, cracking and spalling to a minimum.

- D. All mechanical and electrical equipment and instruments subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a weather-tight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer.
1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.
 2. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
 3. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.
 4. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.
- E. All paint and other coating products shall be stored in areas protected from the weather. Follow all storage requirements set forth by the paint and coating manufacturers.

END OF SECTION

SECTION 01700
CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies administrative, verification and procedural requirements for project closeout, including but not limited to:
 - 1. Final cleaning (Section 01710).
 - 2. Operation, instrumentation and control adjustments (Section 13).
 - 3. Project Record Documents (Section 01720).
 - 4. Spare parts and maintenance materials (spare paint, lubricants, special tools) (applicable Sections in Divisions 09 through 16).
 - 5. Record Shop Drawings (Section 01300).
 - 6. Warranties, guarantees, and bonds (Section 01740) and applicable Sections in Technical Divisions 10 through 16.
 - 7. Reconciliation of final accounting, final change order, final payment application and Contractor's releases.
 - 8. Permit close-outs including Certificate of Occupancy or Certificate of Completion.

1.02 RELATED WORK

- A. Operation and Maintenance (O&M) data and manuals (Section 01730) and applicable Sections in Technical Divisions.
- B. Certified Surveyor documentation submittals (Section 01050).

1.03 CLOSEOUT PROCEDURES

- A. Provide all deliverables as specified, prior to submitting the final payment application.
- B. Provide submittals to Engineer that are required by governing or other authorities having applicable jurisdiction including but not limited to permit close out information, certificates of occupancy, etc.
- C. Submit Application for Final Payment identifying total adjusted Contract Sum, previous payments and sum remaining due, following submittal and approval of Record Documents and Record Drawings.
- D. Submit Contractor's Final Release and Release of Liens with final payment application.

1.04 FINAL CLEANING

- A. Contractor to complete final cleaning prior to submittal of the final application for payment.
- B. Contractor to comply with requirements as specified in Section 01710.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01710
CLEANING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Execute cleaning, during progress of the work, and at completion of the work.

1.02 RELATED WORK

- A. Instructions to Respondents of the Construction Contract with District.

1.03 DISPOSAL AND CLEANING

- A. The Contractor shall conduct cleaning and disposal operations to comply with codes, ordinances, regulations and anti-pollution laws.

PART 2 PRODUCTS

2.01 MATERIALS

- A. The Contractor shall use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
- B. The Contractor shall use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.
- C. The Contractor shall use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 EXECUTION

3.01 DURING CONSTRUCTION

- A. The Contractor shall execute periodic cleaning to keep the work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.
- B. The Contractor shall provide on-site containers for the collection of waste materials, debris and rubbish.
- C. The Contractor shall remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

3.02 DUST CONTROL

- A. The Contractor shall clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

- B. The Contractor shall schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

- A. The Contractor shall employ skilled workmen for final cleaning.
- B. The Contractor shall remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed interior and exterior surfaces.
- C. The Contractor shall wash and shine glazing and mirrors.
- D. The Contractor shall polish glossy surfaces to a clear shine.
- E. Ventilating Systems:
 - 1. The Contractor shall clean permanent filters and replace disposable filters if units were operated during construction.
 - 2. The Contractor shall clean ducts, blowers and coils if units were operated without filters during construction.
- F. The Contractor shall broom clean exterior paved surfaces; rake clean other surfaces of the grounds.
- G. Prior to final completion, or District occupancy, conduct an inspection of sight-exposed interior and exterior surfaces and all work areas, to verify that the entire work is clean.

END OF SECTION

SECTION 01720
PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall keep and maintain, at the job site, a copy of contract documents, marked up to indicate all changes made during the course of a project, as specified herein.

1.02 RELATED REQUIREMENTS

- A. Contract close-out submittals are included in Section 01700.
- B. Warranties and bonds are included in Section 01740.
- C. As-built construction schedules are included in Section 01310.
- D. As-built wiring diagrams are included in Section 01730.
- E. As-built surveys are included in Section 01050.
- F. Record shop drawings are included in Section 01300.
- G. Construction photographs are included in Section 01380.

1.03 REQUIREMENTS INCLUDED

- A. Contractor shall maintain a record copy of the following documents, marked up to indicate all changes made during the course of a project:
 - 1. Contract Drawings
 - 2. Record Drawings
 - 3. Specifications
 - 4. Addenda
 - 5. Change orders and other modifications to the contract
 - 6. Engineer's and District's Supplemental Instructions Forms or written instructions
 - 7. Approved shop drawings, working drawings, and samples
 - 8. Field test records
 - 9. Construction photographs

- B. Contractor shall assemble copies of the following documents for turnover to the Engineer and District at the end of the project, as specified.
1. District's Supplemental Instructions Forms, Change Orders, Design Modifications, and RFIs
 2. Field Test records
 3. Permits and permit close-outs (final approvals)
 4. Certificate of Occupancy or Certificate of Completion, as applicable
 5. Laboratory test reports (e.g., bacteriological and primary & secondary water quality)
 6. Certificates of Compliance for materials and equipment
 7. Record Shop Drawings
 8. Samples
 9. Record Drawings and Specifications

C. RECORD DRAWINGS

1. The Contractor shall annotate (mark-up) the Contract Drawings to indicate all project conditions, locations, configurations, and any other changes or deviations that vary from the original Contract Drawings. This requirement includes, but is not limited to, buried or concealed construction, and utility features that are revealed during the course of construction. Special attention shall be given to recording the locations (horizontal and vertical) and material of all buried utilities that are encountered during construction – whether or not they were indicated on the Contract Drawings. The record information added to the drawings may be supplemented by detailed sketches, if necessary, clearly indicating, the Work, as constructed.
2. These annotated Contract Drawings constitute the Contractor's Record Drawings and are actual representations of as-built conditions, including all revisions made necessary by change orders, design modifications, requests for information and District's Supplemental Instructions Forms.
3. Record drawings shall be accessible to the District and Engineer at all times during the construction period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS AND SAMPLES

- A. Store documents and samples in Contractor's field office apart from documents used for construction.
1. Provide files and racks for storage of the record documents.

2. Provide locked cabinet(s) or secure storage space for storage of samples.
- B. File documents and samples in accordance with Construction Specifications Institute (CSI) format.
- C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.
- D. Make documents and sample available for inspection by the Engineer or District at all times.
- E. Up-to-date Record Drawings may be a pre-requisite of processing periodic monthly pay applications, if so specified under the section for progress payments.

3.02 MARKING METHOD

- A. Use the color Red (indelible ink) to record information on the Drawings and Specifications,
- B. Label each document "PROJECT RECORD" in neat large printed letters.
- C. Unless otherwise specified elsewhere, notations shall be affixed to hardcopies of documents.
- D. Record information contemporaneously with construction progress.
- E. Legibly mark drawings with as-built information:
 1. Elevations and dimensions of structures and structural elements.
 2. All underground utilities (piping and electrical), structures, and appurtenances
 - a. Changes to existing structure, piping and appurtenance locations.
 - b. Record horizontal and vertical locations of underground structures, piping, utilities and appurtenances, referenced to permanent surface improvements.
 - c. Record actual installed pipe material, class, size, joint type, etc.

3.03 RECORD INFORMATION COMPILATION

- A. Do not conceal any work until the required information is acquired.
- B. Drawings: Legibly mark to record actual construction.
- C. Do not conceal any work until the required information is acquired.
- D. Items to be recorded include, but are not limited to:
 1. Location of internal utilities and appurtenances concealed in the construction – referenced to visible and accessible features.
 2. Field changes of dimensions and/or details;
 - a. Interior equipment and piping relocations.
 - b. Architectural and structural changes, including relocation of doors, windows, etc.
 - c. Architectural schedule changes.

3. Changes made by District's Supplemental Instructions Form, change order, design modification, and RFI, and approved shop drawings.
4. Details not indicated on the original contract drawings.
5. Specifications - legibly mark each section to record: Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed, and changes made by District's Supplemental Instructions Form, Change Order, RFI, and approved shop drawings.
6. Coordinates and elevations of each valve and fitting.
7. All underground duct banks with elevations and dimensions, horizontal and vertical locations of underground duct banks, and manholes along duct banks.
8. Depths of various elements of foundations in relation to finish first floor datum
9. All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of all underground utilities, valves, and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class, etc. All pipes shall be labeled using the method as per the contract drawings.
10. All underground cable elevations and horizontal locations of underground cables.
11. All existing and new structures clearly identified.
12. All elevations of new structures (including weirs) clearly indicated.
13. Architectural schedule changes according to Contractor's records and shop drawings
14. Location, elevation, and datum of Benchmark used.
15. Easements as shown on approved paving and drainage drawings.
16. Locations, elevations, sizes, types and material of the following must be accurately shown and labeled (as applicable).
 - a. Manholes (including specialty lining material, pipe invert, manhole rim, and bottom elevations).
 - b. Valves.
 - c. Water and sewer services.
 - d. Fire Hydrant and all associated structures.
 - e. Fittings.
17. All water and sewer mains must be identified on the record drawings by their size, material, and DR/SDR classification. Horizontal locations and top of pipe elevations must also be labeled every 100 linear feet. **All valves shall be labeled using the method as per the contract drawings.**
18. All new hydrant locations shall be identified based upon the Florida State Plane Coordinate System.

- E. Specifications - legibly mark each Section to record:
 - 1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually installed.
 - 2. Changes made by District's Supplemental Instructions Form, Change Order, RFI, and approved shop drawing.
- F. Shop Drawings (after final review and approval):
 - 1. Five sets of record drawings for each process equipment, piping, electrical system and instrumentation system.

3.04 SUBMITTAL

- A. If specified under the section for progress payments, monthly applications for payment will be contingent upon up-to-date Record Drawings. If requested by the Engineer or District, Contractor shall provide a copy of the Record Drawings, or present them for review prior to processing monthly applications for payment.
- B. Upon substantial completion of the WORK and prior to final acceptance, the Contractor shall finalize and deliver a complete set of Record Drawings to the Engineer conforming to the construction records of the Contractor. The set of drawings shall consist of corrected and annotated drawings showing the recorded location(s) of the Work. Unless specified otherwise elsewhere, Record Drawings shall be in the form of a set of prints with annotations carefully and neatly superimposed on the drawings in red.
- C. Upon substantial completion of the Work and prior to final acceptance, the Contractor shall finalize and deliver a complete set of Record Documents to the Engineer conforming to the construction records of the Contractor. The set of documents shall consist of corrected and annotated documents showing the as-installed equipment and all other as-built conditions not indicated on the Record Drawings.
- D. The information submitted by the Contractor into the Record Drawings and Record Documents will be assumed to be correct, and the Contractor shall be responsible for the accuracy of such information, and shall bear the costs resulting from the correction of incorrect data. Final Record Drawings shall be certified by a surveyor licensed in the State of Florida.
- E. Delivery of Record Drawings and Record Documents to the Engineer will be a prerequisite to Final payment.
- F. The Contractor shall maintain a copy of all books, records, and documents pertinent to the performance under this Agreement for a period of five years following completion of the contract.

END OF SECTION

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SECTION 01730
OPERATION AND MAINTENANCE DATA AND ASSET MANAGEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project.

1.02 RELATED WORK

- A. Submittals are included in Section 01300.
- B. Contract closeout is included in Section 01700.
- C. Warranties and Bonds are included in Section 01740.

1.03 OPERATING MANUALS

- A. The Manufacturer shall provide specific operation and maintenance instructions for all electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections.
- B. Six complete sets of operation and maintenance manuals approved by the Engineer covering all equipment furnished under Divisions 11, 13, 15 and 16 shall be delivered at least 30 days prior to scheduled start-up directly to the District. One set of originals must be part of the six sets of operation and maintenance instructions required, including original manuals covering components manufactured by others.
- C. An electronic copy of the manual will be provided with each hard copy submittal.
- D. Separate manuals shall be provided for each type of equipment, or each Section number. Each manual shall contain the following specific requirements. Manuals that do not meet the requirements will be rejected and Equipment Supplier/Manufacturer will bear all expenses to resubmit the manual to meet the following requirements.

1. Format and Materials

- a. Binders:
 - 1) Commercial quality three ring binders with durable and cleanable plastic covers
 - 2) Maximum ring width capacity: 3 inches
 - 3) When multiple binders are used, correlate the data into related consistent groupings/volumes.
- b. Identification: Identify each volume on the cover and spine with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". Include the following:
 - 1) Title of Project.
 - 2) Identify the general subject matter covered in the manual.
 - 3) Identify structure(s) and/or location(s), of the equipment provided.
 - 4) Specification Section number.
- c. 20 lb loose leaf paper, with hole reinforcement

- d. Page size: 8-1/2 inch by 11 inch
 - e. Provide heavy-duty fly leafs (section separators), matching the table of contents, for each separate product, each piece of operating equipment, and organizational sections of the manual.
 - f. Provide reinforced punched binder tab; bind in with text.
 - g. Reduce larger drawings and fold to the size of text pages - but not larger than 11 inches x 17 inches - or provide a suitable clear plastic pocket (with drawing identification) for such folded drawings/diagrams.
2. Contents:
- a. A table of contents/Index, divided into section reflective of the major components provided.
 - b. Specific description of each system and components
 - c. Name, address, telephone number(s) and e-mail address(es) of vendor(s) and local service representative(s)
 - d. Equipment Supplier/Manufacturer shall clearly strike out portions of manual that do not apply to the project. Manual will be rejected until inapplicable information is deleted and only applicable information is clearly indicated
 - e. Specific on-site operating instructions (including starting and stopping procedures)
 - f. Safety considerations
 - g. Project specific operational procedures and recommended log sheet(s).
 - h. Project specific maintenance procedures
 - i. Manufacturer's operating and maintenance instructions – specific to the project
 - j. Copy of each wiring diagram
 - k. Copy of approved shop drawing(s) and Contractor's coordination/layout drawing(s)
 - l. List of spare parts and recommended quantities
 - m. Product Data: Mark each sheet to clearly identify specific products and component parts and data applicable to installation. Delete inapplicable information.
 - n. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams
 - o. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified.
 - p. Warranties and Bonds, as specified in the Bid Documents
 - q. Equipment attributes sheet for submittal of nameplate data
 - r. Electronic copy of manual on CD
3. Transmittals
- a. Prepare separate transmittal sheets for each manual. Each transmittal sheet shall include at least the following: Contractor's name and address, District's name, project name, project number, submittal number, description of submittal and number of copies submitted.
 - b. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or as otherwise directed by the Engineer.
 - c. Provide copies of transmittals (only, i.e., without copies of the respective submittal) directly to the Resident Project Representative.

- E. Manuals for Equipment and Systems - In addition to the requirements listed above, for each System, provide the following:
1. Overview of system and description of unit or system and component parts. Identify function, normal operating characteristics and limiting conditions. Include legible performance curves, with engineering data and tests and complete nomenclature and commercial number of replaceable parts.
 2. Panelboard circuit directories including electrical service characteristics, controls and communications and color-coded wiring diagrams as installed.
 3. Operating procedures: include start-up, break-in and routine normal operating instructions and sequences; regulation, control, stopping, shut-down and emergency instructions; and summer, winter and any special operating instructions.
 4. Maintenance Requirements
 - a. Procedures and guides for trouble-shooting; disassembly, repair, and reassembly instructions
 - b. Alignment, adjusting, balancing and checking instructions
 - c. Servicing and lubrication schedule and list of recommended lubricants
 - d. Manufacturer's printed operation and maintenance instructions
 - e. Sequence of operation by instrumentation and controls manufacturer
 - f. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance
 5. Control diagrams by controls manufacturer as installed (as-built)
 6. Contractor's coordination drawings, with color coded piping diagrams, as installed (as-built)
 7. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams. Include equipment and instrument tag numbers on diagrams.
 8. List of original manufacturer's spare parts and recommended quantities to be maintained in storage
 9. Test and balancing reports, as required
 10. Additional Requirements as specified in individual product specification
 11. Design data for systems engineered by the Contractor or its Suppliers
- F. Manual for Materials and Finishes - In addition to the requirements listed above, for each material or finish, provide the following:
1. Building Products, Applied Materials and Finishes: Include product data, with catalog number, size, composition and color and texture designations. Provide information for re-ordering custom manufactured products.

2. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
3. Moisture Protection and Weather Exposed Products: Include product data listing, applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance and repair.
4. Additional Requirements: As specified in individual product specifications.

G. Electronic Transmission of O&M Manuals

1. Unless otherwise approved by the Engineer, O&M manuals may not be transmitted by electronic means other than by CD-ROM or USB flash drive. Electronic O&M manuals shall meet the following conditions:
 - a. The above-specified transmittal form is included.
 - b. All other requirements specified above have been met, including, but not limited to, coordination by the Contractor, review and approval by the Contactor.
 - c. The submittal contains no pages or sheets large than 11 x 17 inches.
 - d. With the exception of the transmittal sheet, the entire submittal is included in a single file.
 - e. Files are Portable Document Format (PDF) – with the printing function enabled.
 - f. The Vendor provided equipment, sub-system, or system manuals shall be in PDF format, compliant with the Adobe PDF Specification Version 1.7. The manual shall be Searchable Image. The Optical Character Recognition of the image shall be at a 95% confidence level. The manuals shall be linked and bookmarked as follows:
 - 1) Provide links from all Table of Contents, List of Tables, List of Figures, etc., entries to the actual occurrence in the body of the manual.
 - 2) Create bookmarks for all linked Table of Content entries.
 - g. All drawings shall be in PDF format, compliant with the Adobe PDF Specification Version 1.7. The manual shall be PDF Searchable Image. The Optical Character Recognition of the image shall be at a 95% confidence level. The drawings shall be linked as follows:
 - 1) External links from the Drawing Index (if it exists) to each drawing.
 - 2) External links from references within drawings to other drawings.
 - h. All scanned manufacturer's O&M manuals must be quality checked after scanning to ensure the page are not crooked and all information is legible.
2. When electronic copies are provided, transmit two hard copy (paper) originals to the Engineer with an electronic copy on CD-ROM.
3. The electronic copy of the O&M manual shall be identical in organization, format and content to the hard copies of the manual.
4. The electronic O&M Manual shall be bookmarked identically to the paper manual table of contents to allow quick access to information. Electronic submittals that require extensive scrolling will not be accepted. The document shall be indexed and searchable.

H. Quick Reference Sheets for Equipment

1. For each item of equipment furnished under Divisions 11, 15, and 16 provide the following:
 - a. A minimum of one 8 ½ x 11-inch laminated quick reference sheet. Sheets shall be three hole punched and may be double sided.
 - b. Each quick reference sheet shall include the following minimum information:
 - 1) Safety Procedures:
 - a) Brief descriptions of each piece of equipment and components;
 - b) Starting and stopping procedures;
 - c) Special operating instruction;
 - d) Routine maintenance procedures;
 - e) Calibration procedures;
 - f) Pump curves;
 - g) Trouble shooting procedures; and
 - h) Name, address, and telephone numbers of local service representative.
 - c. Provide three copies of quick reference sheets for review by the Engineer.
 - d. After quick reference sheets have been approved, provide four copies of laminated quick reference sheets to the Engineer in one commercial coiled three-ring binder with durable and cleanable plastic cover.

1.04 SERVICES OF MANUFACTURERS' REPRESENTATIVE

- A. A. All electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections shall include the cost of a competent representative of the manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment; and, to instruct the District's operating personnel on operation and maintenance. This supervision may be divided into two or more time periods to suit the Contractor's schedule and/or the District's personnel availability.
- B. See the detailed specifications for additional requirements for furnishing the services of manufacturer's representatives.
- C. The manufacturer's representative shall certify that the installation of the equipment is satisfactory; that the unit has been satisfactorily tested; that the equipment is ready for operation; and, that the operating personnel have been suitably instructed in the operation, maintenance, care, and safe operation of the equipment. The Equipment Manufacturer's Certificate of Installation, Testing, and Instruction attached to this Section shall be used for this certification.
- D. For other materials furnished under other specification Sections, furnish the services of approved representative(s) of the manufacturer when, in the opinion of the Engineer, some evident product failure or malfunction makes such services necessary.

1.05 EQUIPMENT ATTRIBUTE INFORMATION

- A. Equipment Attribute Worksheets as presented at the end of this Section shall be provided for all equipment meeting the asset definition as follows:
 1. Asset Definition

- a. Maintenance is recommended
 - b. Assets have a value greater than \$1,000
 - c. Assets are complete and usable, and perform a distinct function independently (i.e., they pump waste, remove solids, etc.)
- B. This asset definition is intended to give a general indication of which equipment must be included in the Equipment Attribute Worksheets. The Engineer will provide the specific list of equipment that the Vendor must provide information for.
- C. The information requirements are shown in detail in the table. The data requirements include nameplate data, manufacturer and supplier information, information specific to the type of equipment, and recommended preventative maintenance activities.
- D. An electronic copy of the Equipment Attribute Worksheets must be delivered in Excel format and submitted to the Engineer on CD-ROM and submitted with the O&M manuals. It is not necessary to submit printed copies of the Equipment Attribute Worksheets.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTAL SCHEDULE

- A. Operation and maintenance manuals shall be delivered directly to the office of the Engineer, as follows:
1. Provide preliminary copies of each manual to the office of the Engineer, no later than 30 days following approval of the respective shop drawings.
 2. Provide final copies of each completed manual prior to testing.
 3. Provide a letter that grants the Engineer and District to the limited right to use and reproduce each manual (in its entirety or any portion thereof) from the respective equipment manufacturer(s). Such limited right shall allow the Engineer and District to use each manual or any portion thereof for:
 - a. The potential assembly of a comprehensive facility operation and maintenance manual for the sole benefit of the District; and,
 - b. Supplemental training of the District's personnel and operators, over and above the required vendor's training, regarding operation of the facility as a system.
- B. The Engineer will review Operation and Maintenance manuals submittals for operating equipment for conformance with the requirements of the applicable specification Section. The review will generally be based on the O&M Manual Review Checklist appended to this Section.
- C. If during test and start-up of equipment, any changes were made to the equipment, provide two hard copies of as-built drawings or any other amendments for insertion, by the Contractor, in the previously transmitted final manuals. In addition, provide one revised electronic version including the as-built drawings and any other amendments. The manuals shall be completed, including updates, if any, within 30 days of start-up and testing of the facility.

3.02 VENDOR TRAINING/INSTRUCTIONS (TO DISTRICT'S PERSONNEL)

- A. Before final initiation of operation, Contractor's vendors shall train/instruct District's designated personnel in the operation, adjustment, and maintenance of products, equipment and systems at times convenient to the District.
- B. Unless specified otherwise under the respective equipment specification section, vendor training/instruction shall consist of eight hours of training for each type of equipment. Such training/instruction shall be scheduled and held at times to accommodate the work schedules of District's personnel, including splitting the required training/instruction time into separate sessions and/or presented at reasonable times other than the Contractor's "normal working hours" or the District's normal day shift.
- C. Use operation and maintenance manuals as basis for instruction. Train/instruct the District's personnel, in detail, based on the contents of manual explaining all aspects of operation and maintenance of the equipment. If the respective equipment is inter-related to the operation of other equipment, all interlock, constraints, and permissives shall be explained.
- D. At least two weeks prior to the schedule for vendor training, a detailed lesson plan, representative of the material to be covered during instruction, shall be submitted to the Engineer for approval. Lesson plans shall consist of in-depth outlines of the training material, including a table of contents, resume of the instructor, materials to be covered, start-up procedures, maintenance requirements, safety considerations, and shut-down procedures.
- E. Prepare and insert additional data in each Operation and Maintenance Manual when the need for such data becomes apparent during training/instruction.
- F. Vendor's training/instruction will be considered acceptable based on the completed District's Acknowledgement of Manufacturer's Instruction as indicated on the Equipment Manufacturer's Certification of Installation, Testing, and Instruction appended to this Section.
- G. Training Video
 - 1. All equipment suppliers shall supply to the Engineer three copies of a training video specific to the equipment furnished for the project. The film shall be of a high quality, with both picture and sound.
 - 2. The training video shall be organized so as to show and identify each element of the equipment; including a clear explanation of its function, troubleshooting criteria; disassembly and reassembly
 - 3. Portions of the training video shall be recorded at the on-site O&M training sessions conducted by the equipment manufacturer's representative.
 - 4. The video shall be submitted to the Engineer for approval not less than 30 calendar days after the start-up of the equipment.
 - 5. The video recording should be playable on VCD recorded discs using MPEG-1 video (MP3 audio) and thereby able to be replayed through Windows Media Player, QuickTime or RealPlayer on PCs and most DVD players. VCD stored on CD-ROMs have the capacity to hold up to 74/80 minutes on a 650MB/700MB CD respectively, of video with stereo

quality sound. All video and audio should be of the highest quality. All CD-OMS shall bear a label identifying the Equipment(s) trained on, general Training topic (i.e., Maintenance, Operations, Storage, or O&M, etc.), the date of the video, trainer and his affiliation (i.e. John Doe, XYZ Company), and video file one of how many on the topic (Video 1 of 2) if the video exceeds the recording time of the CD.

3.03 VIDEOGRAPHY OF VENDOR TRAINING/INSTRUCTION

- A. Audio/video (A/V) record (in DVD format) training/instructions as they are being provided to the District's personnel. Such recording shall include the entire training/instruction session(s) as well as all questions and answers. A/V recording shall be performed by a professional organization experienced in the production of such recordings. Self-recording by the Contractor may be considered, provided that Contractor can demonstrate, in advance, proficient examples of such recordings.
- B. To avoid audio problems, training/instruction shall be held in a location sufficiently removed from construction activity, insulated from the noise of construction activity, or during a time when construction activity is not occurring in the vicinity.
- C. The audio portion of the A/V recording should be done with a microphone (wired or wireless) attached to the trainer/instructor to maximize the quality of speech.
- D. Each A/V recording should have "chapters" to segregate the distinct portions of the training/instruction, or have visual cues at the start of a change in subject.
- E. Two copies of the A/V recordings shall be submitted to the Engineer on DVD disk(s). The DVDs will become the property of the District.

END OF SECTION

O&M Manual Review Checklist

Submittal No.: _____

Project No.: _____

Manufacturer: _____

Equipment Submitted: _____

Specification Section: _____

Date of Submittal: _____

General Data		
1.	Are the area representative's name, address, e-mail address and telephone number included?	
2.	Is the nameplate data for each component included?	
3.	Are all associated components related to the specific equipment included?	
4.	Is non-pertinent data crossed out or deleted?	
5.	Are drawings neatly folded and/or inserted into packets?	
6.	Are all pages properly aligned and scanned legibly?	
7.	Is the .PDF document bookmarked according to the table of contents?	
Operations and Maintenance Data		
8.	Is an overview description of the equipment and/or process included?	
9.	Does the description include the practical theory of operation?	
10.	Does each equipment component include specific details (design characteristics, operating parameters, control descriptions, and selector switch positions and functions)?	
11.	Are alarm and shutdown conditions specific to the equipment provided on this project clearly identified? Does it describe possible causes and recommended remedies?	
12.	Are step procedures for starting, stopping, and troubleshooting specific to the equipment provided included?	
13.	Is a list of operational parameters to monitor and record specific to the equipment provided included?	
14.	Is a proposed operating log sheet specific to the equipment provided included?	
15.	Is a spare parts inventory list included for each component?	
16.	Is a lubrication schedule for each component specific to the equipment provided included - or does it clearly state "No Lubrication Required"?	
17.	Is a maintenance schedule for each component specific to the equipment provided included?	
18..	Is a copy of the warranty information included?	

Review Comments

Is the submittal fully approved (yes/no)? _____

If not, the following points of rejection must be addressed and require resubmittal by the Contractor:

Item No.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

Reviewed By: _____ Date: _____

Legend

- 1 = OK
- 2 = Not Adequate
- 3 = Not Included

Note: This submittal has been reviewed for compliance with the Contract Documents.

SECTION 01740
WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer Equipment Supplier/Manufacturer's standard warranties on products and special warranties.

1.02 RELATED WORK

- A. General closeout requirements are included in Section 01700 Project Closeout.
- B. Specific requirements for warranties for the work and products and installations that are specified to be warranted are included in the individual Sections.

1.03 SUBMITTALS

- A. The individual Equipment Supplier/Manufacturer shall submit written warranties to the District prior to the date fixed by the Equipment for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the work, or a designated portion of the work, submit written warranties upon request of the District.
- B. When a designated portion of the work is completed and occupied or used by the District, by separate agreement with the Equipment Supplier/Manufacturer (as applicable) during the construction period, submit properly executed warranties to the District via the Equipment within 15 days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the Equipment Supplier/Manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the District via the Equipment for approval prior to final execution.
- D. Forms for special warranties are included at the end of this Section. Prepare a written document utilizing the appropriate form, ready for execution by the Contractor, or the Contractor and subcontractor, or Equipment Supplier/Manufacturer. Submit a draft to the District for approval prior to final execution.
- E. Refer to individual Sections for specific content requirements, and particular requirements for submittal of special warranties.
- F. At Final Completion the Contractor shall compile two copies of each required warranty and bond properly executed by the Equipment Supplier/Manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- G. Bind warranties and bonds in heavy-duty, commercial quality, durable three-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents and sized to receive 8-1/2-inch by 11-inch paper.

- H. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the Section in which specified and the name of the product or work item.
- I. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address and telephone number of the installer or Equipment Supplier/Manufacturer.
- J. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the project title or name and the name, address and telephone number of the Equipment Supplier/Manufacturer.
- K. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.04 WARRANTY REQUIREMENT

- A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.
- B. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The Equipment Supplier/Manufacturer is responsible for the cost of replacing or rebuilding defective work regardless of whether the District has benefited from use of the work through a portion of its anticipated useful service life.
- D. District's Recourse: Written warranties made to the District are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the District can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The District reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The District reserves the right to refuse to accept work for the Project where a special warranty, certification, or similar commitment is required on such work or part of the work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Equipment Supplier/Manufacturer (as applicable) of the warranty on the work that incorporates the products, nor does it relieve Equipment Supplier/Manufacturer and subcontractors required to countersign special warranties with the Contractor.

1.05 MANUFACTURERS CERTIFICATIONS

- A. Where required, the Contractor shall supply evidence, satisfactory to the Equipment, that the Equipment Supplier/Manufacturer can obtain manufacturers' certifications as to the Contractor's installation of equipment.

1.06 DEFINITIONS

- A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the District.
- B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the District.

1.07 EQUIPMENT WARRANTIES

- A. All equipment supplied under this Contract shall be guaranteed to be free from defects in workmanship, design, and/or materials for a period of two years unless otherwise specified. The period of such warranties shall start on the date the particular equipment is placed in use by the District and provided that the equipment demonstrates satisfactory performance during the 30-day operational period after equipment startup. If the equipment does not perform satisfactorily during the 30-day startup operational period, the start of the warranty period shall be delayed until the equipment demonstrates proper operation. Warranties and guarantees shall be indicated on the Warranty for Equipment Item form appended to this Section. The Equipment Supplier/Manufacturer shall repair or replace without charge to the District any part of equipment which is defective or showing undue wear within the warranty period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified level.
- B. 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 in the equipment(s) and the equipment and/or unit(s) restored to service at no expense to the District.
- C. Obtain equipment warranties in accordance with Section 01740 from each of the respective Equipment Supplier/Manufacturer for all the equipment specified under Divisions 11, 13, 15 and 16 of these Specifications. The form of warranty is included at the end of this Section.
- D. The Equipment Supplier/Manufacturer's warranty period shall run concurrently with the Contractor's warranty or guarantee period. No exception to this provision shall be allowed. In the event that the Equipment Supplier/Manufacturer is unwilling to provide a two-year warranty commencing at the time of District acceptance, obtain from the Equipment Supplier/Manufacturer a three-year warranty starting at the time of equipment delivery to the job site. This three-year warranty shall not relieve the Contractor of the two-year warranty starting at the time of District acceptance of the equipment.

1.08 FINAL GUARANTEE

- A. All work shall be guaranteed by the Contractor for a period of two years from and after the date of acceptance of the work by the District.

- B. If, within the guarantee period, repairs or changes are required in connection with guaranteed work, which, in the opinion of the Equipment, is rendered necessary as the result of the use of materials, equipment or workmanship which are inferior, defective, or not in accordance with the terms of the Contract, promptly upon receipt of notice from the District and without expense to the District, replace any part of equipment which is defective or showing undue wear within the warranty period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

WARRANTY FOR EQUIPMENT ITEM

LOCATION OF PROJECT: _____

DISTRICT: _____

PROJECT NUMBER: _____

EQUIPMENT ITEM: _____

SECTION NO. / ITEM NO.: _____

SUPPLIER/MANUFACTURER: _____

SUPPLIER/MANUFACTURER'S ADDRESS: _____

SUPPLIER/MANUFACTURER'S REFERENCE NO.: _____

The undersigned guarantees that the above equipment is of good merchantable quality, free from defects in material or workmanship, fully meets the type, quality, design and performance requirements defined in the Contract Documents of the above project, and that the equipment will in actual operation satisfactorily perform the functions for which installed.

The undersigned agrees to repair, replace, or otherwise make good, any defect in workmanship or materials in the above described equipment which may develop within a period of two years from the date of final acceptance by the District of the above-named project.

COMPANY _____

COMPANY ADDRESS _____

BY _____

TITLE _____

SIGNED _____

DATE _____

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SECTION 02100
SITE PREPARATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required and perform all site preparation, complete as shown on the Drawings and as specified herein.
- B. Obtain all permits required for site preparation work prior to proceeding with the work, including clearing and tree removal.
- C. The areas to be cleared, grubbed and stripped within public rights-of-way and utility easements will be minimized to the extent possible. No unnecessary site preparation within these areas will be performed.

1.02 RELATED WORK

- A. Refer to Florida Department of Transportation Standards for sodding requirements.

1.03 SUBMITTALS

- A. Submit to the Engineer and District, in accordance with Section 01300, copies of all permits required prior to clearing, grubbing, and stripping work.
- B. Submit to the Engineer documentation demonstrating qualifications of biologist(s) employed by firm performing gopher tortoise survey, capture, and on-site relocation shall be submitted along with the firm's plan for performing the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

- A. Cut and remove all timber, trees, stumps, brush, shrubs, roots, grass, weeds, rubbish and any other objectionable material resting on or protruding through the surface of the ground.
- B. Preserve and protect trees and other vegetation designated on the Drawings or directed by the Engineer to remain.

3.02 GRUBBING

- A. Grub and remove all stumps, roots in excess of 1-1/2-in in diameter, matted roots, brush, timber, logs, concrete rubble and other debris encountered to a depth of 18-in below original grade or 18-in beneath the bottom of foundations, whichever is deeper.
- B. Refill all grubbing holes and depressions excavated below the original ground surface with suitable materials and compact to a density conforming to the surrounding ground surface.

3.03 DISPOSAL

- A. Dispose of material and debris from site preparation operations by hauling such materials and debris to an approved offsite disposal area. No rubbish or debris of any kind will be buried on the site.
- B. No on-site disposal of cleared and grubbed materials by open-air burning will be permitted by the District.

3.04 PROTECTION

- A. Trees and other vegetation designated on the Drawings or directed by the Engineer to remain will be protected from damage by all construction operations by erecting suitable barriers, guards and enclosures, or by other approved means. Conduct clearing operations in a manner to prevent falling trees from damaging trees and vegetation designated to remain and to the work being constructed and so as to provide for the safety of workers and others.
- B. Maintain protection until all work in the vicinity of the protected trees and vegetation has been completed.
- C. Do not operate heavy equipment or stockpile materials within the branch spread of existing trees.
- D. Immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during the work will immediately be cut off cleanly inside the exposed or damaged area. Treat cut surfaces with an acceptable tree wound paint and topsoil spread over the exposed root area.
- E. When work is completed, remove all dead and downed trees. Live trees will be trimmed of all dead and diseased limbs and branches. All cuts will be cleanly made at their juncture with the trunk or preceding branch without injury to the trunk or remaining branches. Cuts over one-in. in diameter will be treated with an acceptable tree wound paint.
- F. Restrict construction activities to those areas within the limits of construction designated on the Drawings, within public rights-of-way, and within easements provided by the District. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations will be promptly restored to their original condition, to the full satisfaction of the property District.

END OF SECTION

SECTION 02140
DEWATERING AND DRAINAGE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Design, furnish, install, operate, monitor, maintain and remove a temporary dewatering system as required to lower and control water levels at least two ft below trench and structure excavation subgrades, including launch/exit shafts, and one ft below trenchless casing invert to permit construction to proceed in-the-dry.
- B. Furnish, operate, maintain and remove temporary surface water control measures to prevent surface water from entering excavations.
- C. Retain the services of a professional engineer registered in the State of Florida to prepare dewatering and drainage system designs and submittals described herein.
- D. Work shall include the design, equipment, materials, installation, protection, and monitoring of geotechnical instrumentation required to monitor the performance of the dewatering and drainage system as required herein.
- E. Collect and properly dispose of all discharge water from the dewatering operations.
- F. Obtain permits required for discharge of groundwater from dewatering operations.
- G. Repair damage caused by dewatering and drainage system operations.

1.02 RELATED WORK

- A. Submittals are included in Section 01300.
- B. Site Preparation is included in Section 02100.
- C. Jack and Bore is included in Section 02157.
- D. Microtunneling is included in Section 02325.
- E. Excavation Support and Protection is included in Section 02311.
- F. Geotechnical Instrumentation is included in Section 02495.

1.03 DESIGN REQUIREMENTS

- A. The Contractor is responsible for the proper design and implementation of methods for controlling surface water and groundwater.
- B. The discharges of groundwater from the Contractor's dewatering operations shall be in accordance with the requirements of an NPDES permit for construction activities obtained by the Contractor from the FDEP or in accordance with a "Generic Permit for Discharge of Groundwater from Dewatering Operations" obtained by the Contractor from FDEP.

- C. The primary purpose of the groundwater control system is to preserve the natural undisturbed condition of the subgrade soils in the areas of the proposed excavations. Prior to excavation, the Contractor shall lower the groundwater to at least two ft below pipe trench bottom and two ft below the lowest excavation subgrade elevation (including launch and exit shafts). The Contractor shall lower the groundwater to at least one ft below trenchless casing inverts. Additional groundwater lowering may be necessary beyond the requirements above, depending on construction methods and equipment used and the prevailing groundwater and soil conditions. Dewatering shall be sufficient to control piezometric pressures to avoid any heave or destabilization of the excavation bottoms. The Contractor is responsible for lowering the groundwater as necessary to complete construction in accordance with the plans and specifications at no additional cost to the District.
- D. Design deep wells, well points and sumps, and all other groundwater control system components to prevent loss of fines from surrounding soils. Sand filters shall be used with all dewatering installations unless screens are properly sized by the Contractor's design engineer to prevent passage of fines from surrounding soils.
- E. The Contractor shall be responsible for damage to properties, buildings or structures, pipelines and other utility installations, pavements and work that may result from dewatering or surface water control operations.
- F. Design review and field monitoring activities by the District or by the Engineer shall not relieve the Contractor of his/her responsibilities for the work.

1.04 SUBMITTALS

- A. Dewatering and drainage system design plans shall be prepared and stamped by an experienced licensed professional engineer registered in the state of Florida and retained by the Contractor. The Contractor shall submit an original and three copies of the licensed professional engineer's certification on the PE form specified in Section 01300. The Contractor shall submit documentation of experience and qualifications as required herein.
- B. The plan shall include a description of the proposed dewatering system and include the proposed installation methods to be used for dewatering and drainage system elements and for observation wells. The plan shall include equipment, drilling methods, holes sizes, filter sand placement techniques, sealing materials, development techniques, the number and location of dewatering points, observations wells and piezometers, etc. Include the dewatering system design calculations in the plan.
- C. The plan shall identify the anticipated areas influenced by the dewatering system and address impacts to adjacent existing and proposed structures.
- D. Coordinate dewatering and drainage submittals with the excavation and support of excavation submittals. The submittal shall show the areas and depths of excavation to be dewatered.
- E. Do not proceed with any excavation or dewatering activities until the dewatering submittals have been reviewed by the Engineer for conformance with the Contract Documents and for general compatibility with the work and with accepted engineering practices.

1.05 QUALITY ASSURANCE

- A. Regulations: Perform all work in accordance with current applicable regulations and codes of all Federal, State and local agencies.
- B. The Contractor shall have at least five years of experience with dewatering system operations comparable to the dewatering operations required for the performance of the Work, employing labor and supervisory personnel who are similarly experienced in this type of Work.
- C. The Contractor's dewatering and drainage system design engineer shall be licensed in the State of Florida and have a minimum of five years of professional experience in the design and construction of dewatering and drainage systems and shall have completed not less than five successful dewatering and drainage projects of equal type, size, and complexity to that required for the work.

1.06 DEFINITIONS

- A. Where the phrase "in-the-dry" is used in this Section, it shall be defined as an excavation subgrade where the groundwater level has been lowered to at least two ft below excavation subgrade and one-ft casing invert, is stable with no ponded water, mud, or muck, is able to support construction equipment without rutting or disturbance and is suitable for the placement and compaction of fill material, pipe or concrete foundations.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Observation wells and piezometers shall consist of minimum two-in I.D, Schedule 40 PVC pipe and machine slotted PVC wellpoints, and maximum slot size 0.010-in.
- B. Piping, pumping equipment and all other materials required to provide control of surface water and groundwater shall be suitable for the intended purpose.
- C. Standby pumping systems and a source of standby power shall be maintained at all sites.

PART 3 EXECUTION

3.01 GENERAL

- A. Control surface water and groundwater such that excavation to final grade is made in-the-dry, the natural undisturbed condition of the subgrade soils is maintained, and softening and/or instability or disturbance due to the presence or seepage of water does not occur. All construction and backfilling shall proceed in-the-dry and flotation of completed portions of work shall be prohibited.
- B. Methods of groundwater control may include but are not limited to perimeter trenches and sump pumping, perimeter groundwater cutoff, well points, ejectors, deep wells and combinations thereof.
- C. Where groundwater levels are above the proposed bottom of excavation level, a pumped dewatering system will be required for pre-drainage of the soils prior to excavation, and for

maintaining the lowered groundwater level and controlling piezometric pressures, until construction has been completed to such an extent that the structure, pipeline or fill will not be floated or otherwise damaged.

- D. It is expected that the type of system, spacing of dewatering units and other details of the work will have to be varied depending on soil/water conditions at a particular location.
- E. All work included in this Section shall be done in a manner which will protect adjacent structures and utilities and shall not cause loss of ground or disturbance.
- F. Install, monitor and report data from observation wells. Evaluate the collected data relative to groundwater control system performance and modify systems as necessary to dewater the site in accordance with the Contract requirements.
- G. Locate groundwater control system components where they will not interfere with construction activities adjacent to the work area or interfere with the installation and monitoring of geotechnical instrumentation including observation wells. Excavations for sumps or drainage ditches shall not be made within or below 1H:1V slopes extending downward and out from the edges of existing or proposed foundation elements or from the downward vertical footprint of the pipe.

3.02 SURFACE WATER CONTROL

- A. Construct surface water control measures, including dikes, ditches, sumps and other methods to prevent, as necessary, flow of surface water into excavations and to allow construction to proceed without delay.

3.03 EXCAVATION DEWATERING

- A. At all times during construction, provide and maintain proper equipment and facilities to promptly remove and properly dispose of all water entering excavations. Excavations shall be maintained in-the-dry.
- B. Excavation dewatering shall maintain the subgrade in a natural undisturbed condition and until the fill, structure or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural elevations.
- C. Pipe, masonry, and concrete shall not be placed in water or be submerged within 24 hours after being installed. Water shall not flow over new masonry or concrete within four days after placement.
- D. In no event shall water rise to cause unbalanced pressure on structures until the concrete or mortar has set at least 24 hours. Prevent flotation of the pipe by promptly placing backfill.
- E. Dewatering shall at all times be conducted in such a manner as to preserve the natural undisturbed condition of the subgrade soils at the proposed bottom of excavation.
- F. If the subgrade of the trench or excavation bottom becomes disturbed due to inadequate dewatering or drainage, excavate below normal grade as directed by the Engineer and refill with bedding rock or other material as approved by the Engineer at no additional cost to the District.

- G. It is expected that the initial dewatering plan may have to be modified to suit the variable soil/water conditions to be encountered during construction. Dewater and excavate, at all times, in a manner which does not cause loss of ground or disturbance to the bearing soil or soil which supports overlying or adjacent structures or instability of the excavation.
- H. If the method of dewatering does not properly dewater the excavation as specified, install additional groundwater observation wells as directed by the Engineer and do not place any pipe or structure until the readings obtained from the observation wells indicate that the groundwater has been lowered as specified within the excavation limits.
- I. Dewatering units used in the work shall be surrounded by suitable filter sand and no fines shall be removed by pumping. Pumping from the dewatering system shall be continuous until pipe or structure is adequately backfilled. Stand-by pumps shall be provided.
- J. Existing or new sanitary sewers shall not be used to dispose of drainage.

3.04 WELL POINT SYSTEMS

- A. Where necessary, install a vacuum wellpoint system or deep wells around the excavation to dewater the excavation. Each wellpoint and/or well and riser pipe shall be surrounded by a sand or gravel filter. Sand shall be of such a gradation that, after initial development of the wellpoints or wells, the quantity and size of soil particles discharged shall be negligible.
- B. Wellpoint systems shall be capable of operating continuously under the highest possible vacuum.
- C. Installation of wellpoint systems or wells shall be in accordance with the final reviewed submittal in the presence of the Engineer.

3.05 DEEP WELLS

- A. Where necessary, install a deep well system around the excavation to dewater the excavation. Each well shall be surrounded by a sand or gravel filter with adequate gradation such that after development, the quantity and size of soil particles is negligible. Sufficient number of wells shall be installed to lower the groundwater level to allow excavation to proceed in-the-dry.
- B. Installation of deep wells shall be in accordance with the approved submittal in the presence of the Engineer.

3.06 OBSERVATION WELLS

- A. Install observation wells as required under this Section or in accordance with the approved submittal to monitor groundwater levels beneath and around the excavated areas until adjacent structures and pipelines are completed and backfilled.
- B. Observation Well Locations and Depths:
 - 1. Observation wells required shall be installed to a depth of at least five ft below the deepest level of excavation, unless otherwise approved by the Engineer, or to whatever depth is necessary to indicate that the groundwater control system designed by the Contractor's engineer is performing as intended. Additional observation wells may be required by the

Engineer if deemed necessary to monitor the performance of the Contractor's groundwater control system.

2. Locations and depths of observation wells are subject to approval by the Engineer.
- C. Protect the observation wells at ground surface by providing a lockable box or outer protective casing with lockable top and padlock. Design the surface protection to prevent damage by vandalism or construction operations and to prevent surface water from infiltrating.
1. Provide two copies of keys for each padlock to the District for access to each well.
 2. Observation wells shall be developed so as to provide a reliable indication of groundwater levels. Wells shall be re-developed if well clogging is observed, in the event of apparent erroneous readings, or as directed by the Engineer.
 3. Submit observation well installation logs, top of casing elevation, and well locations to the Engineer within 24 hours of completion of well installation.
- D. Observation Well Maintenance
1. The Contractor shall maintain each observation well until adjacent structures and pipelines are completed and backfilled. Clean out or replace any observation well which ceases to be operable before adjacent work is completed.
 2. It is the Contractor's obligation to maintain observation wells and repair or replace them at no additional cost to the District, whether or not the observation wells are damaged by the Contractor's operations or by third parties.
- E. Monitoring and Reporting of Observation Well Data
1. The Contractor shall begin monitoring of groundwater levels in work areas prior to initial operation of drainage and dewatering system. Daily monitoring in areas where groundwater control is in operation shall continue until the time that adjacent structures and pipelines are completed and backfilled and until the time that groundwater control systems are turned off.
 2. The Contractor is responsible for processing and reporting observation well data to the Engineer on a daily basis. Data is to be provided to the Engineer on a form, which shall include the following information: observation well number, depth to groundwater, total depth to well, top of casing elevation, groundwater level elevation and date and time of reading.

3.07 REMOVAL OF SYSTEMS

- A. At the completion of the excavation and backfilling work, and when approved by the Engineer, wellpoints, pumps, generators, other equipment and accessories used for the groundwater and surface water control systems shall be removed from the site. All materials and equipment shall become the property of the Contractor. All areas disturbed by the installation and removal of groundwater control systems and observation wells shall be restored to their original condition.

- B. Leave in place any casings for deep wells, wellpoints or observation wells located within the zone below 1H:1V planes extending downward and out from the downward vertical footprint of the pipe, or where removal would otherwise result in ground movements causing adverse settlement to adjacent ground surface, utilities or existing structures.
- C. Where casings are pulled, holes shall be filled with sand. Where left in place, casings should be filled with cement grout and cut off a minimum of three ft below finished ground level or one ft below foundation level so as not to interfere with finished structures or pipelines.
- D. When directed by the District, observation wells should be left in place for continued monitoring. When so directed, cut casings flush with final ground level and provide protective lockable boxes with locking devices. The protective boxes shall be suitable for the traffic and for any other conditions to which the observation wells will be exposed.
- E. All deep wells, observation wells, and piezometers shall be properly installed and abandoned per SJRWMD requirements.

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SECTION 02200
EARTHWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and perform all earthwork, which includes clearing and stripping, procurement of fill material (on-site and imported), excavating, placing, and compacting fill and backfill, structural excavating and backfilling, transportation and storage of excess earthwork materials; disposal of unsuitable, waste and surplus materials, restoration of excavation and trench surfaces, and all subsidiary work necessary to complete the grading of the developed areas to conform with the lines, grades, and slopes as shown on the Drawings and as specified herein.
- B. The work shall include, but not necessarily be limited to; excavation for structures, foundations, pipes, paving; embankments; grading; and all related work such as sheeting, bracing and dewatering.
- C. Furnish and install temporary excavation support systems, including sheeting, shoring and bracing, to insure the safety of personnel and protect adjacent structures, piping, etc., in accordance with Federal, State and local laws, regulations and requirements. Temporary excavation support systems shall be in accordance with Section 02311.
- D. Furnish and install temporary dewatering and surface water control systems and operate to dewater and maintain excavations in a dry condition. Control drainage into excavations and remove seepage water and rainwater. Dewatering and surface water control shall be in accordance with Section 02140.
- E. Examine the site and review the available geotechnical data report prior to submitting their proposal, taking into consideration all conditions that may affect his work. The District and Design Engineer do not assume responsibility for variations of subsurface conditions at locations other than places shown and at the time the investigations were made.
- F. Protect existing structures and utilities to remain.

1.02 RELATED WORK

- A. Submittals is included in Section 01300.
- B. Dewatering and Drainage is included in Section 02140
- C. Excavation Support and Protection is included in Section 02311.
- D. Microtunneling is included in Section 02325.
- E. Geotechnical Instrumentation is included in Section 02495.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, the proposed methods of construction, including earthwork operations, excavation limits, slopes, fill material moisture conditioning and handling,

compaction equipment, backfilling and filling and compaction for the various portions of the work, and material sources for the various portions of the work. Review will be for information only. Contractor shall remain responsible for adequacy and safety of construction means, methods, and techniques.

- B. Furnish the Engineer a representative sample weighing approximately 50 pounds of each fill material, filter sand and crushed stone contained in sealed five-gallon containers, at least 30 calendar days prior to the date of anticipated use of such material for approval.
- C. Submit laboratory test results for all fill materials (maximum density, gradation, Atterberg limits, sand equivalent, etc., as applicable) at least 72 hours prior to importing or placing any fill.

1.04 DEFINITIONS

- A. Percent Compaction is the required in-place dry density of the material, expressed as a percentage of the maximum dry density of the same material, as determined in the laboratory by AASHTO T-180 (Standard Proctor). The percent compaction requirements for earthwork will be evaluated as follows: The in-place density as compacted by the Contractor will be determined by the field density test using the sand-cone method, drive cylinder method, or the nuclear method. The maximum dry density of the fill at the location of the in-place density test will be estimated using a one-point compaction test and full-curve compaction tests (family of curves) of representative fill materials. The one-point compaction data will be used by the Engineer in conjunction with the representative compaction curves to estimate the maximum dry density of the compacted fill at the location of the in-place density test. The percent compaction in-place will be calculated as the ratio (in percent) of the in-place dry density to the estimated maximum dry density of the compacted fill at the location of the in-place density test.
- B. Optimum Moisture Content is the moisture content (percent by dry weight) corresponding to the maximum dry density of the same material as determined by AASHTO T-180 (Standard Proctor).
- C. Moisture-Sensitive Soil is on-site soil containing more than 12 percent fines (silt- or clay-sized particles) based on the fraction passing the No. 200 sieve.
- D. Structures: Buildings, wet wells, manholes and below grade vaults, pipelines and utilities, pavements, and slabs-on-grade both above and below ground.
- E. Unsuitable Soil: Includes existing fill materials, organic soils, weak native soils, or clays with a plasticity index of greater than 30.
- F. Objectionable Material: Includes topsoil, organic matter, contaminated soil, construction debris, perishable materials, snow, ice, frozen earth, and rocks or lumps of cemented soils over six inches in maximum dimension.
- G. Overexcavation: Removal of Unsuitable Soil or Objectionable Material at or below the normal grade of the excavation or subgrade as indicated on the Drawings.
- H. Subgrade: Required surface of subsoil, borrow fill or compacted fill. This surface is immediately beneath site improvements, especially dimensioned fill, paving, or other surfacing material.

- I. Finished Grade: Required final grade elevation indicated on the Drawings. Spot elevations shall be precedent over proposed contours.
- J. Coverage: Pass of compaction equipment over the complete surface area of exposed lift or subgrade to receive compaction.

1.05 STATUTORY REQUIREMENTS

- A. All excavation, trenching, sheeting, bracing, etc. shall conform to the requirements of the Florida "Trench Safety Act" (CS/SB 2626) which incorporates, by reference, OSHA excavation safety standards, 29 CFR 1926 Subpart P.
- B. Three working days prior to starting any excavation, the Contractor shall notify 811 and underground utility owners who are not members of the notification centers.

1.06 PROTECTION

- A. All existing facilities which include but are not limited to structures, utilities, pavements, sidewalks, curbing, driveway aprons, fencing, landscaping and other improvements in the vicinity of the Contractor's operations shall be adequately protected. If necessary, curbing, driveway aprons and fencing shall be removed and restored or replaced after backfilling. All existing facilities damaged by the construction shall be replaced with material fully equal to that existing prior to construction to the satisfaction of the District.
- B. Design, furnish, install, monitor and maintain excavation support as required and as specified in Section 02311.
- C. Furnish, install, monitor and maintain settlement monitoring as required and as specified in Section 02495.
- D. Furnish, install, monitor and maintain dewatering and drainage systems as required and as specified in Section 02140.
- E. Excavations within the zone of influence of any existing structures or utility will require the use of excavation support system as specified in Section 02311. The zone of influence is defined as a line extending at least 2 feet beyond of edge of the foundation, then outward and downward at a slope of one horizontal to one vertical. No excavation below the foundation of existing structures is allowed.
- F. Excavations below the level of the base of any adjacent foundation or retaining wall shall not be permitted unless the design of the excavation and bracing includes an analysis of the stability of the structure supported by the foundation and as necessary, incorporates required bracing / underpinning of the foundation.

1.07 QUALITY ASSURANCE

- A. At all structures, prior to the placement of bedding material, concrete work mats, structural fill or structural concrete, coordinate with the soils testing laboratory to verify the suitability of the existing subgrade soil.

- B. Prior to and during the placement of backfill and fill coordinate with the soils testing laboratory to perform in-place soil density tests to verify that the backfill/fill material has been placed and compacted in accordance with the compaction requirements specified elsewhere. At least 48 hours notice shall be provided prior to placement of backfill and fill.
- C. Subgrades shall not be covered with fill nor fill placed without the observation, testing, and approval by the Soils Testing Laboratory. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by the Engineer at no expense to the District.
- D. Materials will be tested and observed as described in the following paragraphs. Cooperate by allowing free access to the work for selection of test materials and observations.
 - 1. Materials to be used in the work shall be tested by a certified independent laboratory, engaged by the Contractor and acceptable to the Engineer, to demonstrate conformance with the requirements of these Specifications. Such testing will be paid for by the Contractor. Deliver test reports and material certifications to the Engineer before using any material in the work.
 - 2. If field test results are not in conformance with the requirements of these Specifications, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the Engineer and costs of re-testing after correction of deficiencies shall be borne by the Contractor.
 - 3. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by the Engineer at no expense to the District.
 - 4. Testing methods shall comply with the latest applicable ASTM or equivalent AASHTO Standards specified.
 - 5. During the placement of bedding, backfill and fill, the Contractor shall perform in-place soil density testing to confirm that fill material has been compacted in accordance with the requirements of this Section. The Engineer may designate areas to be tested. Contractor shall notify Engineer at least 72 hours in advance of scheduled compaction testing. In place soil density tests on backfill/fill material shall be as required by City, State, or Federal Codes, and the project geotechnical data report, but in no instance shall less than those listed below:
 - a. Structures and Embankments. At least one density and moisture content test for each 2,500 square feet of surface area for each lift of fill at embankment, structure and manhole locations
 - b. Trench Excavations. At least one nuclear density and moisture content test shall be conducted at a maximum of 50-ft intervals for each lift of fill placed or as directed by the Engineer.
 - c. The Engineer may designate additional areas to be tested.
 - 6. Materials which have been previously tested may be subjected to further testing from time to time and may be rejected if it is determined that they do not conform to the requirements of these Specifications. Rejected materials shall be removed from the work immediately when so directed by the Engineer, notwithstanding the results of previous testing.

- E. The Engineer or District may conduct additional soil testing. Cooperate fully in obtaining the information desired and allowing free access to the work.

1.08 CONSTRUCTION CONTROL

- A. The Contractor is responsible for all construction layout and reference staking necessary for the proper control and satisfactory completion of all structures, cutting, filling, grading, drainage, fencing, embankment improvements, curbing, and all other appurtenances required for the completion of the construction work and acceptance of the Contract as specified and as shown on the Drawings.
- B. All construction layout and staking shall be performed by a professional land surveyor or professional engineer licensed by the State, experienced and skilled in construction layout and staking of the type required under this Contract, and acceptable to the Engineer and District.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Common Fill: Common Fill materials shall be soils having a group classification of SP, SP-SM, SP-SC, GM, or GC in accordance with the Unified Soil Classification per ASTM D2487. SM and SC may be used if they are effectively blended on-site with the cleaner sands to reduce the fines contents to no more than 20 percent passing the No. 200 sieve. Perform lab testing to verify fines content of blended soils. Particles larger than two-inch in diameter shall not be allowed in these materials. These materials shall be free of roots, vegetative matter, topsoil, waste, construction materials, highly micaceous silt, frozen soil, marl, hardpan, or other objectionable material. Stone blocks, broken concrete, masonry rubble, or other similar materials shall not be allowed.
- B. Select Common Fill: Select common fill materials shall be soils having a group classification of SP, SP-SM, SP-SC, GM, or GC in accordance with the Unified Soil Classification per ASTM D2487. SM and SC may be used if they are effectively blended on-site with the cleaner sands to reduce the fines contents to no more than 20 percent passing the No. 200 sieve. Perform lab testing to verify fines content of blended soils. Particles larger than three-fourths-inch in diameter shall not be allowed in these materials. These materials should be free of roots, vegetative matter, topsoil, waste, construction materials, highly micaceous silt, frozen soil, marl, hardpan, or other objectionable material. Stone blocks, broken concrete, masonry rubble, or other similar materials shall not be allowed.
- C. Structural Fill – Structural fill shall consist of a mineral soil free of organic material, loam, debris, frozen soil or other deleterious material which may be compressible or which cannot be properly compacted. Shell and shell fragment content larger than the No. 10 I.S. Standard sieve size shall be no more than 10 percent by dry weight as measured by particle size analysis (ASTM D422). Structural fill should consist of materials with the following gradation:

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>
3-in	100
No. 4	20 to 90
No. 40	5 to 75
No. 200	0 to 12

Structural fill a maximum dry density of at least 98 pcf as determined by AASHTO T-180.

- D. Unsuitable Materials: Unsuitable materials are soil, soil-aggregate and rock having a classification of MH, ML, CH, CL or PT, along with materials having an organic content exceeding five percent by weight. Soils with a plasticity index greater than 10%, or a liquid limit greater than 40% shall not be used.
- E. Crushed Stone
 - 1. Crushed stone shall conform to No. 89 Stone of the Florida Department of Transportation (FDOT) Standard Specifications for Roads and Bridges, latest edition and all addenda and supplements thereto.
- F. Filter Fabric
 - 1. Filter fabric shall be used as necessary or where indicated on the Drawings and shall conform to the following requirements:
 - a. Minimum grab strength of 120 lbs per ASTM D1682.
 - b. Apparent opening size to be equal to or greater than the U.S. Standard Sieve No. 100 (0.210 mm) per ASTM D4751.
 - c. Percent open area not to exceed about 25 percent. The percent open area is defined as the ratio of the sum of 20 or more individual open areas (times 100) to the sum of the corresponding 20 or more individual total areas.
 - d. Coefficient of permeability shall not be less than 0.2 cm/sec.
 - e. Filter fabric shall be Mirafi, Type 140N; Dupont, Type PAR, Style 3401 or equal product by Amoco.

PART 3 EXECUTION

3.01 PREPARATION

- A. All excavation, backfill and grading necessary to complete the work shall be made by the Contractor and the cost thereof shall be included in the contract price.
- B. The Contractor shall take all the necessary precautions to maintain the work area in a safe and workable condition.
- C. The Contractor shall protect the work area at all times by flagging, marking, lighting and barricading. It shall also be the Contractor's responsibility to preserve and protect all existing above and underground structures, pipe lines, conduits, cables, drains or utilities. Failure of the Drawings to show the existence of these obstructions shall not relieve the Contractor from this responsibility. The cost of repair of any damage which occurs to these obstructions during or as a result of construction shall be borne by the Contractor without additional cost to the District.
- D. Clearing and Stripping. The ground surface beneath all planned Structures and in all areas requiring excavation or filling shall initially be cleared and stripped of all organic material and debris. These materials shall not be reused as On-Site Fill Material; they shall be removed from the site and disposed of or reused as topsoil in landscape areas.

3.02 EXCAVATION

- A. Excavations shall be made to the grade indicated on the Drawings and in widths sufficient for laying the pipe, construction of the structure, bracing and for dewatering and drainage facilities. Excavations for structures shall be suitably wide for construction of the structures, including excavation supports, dewatering and drainage systems and working clearances.
- B. Excavation shall be performed in-the-dry and shall be accomplished by methods which preserve the natural undisturbed condition of the subgrade soils.
- C. Moisture Sensitive Soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, use a smooth-edge bucket to excavate the last one foot of depth.
- D. If the bottom of any excavation is taken out below the limits shown on the Drawings, specified, or directed by the Engineer, it shall be refilled at no additional cost to the District with structural fill or screened gravel.
- E. Subgrade soils that have become soft, loose, "quick," or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods, in the opinion of the Engineer, shall be removed and replaced with structural fill or screened gravel, as acceptable to the Engineer at the Contractor's expense.
- F. Exposed subgrades for foundations shall be proof rolled with at least two overlapping coverages of a vibratory drum roller with a minimum of a 10-ton static drum weight. Proofrolling in confined areas may be accomplished with hand operated vibratory equipment approved by the Engineer. Proofrolling shall be conducted in the presence of the Engineer. The Engineer shall waive this requirement if, in his/her opinion, the subgrade will be rendered unsuitable by such proofrolling.
- G. Perform overexcavation at the request of the Engineer to remove Unsuitable Soil, Objectionable Material, or other materials as determined by the Engineer to such depth and width as the Engineer may direct and shall be replaced with suitable material as directed by the Engineer for which compensation will be made pursuant to the Change Order clause in the Agreement.
- H. Excavation for all pipe lines beneath structures and excavation for all footings shall be carried out with the excavating equipment operating from the subgrade for the structure. The excavation shall be carried out "in-the-dry" and in a manner which will preserve the undisturbed state of the subgrade soils.
- I. When excavations have reached the required subgrade, including any allowances for working mats or base materials, prior to the placement of working mats or base materials, notify the soils testing laboratory to verify the suitability of the existing subgrade soils for the anticipated foundation and structural loadings. If the existing subgrade soils are determined to be unsuitable, direction will be provided by the Engineer regarding removal and replacement with suitable materials. If Contractor believes that such direction would increase Contractor's cost and would thereby entitle Contractor to a change in Contract cost, Contractor shall notify the Engineer in accordance with the applicable article(s) in the Agreement pertaining to changes in the work.

3.03 SUBGRADE PREPARATION

- A. Maintain the excavated subgrade "in-the-dry".
- B. Prior to placement of fill, remove all objectionable material which shall include but not be limited to pavement, topsoil, organic matter, contaminated soil, construction debris, perishable materials, snow, ice, frozen earth, and rocks or lumps of cemented soils over six inches in maximum dimension.
- C. For subgrades consisting of granular soils, proof compact the final subgrade using at least four coverages of a vibrator plate compactor.
- D. Where existing subgrade contains a significant amount of clay or cohesive soils, over-excavate sufficiently below the bottom of structure for placement of a lean concrete working mat. Remove all loose or soft material from the subgrade immediately prior to placing the lean concrete working mat.
- E. Soft subgrades or unusable material shall be removed and replaced with compacted structural fill.
- F. Notify the Engineer to observe the subgrade following subgrade preparation and prior to fill placement. If the existing subgrade soils are determined to be unsuitable, direction will be provided by the Engineer regarding removal and replacement with suitable materials.

3.04 FILLING PLACEMENT AND COMPACTION PROCEDURES

- A. Fill and backfill materials shall be placed in lifts to suit the specified compaction requirements to the lines and grades required, making allowances for settlement and placement of cover materials (i.e., topsoil, sod, etc.). Soft spots or uncompacted areas shall be corrected.
- B. Fill and backfill shall not be placed and compacted when the materials are too wet to properly compact (i.e., the in-place moisture content of the soil at that time is no more than three percentage points above the optimum moisture content of that soil as determined by the laboratory test of the moisture-density relation appropriate to the specified level of compaction).
- C. Structural Fill and Embankment Fill shall be constructed to the lines and grades required, making allowances for settlement and placement of cover materials (i.e. topsoil, sod, etc.). Soft spots or uncompacted areas shall be corrected.
- D. All structure water-tightness tests and dampproofing/waterproofing shall be completed prior to placing fill or backfill around structures.
- E. If the subgrade slopes more than 10%, the subgrade shall be stepped to produce a stable, horizontal surface for the placement of fill materials. The existing subgrade slope shall then be scarified to a depth of at least six inches.
- F. Fill slopes should be compacted by slope rolling and trimming, or should be overfilled and trimmed back to plan grade to expose a firm, smooth surface free of loose material.
- G. Fill lifts shall not contain stones with a dimension larger than two-thirds the specified loose measure lift thickness.

- H. Compaction in open areas may be accomplished by any of the following methods: compaction equipment, fully loaded ten-wheel trucks or front end loaders, tractor dozers weighing at least 30,000 lbs or heavy vibratory rollers. Compaction in confined areas (including areas within a 45 degree angle extending upward and outward from the base of a wall) and in areas where the use of large equipment is impractical, shall be accomplished by hand operated vibratory equipment or mechanical tampers. Lift thickness shall not exceed six in. (measured before compaction) when hand operated equipment is used.
- I. On-Site Fill Material shall be moisture conditioned prior to placement unless the Contractor demonstrates to Engineer in-place moisture conditioning methods that can achieve the required moisture content.
- J. Compaction of each specified lift of fill materials shall be conducted by a minimum of four complete coverages with acceptable compaction equipment to a specified density which is expressed as a percentage of the maximum dry density as determined by AASHTO T-180, unless specified otherwise.
- K. Fill required beneath foundations or slabs on grade (except sidewalks) shall be structural fill. Place and compact structural fill in even lifts having a maximum thickness (measured before compaction) of eight in.
- L. Fill and backfill material placed immediately adjacent to and within 10-ft of all structures shall be select common fill. All structure water-tightness tests and dampproofing / waterproofing shall be completed prior to placing fill or backfill around structures. Place and compact select fill in even lifts having a maximum thickness (measured before compaction) of eight in. uniformly around the structure. Select common fill placed from the springline to one foot above pipes shall be placed in six-in. lifts.
- M. Common fill may be used in areas beyond those designated for select fill unless shown or specified otherwise. Common fill shall be placed in even lifts having a maximum thickness (measured before compaction) of 12-in.

3.05 COMPACTION REQUIREMENTS

- A. Perform in place testing of compacted fill lifts to measure in-place density and water content (AASHTO T-180).
- B. Beneath foundations and slabs on grade (except sidewalks): Compact the top eight in. of existing subgrade (and each layer of fill if applicable) to a minimum of 98 percent maximum dry density (AASHTO T-180) at or near its optimum moisture content (minus two to plus three percent).
- C. 10-ft around structures: Compact each layer of fill or backfill to a minimum of 98 percent maximum dry density (AASHTO T-180) at or near its optimum moisture content (minus two to plus three percent).
- D. Embankments (except under roadways and earth dam structures), lawn or unimproved areas: Compact each layer of fill or backfill to a minimum of 95 percent maximum dry density (AASHTO T-180) at or near its optimum moisture content (minus one to plus four percent).

- E. Sidewalks: Compact each layer of fill to a minimum of 95 percent modified proctor (AASHTO T-180) at or near its optimum moisture content (minus two to plus three percent).
- F. Roads, paved areas and roadway embankments: Compact each layer of fill or backfill to a minimum of 95 percent maximum dry density (AASHTO T-180) at or near its optimum moisture content (minus two to plus three percent).

3.06 DISPOSAL OF UNSUITABLE, WASTE AND/OR SURPLUS EXCAVATED MATERIAL

- A. Unsuitable Soil, Objectionable Material, and waste and surplus excavated material shall be removed and disposed of off-site. Materials may be temporarily stockpiled in an area within the limits of construction that does not disrupt construction activities, create any nuisances or safety hazards, or otherwise restrict access to the work site.

3.07 GRADING

- A. Grading shall be performed to the lines and grades shown on the Drawings. All objectionable material encountered within the limits indicated shall be removed and disposed of. Subgrades shall be completely and continuously drained and dewatered throughout the grading process. Install temporary drains, drainage ditches, etc., to intercept or divert surface water which may affect the execution or condition of grading work.
- B. If at the time of grading it is not possible to place any material in its proper section of the Work, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.
- C. In cut areas, all loose or protruding rocks in slopes shall be removed to line or finished grade of the slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings unless otherwise directed by the Engineer.

3.08 RIPRAP AND SLOPE STABILIZATION

- A. Prior to installation of riprap, install erosion control blankets on slopes in accordance with manufacturer's instructions. The area to be covered shall be properly prepared, before the blanket is applied. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. Blankets shall be butted snugly at the ends and side and stapled. Blankets shall be placed a minimum of three rows (of four foot) wide (total 12-ft width) and stapled together in accordance with manufacturer's instructions. Staples shall be driven vertically into the ground, spaced approximately two linear yards apart, on each side and one row in the center alternately spaced between each side. Adjoining blankets shall not be overlapped and shall utilize a common row of staples to attach.
- B. Riprap shall be placed in conjunction with the construction of the embankment with only sufficient lag in the construction of the riprap protection as may be necessary to allow for proper construction of the portion of the embankment protected and to prevent mixture of embankment and riprap material. Bank run gravel shall be placed and graded to a depth of six in. to obtain a continuous uninterrupted bed of the required thickness within the required limits. It shall be compacted by a minimum one coverage by a crawler-type tractor with a total weight, including blade and equipment, of not less than 30,000 lbs.

- C. Riprap shall be hand-placed (not dumped) on the compacted gravel bed. Stones shall be laid so that the maximum dimension is perpendicular to the bed. Stones shall be placed so that the weight of each stone is carried by the underlying material and not by the adjacent stones. Large stones shall be placed at the bottom of the slope. Spaces between stones shall be filled with spalls of suitable size to construct a solid, stable slope, free from large voids and defects which might not protect embankments against erosion.

END OF SECTION

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SECTION 02221
EXCAVATION, BEDDING AND BACKFILL FOR PIPE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to perform all excavation (unclassified), backfill, fill, grading and slope protection required to complete the piping work shown on the Drawings and specified herein.
- B. Excavation shall extend to the width and depth shown on the Drawings or as specified herein and shall provide suitable room for installing pipe, structures and appurtenances.
- C. Furnish and place all sheeting, bracing and supports and remove from the excavation all materials which the Engineer may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry and in all respects, acceptable. If conditions warrant, deposit gravel for pipe bedding, or refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be closely related to the rate of pipe laying. All excavation shall be made in open trenches.
- D. All excavation and related sheeting, shoring, and bracing shall conform to the requirements of the Florida Trench Safety Act, (C5/5B 2626), which incorporates by reference, OSHA's excavation safety standards (29 CFR 1926.650 Subpart P).

1.02 RELATED WORK

- A. Dewatering and Drainage is included in Section 02140.
- B. Excavation Support and Protection is included in Section 02311.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete product data for materials specified in this Section.
- B. For each bedding and backfill material obtained from other than onsite sources, the Contractor shall notify the Engineer of the source of the material and shall furnish the Engineer, for approval, a representative sample weighing approximately 50 pounds, at least seven calendar days prior to the date of anticipated use of such material.
- C. Submit laboratory test results for all fill (offsite and onsite) materials (maximum density, gradation, Atterberg limits, sand equivalent, etc., as applicable) at least five days prior to importing or placing any fill.

1.04 DEFINITIONS

- A. Percent Compaction is the required in-place dry density of the material, expressed as a percentage of the maximum dry density of the same material, as determined in the laboratory by AASHTO T-180 (Standard Proctor).
- B. Optimum Moisture Content is the moisture content (percent by dry weight) corresponding to the maximum dry density of the same material as determined by AASHTO T-180 (Standard Proctor).
- C. Moisture-Sensitive Soil is on-site soil containing more than 12 percent fines (silt- or clay-sized particles) based on the fraction passing the No. 200 sieve.

1.05 QUALITY ASSURANCE

- A. Prior to and during the placement of backfill and fill, coordinate with the soils testing laboratory to perform in-place soil density tests to verify that the backfill/fill material has been compacted in accordance with the compaction requirements specified. The Engineer may designate areas to be tested.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Common Fill: Common Fill materials shall be soils having a group classification of SP, SP-SM, SP-SC, GM, or GC in accordance with the Unified Soil Classification per ASTM D2487. SM and SC may be used if they are effectively blended on-site with the cleaner sands to reduce the fines contents to no more than 20 percent passing the No. 200 sieve. Perform lab testing to verify fines content of blended soils. Particles larger than two-inch in diameter shall not be allowed in these materials. These materials shall be free of roots, vegetative matter, topsoil, waste, construction materials, highly micaceous silt, frozen soil, marl, hardpan, or other objectionable material. Stone blocks, broken concrete, masonry rubble, or other similar materials shall not be allowed.
- B. Select Common Fill: Select common fill materials shall be soils having a group classification of SP, SP-SM, SP-SC, GM, or GC in accordance with the Unified Soil Classification per ASTM D2487. SM and SC may be used if they are effectively blended on-site with the cleaner sands to reduce the fines contents to no more than 20 percent passing the No. 200 sieve. Perform lab testing to verify fines content of blended soils. Particles larger than 3/4-inch in diameter shall not be allowed in these materials. These materials should be free of roots, vegetative matter, topsoil, waste, construction materials, highly micaceous silt, frozen soil, marl, hardpan, or other objectionable material. Stone blocks, broken concrete, masonry rubble, or other similar materials shall not be allowed.
- C. Unsuitable Materials: Unsuitable materials are soil, soil-aggregate and rock having a classification of MH, ML, CH, CL or PT, along with materials having an organic content exceeding five percent by weight. Soils with a plasticity index greater than 10%, or a liquid limit greater than 40% shall not be used.
- D. Bedding Rock: Bedding rock shall be washed and graded crushed limestone or shell and conform to the gradation requirements of FDOT No. 89 stone.

PART 3 EXECUTION

3.01 GENERAL

- A. All excavation, backfill and grading necessary to complete the work shall be made by the Contractor and the cost thereof shall be included in the contract price.
- B. The Contractor shall take all the necessary precautions to maintain the work area in a safe and workable condition.
- C. The Contractor shall protect the work area at all times by flagging, marking, lighting and barricading. It shall also be the Contractor's responsibility to preserve and protect all existing above and underground structures, pipe lines, conduits, cables, drains or utilities. Failure of the Drawings to show the existence of these obstructions shall not relieve the Contractor from this responsibility. The cost of repair of any damage which occurs to these obstructions during or as a result of construction shall be borne by the Contractor without additional cost to the District.

3.02 EXCAVATION

- A. Excavations for the installation of structures, pipes, and electrical ducts shall be made to the depths indicated on the Drawings. Normal grade for excavation of pipes shall be six inches below the invert of the pipe. The minimum trench width shall extend 24 inches beyond the outside diameter of the pipe as indicated on the Drawings and shall be sufficient for installing structures, pipes, or ducts, for bracing and supporting and for pumping and drainage facilities.
- B. The bottom of the excavations shall be firm and dry and in all respects acceptable to the Engineer. Excavate unsuitable soil material from the bottom of the trench to a depth determined by the Engineer and replace with rock bedding.
- C. Where pipe or ducts are to be laid in bedding rock, the trench may be excavated by machinery to, or just below, the designated subgrade provided that the material remaining in the bottom of the trench is no more than slightly disturbed.
- D. Where the pipes or ducts are to be laid directly on the trench bottom, the lower part of the trenches shall not be excavated to the trench bottom by machinery. The last of the material being excavated shall be done manually in such a manner that will give a flat bottom true to grade so that pipe or duct can be evenly and uniformly supported along its entire length. Bell holes shall be made as required manually so that there is no bearing surface on the bells and pipes are supported along the barrel only.
- E. All rocks, roots, and organic muck, clay, or silt lenses removed in the preparation of the excavation for common fill shall be disposed of off-site by the Contractor as excess excavation. Soils which cannot qualify as common fill after preparation, such as muck soil, high organic soil, or non-granular soil high in silt and clay content shall also be disposed of off-site by the Contractor as excess excavation.
- F. Failure of the Contractor to prepare excavated material to qualify as backfill shall not relieve the Contractor from his obligation to furnish common fill for backfill, regardless of the circumstances. The Engineer shall be the sole judge of whether excavation will qualify as

backfill after proper preparation and whether or not such preparation performed by the Contractor is satisfactory. Should the Contractor's preparation not be satisfactory, the Contractor shall use imported fill for backfill at no additional cost to the District.

- G. No more than 100 linear feet of trench shall be open in advance of the pipe laying unless prior approval is given by the Engineer after consideration of ground conditions and/or location by the Engineer.

3.03 DISPOSAL OF MATERIALS

- A. Excavated material shall be stacked without excessive surcharge on the trench bank or obstructing free access to hydrants and gate valves. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.
- B. Excess excavation, excavation which is unsuitable for common fill or select fill backfill, and all removed extraneous materials as identified herein shall be disposed of offsite by the Contractor.
- C. The balance of the stockpiled excess material shall be disposed of offsite by the Contractor at a permitted site.
- D. The Contractor shall locate and make all arrangements for disposal of excess and unsuitable materials. All handling, hauling, and disposal costs shall be included in the bid price. Stockpile areas shall be prepared and seeded. Disposal shall be in compliance with all applicable regulations.
- E. Excess excavation which meets the requirements of common fill shall be stockpiled in a common readily accessible area, graded and/or covered for rain runoff, and used as a source of imported material until all the needs for imported material are identified, at which time the balance of the stockpiled excess material shall be disposed.

3.04 SHEETING AND BRACING

- A. Sheeting and bracing shall be installed as specified in Section 02311.

3.05 STAGE 1 BEDDING

- A. Pressure pipes shall be bedded using bedding rock by the following procedures:
 - 1. Beginning at the bottom of the trench, bedding rock shall be placed and compacted to springline of the pipe, from the centerline of the pipe to the trench wall. Lift thickness shall not exceed six inches. Each lift shall be compacted using at least two passes with a vibratory plate compactor.
- B. Above Stage 1, fill shall be placed and compacted as described below under "Backfilling."
- C. Where stone bedding is used, an impermeable groundwater barrier at 100-foot intervals along the trench shall be used. The impermeable groundwater barrier shall consist of a 10 mil sheet of polyethylene covering the full cross sectional area of the gravel, embedded six inches into the trench sides and bottom, and extending to the top of the bedding rock. The

barrier shall be offset a minimum of two feet from any culvert or pipe joint. Ends and splice points shall be lapped a minimum of 12 inches.

3.06 STAGE 2 BACKFILLING

- A. Where pipes are located under paved roadways, driveways, sidewalks, or FDOT right-of-ways, the trench above the Stage 1 bedding, as described above, shall be backfilled and thoroughly compacted with select common fill from the springline to 12 inches above the pipe crown. Select common soil shall be placed and compacted in layers not to exceed six inches to 98 percent maximum density per AASHTO T-180. Moisture content of the soil shall be within minus three percent to plus two percent of the optimum. Above 12 inches over the crown of pipe, the backfill shall consist of Flowable Fill – Excavatable Design with a Maximum of 28-day compressive strength of 100 psi (full depth) per FDOT Standard Specifications and as shown on the Drawings.
- B. Where pipes are not located under roadways, driveways, sidewalks, or FDOT rights-of-way, the trench above the Stage 1 bedding, as described above, shall be backfilled and thoroughly compacted with select common fill from the springline of the pipe to a height of 12 inches above the crown of the pipe. Compact select common soil in layers not to exceed six inches to 98 percent maximum density per AASHTO T-180. Remainder of trench may be backfilled with select common fill or common fill in layers not to exceed 12-inches to 95 percent maximum density per AASHTO T-180. Moisture content of the soil shall be within minus three percent to plus two percent of the optimum.

3.07 MARKING TAPE

- A. Where pipes are not located under roadways, driveways, or sidewalks, a polyethylene double safe detectable marking tape shall be installed continuously in the backfill along the entire length of all PVC water mains for identification and detection purposes. For pipe sizes smaller than 12 inches, a single four-inch-wide stripe along the top of the pipe shall be provided.
- B. The tape shall be as manufactured by Thor Enterprises or equal. The polyethylene tape shall meet the requirements of ASTM D 1248, Type I, Class A, Grade E 1 for polyethylene plastics molding and extrusion materials. The tape shall have a minimum tensile strength of 1750 psi, a minimum elongation of 250 percent, not less than 50 gauge solid aluminum core and a nominal thickness of five mils. The tape shall be composed of two-mil clear film reverse printed laminated to aluminum, foil laminated to two-mil clear film and reverse printed. Minimum total thickness four mils.
- C. The warning tape shall be printed on one side in black letters (typical for all lettering) and shall be fade resistant olive-green color as follows:

CAUTION: BURIED RAW WATER MAIN BELOW

Minimum marking tape widths shall be as follows:

Pipe Inside Diameter, Inches	Minimum Tape Width, Inches	No. of Tape Strips
12 and Less	4	1
14-20	4	2
24 & Larger	4	3

- D. The Contractor shall submit typical samples of the printed marking tape to the Engineer for approval prior to installation (minimum length to show repeat of message).
- E. The marking tape shall be placed in the trench backfill directly above and centered over the pipeline. The marking tape shall be installed between 12 and 18 inches above the top of the pipe. The Contractor shall exercise care to prevent damage to the polyethylene tape when placing the remaining backfill.
- F. Where the pipeline passes through a manhole, vault or other underground structure, the polyethylene marking tape shall be placed on top of that portion of the pipeline, located inside the structure and shall be secured to the pipeline with adhesive tape.
- G. Openings for air valves and similar appurtenances shall be provided by making an X shaped cut in the polyethylene and temporarily folding back the film. After the polyethylene is installed over the appurtenance, the slack shall be taped securely to the appurtenance and the cut in the polyethylene shall be repaired with adhesive tape.

3.08 RESTORING TRENCH SURFACE

- A. Where the trench occurs adjacent to paved street, in shoulders or sidewalks, the Contractor shall thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, he shall immediately deposit additional fill to restore the level of the ground.
- B. The surface of any driveway or any other area which is disturbed by the trench excavation and which are not a part of the paved highway shall be restored by the Contractor to a condition at least equal to that existing before work began.
- C. In Sections where the pipelines pass through grassed areas, the Contractor shall, at his own expense, remove and replace the soil, or shall loam and sod the surface to the satisfaction of the Engineer. The depth of loam replaced shall be at least equal to that removed by the Contractor in his trenching operations, but in no event, shall it be placed less than four inches in depth. Sod disturbed in front of existing developed lots shall be replaced to match the existing sod.

END OF SECTION

SECTION 02251
TERMITE CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Work Included: Soil treatment below slabs-on-grade and at interior and exterior foundation perimeters, for subterranean insects.

1.02 QUALITY ASSURANCE

- A. Applicator: Company specializing in soil treatment for termite control and Licensed as a professional Pest Control Contractor in the State of Florida.
- B. Materials: Provide certification that toxicant's conform to specified requirements.
- C. Conform to State of Florida requirements for application licensing and authority to use toxicant chemicals.
- D. Conform to Florida Building Code Section 1816 – Termite Protection.

1.03 ENVIRONMENTAL HAZARDS

- A. Do not apply directly to water. Drift and runoff from treated areas may be hazardous to aquatic organisms in adjacent aquatic sites. Do not contaminate water by cleaning of equipment or disposal of waste.

1.04 INSPECTION AND WARRANTY

- A. Provide one-year warranty for material and installation. Cover against invasion or propagation of subterranean termites. Provide inspections and warranty to replace any wood damage through subterranean infestation without cost to the District for a period of one year from date of acceptance by means of a one-year repair and replacement bond, which shall be signed by Applicator and Contractor.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Characteristics: Provide chemicals specially formulated to prevent long term termite infestation, unless forbidden by governing authority. Other solutions may be used if approved by governing authorities and the Engineer. Use only chemicals and concentrations which do not injure plants and grass.
- B. Product shall meet the requirements for registration as a pesticide product as required by Chapter 487, Florida Statutes, and the registered label shall contain directions for use on new construction.

PART 3 EXECUTION

3.01 GENERAL

- A. Installer/Applicator must examine areas and conditions under which Termite Control is to be installed/applied and notify Engineer in writing of conditions detrimental to proper completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer/Applicator.
- C. Beginning of installation/application means acceptance of existing conditions.

3.02 EXTENT, SEQUENCE

- A. Do not apply soil treatment solution until excavating, filling and grading operations are completed, except as otherwise required in construction operations.
- B. Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slab and foundations. Toxicant's may be applied before placement of porous fill under slabs, if recommended by chemical manufacturer.

3.03 APPLICATION

- A. Apply soil treatment solution at rates recommended by soil chemical manufacturer. Comply with chemical manufacturer's printed/written instructions and recommendations for this work where they are the same as or greater than what is specified here.
- B. Allow not less than 12 hours for drying after application before beginning concrete placement or other construction activities.
- C. Post signs in areas of application warning workers that soil poisoning has been applied. Remove signs when areas are covered by other construction.
- D. Reapply soil treatment solution to areas disturbed by subsequent excavation or other construction activities following application.
- E. Apply toxicant immediately prior to placement of vapor retarder under slab-on-grade or finish grading outside foundation walls. Do not apply soil poison when surface water is present.
 - 1. Apply toxicant to soil at the following minimum rates, using metered applicator:
Under floor slabs-on-grade: One gallon per 10 square feet; if fill is washed gravel or other coarse material, apply at rate of one and one-half gallons per 10 square feet.
 - 2. Both sides of foundation wall: Four gallons per 10 linear feet per foot of depth. Mix emulsion with the soil as it is being replaced in the trench.
 - 3. Immediately below expansion joists, control joints: Four gallons per 10 linear feet.
- F. Apply extra treatment to structure penetrations, pipe ducts, and other soil penetrations.

- G. Apply as coarse spray to ensure uniform distribution.
- H. Coordinate soil treatment at foundation perimeter with finish grading and landscaping work to avoid disturbance of treated soil. Retreat disturbed treated soil.

3.04 RETREATMENT

- A. If inspection identifies the presence of termites, retreat soil and retest.
- B. Use same toxicant as for original treatment.

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SECTION 02270
EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and perform all installation, maintenance, removal and area cleanup related to erosion and sedimentation control work as shown on the Drawings and as specified herein. The work shall include, but not necessarily be limited to; installation of temporary access ways and staging areas, silt fences, stone filter boxes, stone filter berms, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, excelsior matting installation and final cleanup.

1.02 RELATED WORK

- A. Dust control is included in Section 01562.
- B. Earthwork is included in Section 02200.
- .
- C. Sodding and seeding is included in Section 02900.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, within 10 days after award of Contract, technical product literature for all commercial products, including straw mulch tackifier, to be used for erosion and sedimentation control.

1.04 QUALITY ASSURANCE

- A. Be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off-site areas or into the stream system via surface runoff or underground drainage systems. Measures in addition to those shown on the Drawings necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the District will be considered.
- B. Sedimentation and erosion control measures shall conform to the requirements outlined in all applicable local, state and federal permits..

PART 2 PRODUCTS

2.01 MATERIALS

- A. Silt fences and turbidity barriers shall conform to FDOT “Standard Plans for Road Construction” and “Standard Specifications for Road and Bridge Construction” (latest editions).
- B. Straw mulch shall be utilized on all newly graded areas to protect areas against washouts and erosion. Straw mulch shall be comprised of threshed straw of oats, wheat, barley, or rye that is free from noxious weeds, mold or other objectionable material. The straw mulch shall contain

at least 50 percent by weight of material to be 10-in or longer. Straw shall be in an air-dry condition and suitable for placement with blower equipment.

- C. Latex acrylic copolymer or organic tackifier shall be a commercial product specifically manufactured for use as straw mulch tackifier.
- D. An asphalt tackifier shall only be used when temperatures are too low to allow the use of a latex acrylic copolymer and only with prior written approval from the Engineer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Silt Fence Installation

- 1. Sediment fences shall be positioned as indicated on the Drawings and as necessary to prevent off site movement of sediment produced by construction activities as directed by the Engineer.
 - 2. Dig trench approximately six in. wide and six in. deep along proposed fence lines.
 - 3. Drive stakes, eight ft on center (maximum) at back edge of trenches. Stakes shall be driven two ft (minimum) into ground.
 - 4. Hang filter fabric on posts carrying to bottom of trench with about four in. of fabric laid across bottom of trench. Stretch fabric fairly taut along fence length and maintain secure both ways.
 - 5. Backfill trench with excavated material and tamp.
 - 6. Install pre-fabricated silt fence according to manufacturer's instructions.
- B. Staging areas and access ways shall be surfaced with a minimum depth of four in. of crushed stone.

3.02 MAINTENANCE AND INSPECTIONS

A. Inspections

- 1. Make a visual inspection of all erosion and sedimentation control devices once per week and promptly after every rainstorm. If such inspection reveals that additional measures are needed to prevent movement of sediment to offsite areas, promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.

B. Device Maintenance

- 1. Sediment Fences
 - a. Remove accumulated sediment once it builds up to 1/2 of the height of the fabric.
 - b. Replace damaged fabric, or patch with a two-ft minimum overlap.
 - c. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.

2. Add crushed stone to access ways and staging area as necessary to maintain a firm surface free of ruts and mudholes.

3.03 TEMPORARY MULCHING

- A. Apply temporary mulch to areas where rough grading has been completed but final grading is not anticipated to begin within 30 days of the completion of rough grading.
- B. Straw mulch shall be applied at rate of 100 lbs/1000 sq ft and tackified with latex acrylic copolymer at a rate and diluted in a ratio per manufacturer's instructions.

3.04 EROSION CONTROL BLANKETS

- A. Erosion control blankets shall be installed in all seeded drainage swales and ditches as shown on the Drawings and as directed by the Engineer in accordance with manufacturer's instructions. The area to be covered shall be properly prepared, fertilized and seeded with permanent vegetation before the blanket is applied. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. The blankets shall be applied in the direction of water flow and stapled. Blankets shall be placed a minimum of three rows (of four ft) wide (total approx. 12-ft width) within the drainage swale/ditch and stapled together in accordance with manufacturer's instructions. Side overlaps shall be four-in minimum. The staples shall be made of wire, .091-in in diameter or greater, "U" shaped with legs 10-in in length and a 1-1/2-in. crown. Commercial biodegradable stakes may also be used with prior approval by the Engineer. The staples shall be driven vertically into the ground, spaced approximately two linear feet apart, on each side, and one row in the center alternately spaced between each side. Upper and lower ends of the matting shall be buried to a depth of four in. in a trench. Erosion stops shall be created every 25-ft by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be four in. below the ground surface. Staple on both sides of fold. Where the matting must be cut or more than one roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of four in. Overlap lower end of upstream roll four-in. past edge of downstream roll and staple.
 1. To ensure full contact with soil surface, roll matting with a roller weighing 100 lbs/ft of width perpendicular to flow direction after seeding, placing matting and stapling. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

3.05 REMOVAL AND FINAL CLEANUP

- A. Once the site has been fully stabilized against erosion, remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in proper manner. Regrade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Drawings.

END OF SECTION

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SECTION 02311
EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The work specified in this Section includes requirements for excavation and support of temporary excavations, launch and exit shafts, and trenches. The Contractor shall design, furnish, install, and maintain a system of supports, including all bracing and associated items, to retain excavations in a safe manner and to control ground movements. Upon completion of the required construction, the system of support shall be removed or cut and left in place as noted herein and the excavation and staging area sites restored as discussed herein.
- B. The work specified in this Section also includes the use of portable trench boxes or sliding shields.
- C. The work shall include site grading; fencing and signing; construction staging areas; design and construction of excavation support systems; design and construction of thrust blocks; disposal of excavated material, surface water, and ground water; backfilling; and site restoration. Work shall include all labor, materials, and equipment required to complete excavation support.
- D. The Contractor shall retain the services of a Professional Engineer licensed in the State of Florida to prepare excavation support and protection system designs and submittals described herein.
- E. All excavations and support systems shall conform to the Florida Trench Safety Act and to applicable OSHA excavation, trenching, and shoring standards which are contained in the U.S. Code of Federal Regulations 29 (C.F.R.) 1926.650-1926.653, other federal, state or local requirements. In the event of a conflict, comply with the more restrictive applicable requirements.
- F. Excavation support at trenchless crossings shall not impede the flow of traffic along the roadway being crossed.
- G. The Contractor shall be responsible for choosing and sizing the support of excavation systems. The size of the systems shall, however, be adequate for removal of material as indicated on the Drawings and to provide adequate space to meet the Contractor's work requirements for his/her selected methods of construction. The excavation support system shall be chosen such that it controls groundwater, limits the amount of ground movements and protects the adjacent structures.

1.02 RELATED WORK

- A. Submittals is included in Section 01300,
- B. Site Preparation is included in Section 02100.
- C. Dewatering and Drainage is included in Section 02140.
- D. Jack and Bore is included in Section 02157.

- E. Excavation, Bedding and Backfill for Pipe is including in Section 02221.
- F. Geotechnical Instrumentation is included in Section 02495.

1.03 DESIGN REQUIREMENTS

- A. The design of the temporary excavation support system is the responsibility of the Contractor. The design calculations and drawings shall be prepared, stamped and signed by a Professional Engineer licensed in the State of Florida, who is experienced in designing similar excavation support systems.
- B. Design the sheeting excavation support system in accordance with requirements of this Section. These criteria are the minimum acceptable standards. Design shall consider all phases of construction and design of each member or support element to support the maximum loads that can occur during construction with appropriate factors of safety.
- C. Design shall consider all phases of construction. Design each member or support element to support the maximum loads that can occur during construction with appropriate factors of safety.
- D. All underground utility lines shall be identified, located, and protected from damage or displacement. Utility companies and other responsible authorities shall be contacted to locate and mark the locations and, if they so desire, direct or assist with protecting the underground installation. When required, the Contractor shall obtain an excavation permit from the local authority having jurisdiction prior to the initiation of any excavation work.
- E. Design excavation support systems in accordance with all OSHA requirements and other local and agency requirements.
- F. Design the support system to minimize horizontal and vertical movements and to protect adjacent structures and utilities from damage.
- G. Excavations below the level of the base of any adjacent foundation or retaining wall shall not be permitted unless the design of the excavation and bracing includes an analysis of the stability of the structure supported by the foundation and as necessary, incorporates required bracing/underpinning of the foundation.
- H. For support systems in which bracing is installed between opposite sides of the excavation, design the excavation support of both sides to be nearly the same as feasible.
- I. Where necessary to resist point loads, pipe piles used as soldier piles shall be filled with concrete with a compressive strength not less than 3,000 psi. The strength of the concrete shall not be considered in design of the pipe pile for bending stress.
- J. Design a working slab for each launch shaft bottom to provide stable support for guide rails, thrust block, and other construction operations.
- K. Design, install, operate, and maintain ground water control system to control ground water inflows, prevent piping or loss of ground, and maintain stability of the excavation. Refer to the requirements of Section 02140.

- L. Thrust blocks shall be designed to resist the maximum jacking load at each launch shaft. The jacking load shall be estimated and thrust block designed based on a minimum friction resistance on the steel casing of 250 psf. A minimum jacking load of 200 tons shall be used. The thrust block shall be designed using a maximum passive earth pressure coefficient of 3.25, and a minimum factor of safety of 1.2. The maximum jacking load shall be incorporated into the launch shaft design.
- M. Design, install, operate, and maintain deformation monitoring points to monitor the performance of the excavation support system in accordance with Section 02495.
- N. Provide temporary fencing around all excavations. Provide pedestrian and traffic control around working areas and support systems located within or adjacent to streets, roadways, driveways, walkways or parking lots.
- O. Receipt of the Contractor's plans and methods of construction by the Engineer does not relieve the Contractor of his responsibility to provide an adequate support system achieving the specified requirements.
- P. Design review and field monitoring activities by the District or by the Engineer shall not relieve the Contractor of his/her responsibilities for the work.

1.04 SUBMITTALS

- A. Submit to the Engineer in accordance with Section 01300, Shop Drawings and design calculations for the Contractor-designed excavation support system stamped by a Professional Engineer in the State of Florida. Submittals shall indicate the following, as a minimum:
 - 1. Provide overall plan layout of the system, as shown on contract drawings, indicating clearances, dimensions, material properties, member sizes, locations, spacing and penetration depths of all members, as well as locations of various types of lateral supports. Indicate existing and proposed utilities, structures or other obstruction. Indicate location and type of instrumentation and monitoring points within the area of influence of the excavation.
 - 2. Provide wall elevations and locations of all bracing and anchors.
 - 3. Show methods and overall sequence of installation and removal of bracing, indicating levels to which the work will be carried out before bracing is installed or removed.
 - 4. Method of preloading bracing (if required) and the preload for each member, and the method of locking-off the preload. Include detailed drawings of the connections, jacking supports and method of shimming.
 - 5. Details, layout, arrangement, equipment requirements, and method of construction of the proposed steel sheeting excavation support system.
 - 6. Submit thrust block design calculations and shop drawings for all jack and bore launch shafts.
 - 7. Submit design calculations and shop drawings for the launch and exit shafts detailing material types, equipment, and construction methods to be used for construction of the excavation support systems prepared by a professional engineer registered in the state of

Florida as shown on the Contract Drawings. Shop drawings shall also detail all member connections and tunnel portal openings.

8. Procedures for resolving difficulties arising from misalignment of members exposed during excavation, and criteria for implementing those procedures.
- B. Design calculations shall include:
1. Loads on the excavation support system for all stages of excavation, bracing removal, and concrete placement, including material and equipment loads on adjacent ground during construction.
 2. Design of wall and all bracing members including all details for all stages of construction. Design shall account for water pressures associated with flood conditions.
 3. Theoretical deflections of excavation support system and deformation of structures, pipelines and other utilities located within the area of influence of the excavation.
- C. Submit quality control measures as required to ensure that the performance of the excavation support system is consistent with the requirements herein.
- D. For portable trench boxes or sliding shields, submittals shall include the following as a minimum:
1. Trench box manufacturer's specifications, recommendations, and limitations.
 2. Detailed drawings showing intended use of trench box during excavation, pipe placement, and backfilling activities.
- E. Submit welder qualifications and weld procedures in accordance with AWS D1.1.
- F. Submit Contractor's and Design Engineer's qualifications as described herein.
- G. At least one copy of the design shall be maintained at the job site during excavation that includes a plan indicating the sizes, types, and configurations of the materials to be used in the protective system, and the identity of the registered engineer who approved the design.
- H. Do not proceed with any support of excavation or protection activities until the submittal has been reviewed by the Engineer for compliance with the Contract Documents and for general compatibility with the work and with accepted engineering practices.
- I. Contractor's Design Engineer's documentation shall include:
1. Periodic on-site inspections of excavation support system as the systems are constructed.
 2. Review of quality control measures and performance data.
 3. Certification that the excavation support system is constructed per the applicable design following completion of each support system and following any modifications by Contractor during construction.

1.05 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A36 - Specification for Structural Steel Standard Specifications
- B. American Welding Society (AWS)
 - 1. AWS D1.1 for Public Works Construction
- C. Codes
 - 1. U.S. Occupational Safety and Health Administration (OSHA) Regulations, 29 CFR Part 1926 Subpart P – Excavations.
- D. Where reference is made to one of the above standards the revision in effect at the time of the bid opening shall apply.

1.06 QUALITY ASSURANCE

- A. Regulations: Perform all work in accordance with current applicable regulations and codes of all Federal, State and local agencies.
- B. The Contractor shall have at least five years of experience with work comparable to the Work shown and specified, employing labor and supervisory personnel who are similarly experienced in this type of Work.
- C. The Contractor's Design Engineer shall be a Licensed Professional Engineer in the State of Florida with at least five years professional experience in the design and construction of support of excavation systems and shall have completed not less than five successful excavation support projects of equal type, size, and complexity to that required for the work.
- D. Design of thrust blocks shall be performed by a professional engineer, licensed in the State of Florida, with at least five years' experience in this type of work.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All timber, structural steel, and steel sheet piling used for the supporting systems, whether new or used, shall be sound and free from defects that may impair their strength.
- B. Soldier piles and structural steel members shall conform to ASTM A572 or ASTM A242 unless approved otherwise. All steel conforming to ASTM A 572 shall be Grade 36 or better. No members with permanent deformations are to be provided. Members shall not be spliced unless approved by the Engineer.
- C. Pipe piles used as soldier piles shall conform to ASTM A252, Grade 36, or better.
- D. Steel sheet piling shall conform to ASTM A328 or ASTM A572 or ASTM A690. All steel sheet piling conforming to ASTM A 572 shall be Grade 50 or better.

- E. Concrete shall conform to ASTM C33 and ASTM C150 unless otherwise approved.
- F. All timber shall be structural grade with a minimum allowable flexural strength of 1100 psi. Timber lagging shall be at least three inches thick and free of large or loose knots.

PART 3 EXECUTION

3.01 GENERAL

- A. Commence installation of support system and excavations only after shop drawings have been reviewed by the Engineer for conformance with the contract documents and for general compatibility with the work and with accepted engineering practices.
- B. All instrumentation required per Section 02495 shall be installed and initialized prior to the start of work.
- C. Methods of construction for excavations shall be such as to ensure the safety of the Work, Contractor's employees, Engineer, and District's employees and inspectors, the public and adjacent property and improvements, whether public or private.
- D. Before beginning construction at any location of this project, adequately protect existing structures, utilities, trees, shrubs, and other existing facilities. The repair of or compensation for damage to existing facilities shall be at no additional cost to the District.
- E. As a minimum, place fencing, gates, lights, and signs as necessary around the excavations and staging areas to provide for public safety.
- F. Install excavation support systems in accordance with the approved shop drawings and applicable permits. Upon completion, the installed excavation support system shall be inspected by the Contractor's Design Engineer with written certification provided to the Engineer.
- G. Care shall be taken to prevent voids outside the excavation support system, but if voids are formed, they shall be immediately filled with common fill material. Voids in locations that cannot be properly compacted upon backfilling shall be filled with lean concrete or other material as approved by the Engineer at no additional cost to the District.
- H. If unstable material is encountered during excavation, all necessary measures shall be taken immediately to contain it in place and prevent ground displacement.
- I. If settlement or deflections of supports indicate that support system requires modification to prevent excessive movements, redesign and resubmit revised shop drawings and calculations to the Engineer at no additional cost to the District.
- J. Sufficient quantity of material shall be maintained on site for protection of work and for use in case of accident or emergency.
- K. All welding shall conform to the applicable provisions of ANSI/AWS D1.1.

3.02 PORTABLE TRENCH BOXES

- A. Portable trench boxes or sliding trench shields may be used for the protection of workers only.

- B. Trench boxes shall not be used in launch or exit shafts for trenchless work.
- C. Additional excavation, backfilling, and surface restoration required as the result of trench box use shall be at no additional cost to the District.
- D. Trench boxes or shields shall be designed, constructed, and maintained to meet acceptable engineering and industry standards.
- E. Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.
- F. A copy of the trench box manufacturer's specifications, recommendations, and limitations shall be in written form and maintained at the job site during all excavation work.

3.03 SOLDIER PILES AND LAGGING

- A. Install soldier piles with the minimum embedment depths as shown on approved shop drawings.
- B. Soldier piles shall be installed in predrilled holes with casing or other methods of support as necessary to prevent caving of holes and loss of ground.
- C. Predrilled holes for soldier piles shall be backfilled with concrete from the pile tip elevation to the elevation of the bottom of the excavation. The remainder of the predrilled hole shall be backfilled with lean concrete or sand. Concrete strength shall be in accordance with the approved shop drawings.
- D. The predrilled hole diameter shall be sufficient to allow for proper alignment and concrete backfilling of the pile.
- E. Provide timber lagging of sufficient thickness to withstand earth pressures and in accordance with the approved shop drawings.
- F. Install lagging such that ground loss does not occur between adjacent or below the lowest board. As excavation proceeds, the maximum height of unlagged face of excavation shall not exceed four feet. The unlagged face shall not exceed two ft if water seeps or flows from the face of the excavation or if the face of the excavation becomes unstable.
- G. As installation progresses, backfill the voids between the excavation face and the lagging. Pack with materials such as hay, burlap, or geotextile filter fabric where necessary to allow drainage of ground water without loss of ground.

3.04 STEEL SHEET PILING

- A. Install steel sheet piling with the minimum embedment depths as shown on the shop drawings.
- B. Drive sheeting in plumb position with each sheet pile interlocked with adjoining piles for its entire length so as to form a continuous diaphragm throughout the length of each run of wall, bearing tightly against original ground. Exercise care in driving so that interlocking members can be extracted without damaging adjacent structures or utilities. The methods of driving, cutting, and splicing shall conform to the shop drawings.
- C. Use templates or other temporary alignment facilities to maintain piling line.

- D. Prior to installation, the sheet piles shall be thoroughly cleaned and inspected for defects and for proper interlock dimensions. The Contractor shall provide a tool for checking the interlock dimensions.
- E. Each sheet pile shall have sufficient clearance in the interlocks to slide, under its own weight, into the interlock of the sheet pile previously placed.
- F. Excavation shall not be carried in advance of steel sheet piling installation.
- G. Where obstructions are anticipated, pre-excavation or pre-drilling along the sheet pile wall alignment shall be conducted at no additional cost to the District. Pre-excavation and pre-drilling shall not extend below the lowest excavation level or into bearing soils for existing or future structures.
- H. Obstructions encountered before the specified embedment for piles shall be removed. Where obstructions cannot be removed, the sheet pile system shall be re-evaluated by the Contractor's Design Engineer for the resulted reduced embedment and additional toe stability measure implemented, as required or for realignment of the sheet pile wall. A submittal of the proposed measures shall be provided.
- I. Damaged piling or piling with faulty alignment shall be withdrawn and new piling driven properly in its place. The cost of such additional work shall be considered as part of the pile driving and shall be borne by the Contractor.

3.05 INTERNAL BRACING

- A. Provide internal bracing to carry maximum design load without distortion or buckling.
- B. Include web stiffeners, plates, or angles as needed to prevent rotation, crippling, or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.
- C. Install and maintain all bracing support members in tight contact with each other and with the surface being supported. Wood shims shall not be used.
- D. Coordinate excavation work with installation of bracing. Excavation shall extend no more than two feet below any brace level prior to installation of the bracing.
- E. Use procedures that produce uniform loading of bracing member without eccentricities or overstressing and distortion of members of system.

3.06 REMOVAL OF EXCAVATION SUPPORT

- A. Do not remove internal bracing and transfer loads to the permanent structure without prior acceptance of the Engineer.
- B. Removal of excavation support system shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly as to note any indication of possible failure of the remaining members or possible cave-in of the sides of the excavation.
- C. Backfilling shall progress together with the removal of support systems from excavations.

- D. Do not remove vertical support members that were installed within the zone of influence of new or existing structures or pipelines. The zone of influence is defined as a zone extending down and away from the outer edge of the structure at one horizontal to one vertical or from the centerline of the pipe. Support members installed within this zone shall be cut off at a minimum of five ft below finished grade and abandoned in place.
- E. Unless otherwise indicated or directed by the Engineer, remove all portions of excavation support.
- F. No wood shall remain as part of the abandoned portion of the work.
- G. When removing the excavation support system, do not disturb or damage adjacent buildings, structures or utilities. Fill voids immediately with lean concrete or well-graded cohesionless sand, as indicated or directed by the Engineer.
- H. Remove material of the excavation support system from the site immediately.

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SECTION 02325
MICROTUNNELING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment, supplies and incidentals required and install pipe by microtunneling, as indicated on the Drawings and specified to retain excavations in a safe manner, to control ground movements, and to protect adjacent structures, or as otherwise directed by the Engineer or required by agencies having jurisdiction over the Work.
- B. Contractor's responsibility shall include but not limited to the following:
1. Responsible for selection of microtunneling means and methods subject to review by the Engineer. Contractor shall provide a minimum casing size of 42 inches.
 2. Developing a means and methods of construction for shafts and microtunneling that account for the following baseline conditions:
 - a. Groundwater assumed to be a maximum of five feet below ground surface.
 - b. Overburden soil consists of sand, silt and clay with the following engineering properties:
 - 1) Unit weight: 120 pcf
 - 2) $\phi = 30$ degrees
 - 3) K_a , K_o and $K_p = 0.33$, 0.5 and 3.0, respectively.
 3. Furnish labor, equipment, and material required to complete work by microtunneling including but not limited to; microtunneling system and all related accessories, spoil transportation, separation, removal and disposal, hoisting, lifting, safety, and control equipment.
 4. Furnish labor, equipment, and material for jacking and receiving shaft construction, complete in place including, but not limited to:
 - a. Re-handling and disposal of unsuitable materials, control of groundwater and surface water, utility adjustments/support, tests, excavation, sheeting and shoring, backfilling, cleanup, security, restoration of surface features, other related work necessary for construction as specified and/or as shown on the Drawings.
 5. Furnish all labor, materials, equipment and incidentals required and perform tunnel backfill grouting complete after the installation of carrier pipes inside the tunnel, as shown on the Drawings and as specified herein.
- C. Furnish the services of a licensed professional engineer registered in the State of Florida to prepare microtunneling designs and submittals.

- D. If any movement or settlement occurs which causes or might cause damage to an existing structure or road over, along or adjacent to the work, immediately stop any or all work except that which assists in making the work secure and in preventing further movement, settlement or damage. Resume tunneling only after all necessary precautions have been taken to prevent further movement, settlement or damage, and repair the damage at the Contractor's own cost and to the satisfaction of the Engineer.
- E. Follow all OSHA regulations regarding confined space for casing installation. Obtain all permits required associated with OSHA regulations and requirements for confined space entry.

1.02 RELATED SECTIONS

- A. Section 02140 - Dewatering
- B. Section 02200 - Earthwork
- C. Section 02311 – Excavation Support and Protection

1.03 MEASUREMENT AND PAYMENT

A. Microtunneling:

- 1. Measurement: This quantity shall be a lump sum to install the Microtunnel as shown on the Drawings.
- 2. Payment: The lump sum price bid to be paid under this Item shall be full compensation for all design, labor, materials, tools, equipment, monitoring, supervision, and necessary for microtunneling including microtunneling, control of groundwater during microtunneling, installation of carrier pipe in the casing, casing pipe, casing grouting, annular space grouting, and all else necessary to complete construction as shown on the Drawings and not covered under other Bid items.

B. Launch and Receiving Shafts:

- 1. Measurement: This quantity shall be a lump sum to install the launch and receiving shafts as shown on the Drawings.
- 2. Payment: The lump sum price bid to be paid under this Item shall be full compensation for all design, labor, materials, tools, equipment, monitoring, supervision, and incidentals necessary to construct launch and receiving shafts for microtunneling including ground support system, surface and groundwater control plans, excavation, thrust blocks, backstops, shaft penetrations, removal/decommissioning, carrier pipe installation within the shaft footprint, backfill, restoration, and all else necessary to complete construction as shown on the Drawings and not covered under other Bid items.

C. Carrier Pipe:

- 1. Measurement: The quantity of Carrier pipe to be paid for under this Item will be the actual number of linear feet measured in a straight-line from launch shaft to receiving shaft as shown on the Drawings.

2. Payment: The unit price bid per linear foot of this Item will be full compensation for furnishing and installing Carrier pipe as shown on the Drawings and specified herein. Payment for this Item shall include, but not be limited to: furnishing, transporting, and assembling carrier pipe, casing spacers, pipe supports, and all else incidental thereto for which separate payment is not provided under other Bid Items.

1.04 DEFINITIONS

- A. Tunnel: an underground opening supported using tunnel casing.
- B. Carrier pipes: The pipes inserted within the tunnel liner casing and which acts as the conveyor for the utility.
- C. Microtunneling, Generally: An underground method of construction by jacking pipe behind a remotely controlled, steerable, laser-guided articulated mechanical cutting shield or Microtunnel Boring Machine (MTBM) to excavate a tunnel for installing underground pipelines, ducts and culverts.
- D. Pipe: Steel casing of sufficient thickness to withstand the applied jacking thrust loads.
- E. Launch Shaft: Working shaft used for advancing of tunnel heading by microtunnel jacking technique.
- F. Receiving Shaft: Working shaft used for equipment retrieval.
- G. Drive: Section of pipe installed by microtunneling from jacking shaft to receiving shaft.
- H. Slurry Pressure Balance System:
 1. Pressurized microtunneling system that mixes excavated material with slurry in a chamber located behind cutting head.
 2. Low pressure slurry is used to balance ground and water pressure at face of tunnel, limit settlement and to convey cuttings back to ground surface.
 3. Cuttings are removed or separated and slurry is re-circulated back to MTBM.
- I. Spoil: Excavated soil and bedrock material that has been mixed with either water or slurry and pumped to surface to be separated and recycled or disposed.
- J. Tunnel: Microtunnel casing pipe and the carrier pipes in a two-pass application.
- K. Casing Pipe: A pipe, generally steel, installed behind the microtunneling machine, which is jacked into place, within which a carrier pipe is inserted later.
- L. Carrier Pipe: The pipes which carry the product being transported and which are installed inside the casing pipe.
- M. Admixtures: Materials other than water, aggregate, or cement added to the grout mix to modify the mix properties.

- N. Foam: A synthetic foaming agent which when added to engineered cement slurry enables the production of cellular lightweight concrete.
- O. Annular fill: pumpable grout that has a minimum strength of 500 psi
- P. Structural Grout Backfill: Low-shrink, fluid, unreinforced grout designed to fill the annular space between the carrier pipe and the excavated rock surface or the casing pipe.

1.05 QUALITY ASSURANCE

A. Supervision:

1. Supervised by at least one person with five years of recent previous experience in microtunneling process.
2. Experience in a minimum of five previous microtunneling projects of similar size and scope.
3. Microtunneling operations shall be performed under the constant direction of a microtunneling supervisor who shall remain on site and be in responsible charge throughout the microtunneling operation.

B. Operators:

1. Personnel experienced in microtunneling with prior knowledge and ability in proper operation of systems being employed.
2. Minimum of five years' experience performing Microtunneling of similar size pipe and segment lengths and ground conditions.

C. Operation:

1. Operate systems following manufacturer's instructions.
2. Make available at all times copies of operations manuals to The Engineer and operational personnel on site.

D. Run Test: Test full system on completion of set up and before commencing drive.

E. Surveying: Perform surveying by a surveyor licensed in the State of Florida and with at least three years' experience in related type of work.

F. Drive Start Up:

1. Before commencement of any drive, demonstrate to the Engineer that required set up procedures and system checks are complete and required materials are at hand to commence drive.
2. Do not commence drive until construction of receiving shaft has been completed.

- G. Casing pipe shall be the product of a single domestic manufacturer. Casing pipe shall be tested and inspected at the manufacturing plant as required by the standard specifications to which the material is manufactured.

1.06 SUBMITTALS

- A. If modifications are required during construction, submit for approval information illustrating such modifications, including reasons.
- B. Microtunneling Qualifications for Contractor Performing Microtunneling Work:
 - 1. Cover sheet: Date, company name, address, telephone and fax numbers, email address, and contact person.
 - 2. Resumes of supervisory and operational key personnel: Detailed descriptions of their Microtunneling Projects.
 - 3. Summary sheet of previous projects performed using Microtunneling that demonstrates expertise and experience. Named projects may be used more than once under separate paragraphs if their criteria apply.
 - a. The Contractor shall have a minimum of five years' experience performing microtunneling of similar size and scope, and shall have installed a minimum of 10,000 linear feet of pipe by microtunneling.
 - b. List five separate projects completed using Slurry based microtunneling system.
 - 4. Submit for each named project above, and in same order, following detailed information:
 - a. Date, full name of project, and location.
 - b. Owner's name, address, telephone and fax numbers, email address, and contact person.
 - c. Client's name, address, telephone and fax numbers, and contact person.
 - d. Employees in charge of work at both head office and site.
 - e. Description of relevant work successfully completed, including ground conditions.
 - f. Features under which pipe passed, depth below the water table, photos, and published articles if available.
 - g. Additional information as necessary.
- C. Equipment:
 - 1. Supply full details of microtunneling system to be employed.
 - 2. Manufacturer and date(s) of manufacture.
 - 3. Type and model number for whole system if from single source or separate details for each element of system.
 - 4. Confirmation from manufacturer that machine set up is suitable to limit annular space, as specified, for external diameter of pipe proposed.
 - 5. System of alignment monitoring and steering control and activation.

6. Hydraulic jacking system maximum capacity and method of limiting jacking capacity to that of maximum capacity of specified casing.

D. Procedures:

1. Supply full details of procedures and resources that will be employed to carry out work including method and sequence of:
 - a. Establishment of drive line of MTBM and elevation at base of shaft.
 - b. Pipe handling and connections.
 - c. Maintaining line and grade, and re-establishment of line and grade as required.
 - d. Spoil separation and disposal.
 - e. Spoil and slurry containment during microtunneling work.
 - f. Installation of carrier pipe, including placement of grout between carrier pipe and the casing pipe or the ground.

E. Materials:

1. Supply full details of following materials:
 - a. Design mixes for all concrete, grout.
 - b. Casing pipe including manufacturer, grade, and specification, outside diameter, thickness.

F. Calculations that clearly state:

1. Maximum calculated jacking resistance for installing complete pipe string between the jacking and receiving shafts.
2. Maximum allowable face pressure or slurry pressure that can be exerted at tunnel face without fluid loss to surface, other structures or features or heave of ground.
3. Relationship between hydraulic jacking pressure and force applied to the pipe during jacking.

G. Launch and Receiving Shafts:

1. Submit station specific Working Drawings to include but not limited to:
 - a. Jacking/launch and receiving shaft configurations.
 - b. Design and construction of jacking and receiving shafts.
 - c. Details for ground support system.
 - d. Special requirements for jacking and receiving shaft penetrations, thrust blocks, backstops or other reactions required for Microtunneling.
 - e. Areas for storage, material and spoil handling, water control, ground stabilization if required, excavation procedures, and backfilling.
 - f. Surface water and groundwater control plans for all jacking and receiving shafts.

- H. Other Contingency Plans: Detailed contingency plans are required for the following:
1. High jacking forces
 2. Damaged pipe
 3. Obstruction(s)
 4. Settlement
 5. Loss of line and grade
 6. Major mechanical breakdown
 7. Stoppage of jacking
 8. Loss of cutter tools on the cutter head of the MTBM.
 9. Maintain line and grade during mixed face conditions
- I. Submit the Contractor's Florida professional engineer's qualifications as described herein.
- J. Daily surveyor reports of casing pipe position and control point monitoring, conducted by the Contractor's surveyor, shall be provided in writing to the Engineer.
- K. Working Drawings and Method Statements for tunnel backfill grouting including:
1. Means and Methods for proportioning, mixing, batching and delivering backfill, including storage of raw materials.
 2. Method statements and design calculations for placing backfill materials, including initial lift heights of backfill, rate of placement based upon maximum height of backfill allowed prior to set to prevent overloading of the carrier pipe.
 3. Details for transporting and placing backfill. Describe the sequencing of this work with the installation of the carrier pipe and provide the following:
 - a. Drawings showing details of grout delivery pipes, slicklines, injection ports, bulkheads, vent outlets, and other materials.
 - b. Calculations for preventing floatation and deformation of the carrier pipes.
 - c. Description of labor, equipment and supplies required to perform the work.
 - d. Cross-section and profiles showing the arrangement of transportation, handling, and placing equipment including passing clearances.
 - e. Details of pumping pressures and rates, placement sequences and volumes, lift thicknesses, including theoretical quantity for each placement.
 - f. Methods for diverting construction water and groundwater and protecting the backfill.
 - g. Methods for handling the backfill materials prior to placing the backfill within the annulus, including agitators, remixer or other equipment.
 - h. Methods for blocking or bracing the carrier pipes during backfilling.

4. Methods of controlling lift heights or rate of placement of backfill within the requirements stated herein.
 5. Methods for maintaining uniformity of the backfill elevation around the carrier pipe.
 6. Method statements and design calculations for contract grouting including grouting pressure and volume of grout placed.
- L. Mix design report for tunnel backfill grouting including:
1. Mix type and designation.
 2. Mix constituents and proportions, including materials by weight and volume.
 3. Mix densities and viscosities, including materials by weight and volume.
 4. Initial set time of mix.
 5. Bleeding, shrinkage/expansion.
 6. Compressive strength.
- M. Record drawings:
1. Maintain at construction site a complete set of field drawings for recording of as-built conditions.
 2. Mark or note thereon up-to-date as-built conditions properly dated.

1.07 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
1. ASTM A36 Standard Specification for Carbon Structural Steel.
 2. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 3. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon.
 4. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
 5. ASTM C150 - Standard Specification for Portland Cement.
 6. ASTM C311 – Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
 7. ASTM C494 – Standard Specification for Chemical Admixture for Concrete.
 8. ASTM C495 – Compressive Strength of Lightweight Insulating Concrete.

9. ASTM C567 – Unit Weight of Structural Lightweight Concrete.
 10. ASTM C618 – Fly Ash and Raw Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
 11. ASTM C796 – Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam.
 12. ASTM C869 – Foaming agents Used in Making Preformed Foam for Cellular Concrete.
 13. ASTM C937 – Standard Specification for Grout Fluidifier for Preplaced – Aggregate Concrete.
- B. Where reference is made to one the above standards, the revision in effect at the time of bid opening shall apply.
- C. Occupational Safety and health Administration (OSHA): 29 CFR Part 1926, Subpart S, Regulations and Standards for Underground Construction.
- D. American Society of Civil Engineers (ASCE) Standard Construction Guidelines for Microtunneling CI/ASCE 36-01.
- E. National Electric Code – NFPA70.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

2.02 MATERIALS

- A. Casing Pipe
1. Steel Casing Pipe: Smooth walled with minimum yield strength of 36,000 psi (ASTM A1011 Grade 36), or shall conform to the requirements of ASTM A53 (ASTM A139 Grade "B").
 2. Minimum wall thickness 0.5 inch or as indicated on Drawings. Joints fully welded around circumference of pipe. Use of internal sleeve to make the joint is acceptable. Provide weld of sufficient strength to withstand all forces at pipe joints without any distortion of pipes.
 3. No coating required on casing pipe.
- B. Grout to fill annular space between casing pipe and the ground:
1. Cement: ASTM C150, Type II.
 2. Water: Potable free of deleterious material.

3. Sand: ASTM C404, size No. 1.
 4. Design mix for grout: Minimum compressive strength of 100 psi attained within 24 hours.
- C. Grout to fill annular space between carrier pipes and casing pipe and the ground:
1. Cement: ASTM C150, Type II.
 2. Contractor shall not use admixtures containing chlorides that promote corrosion.
 3. Retarder/Water reducer shall conform to the requirements of ASTM C494, Type D.
 4. Plasticizer/Water Reducer shall conform to the requirements of ASTM C494, Type A.
 5. Fly Ash shall be type F conforming to ASTM C618. Fly ash /cement ratios shall not exceed 1.0 by weight.
 6. Sand shall conform to ASTM C144, except as modified herein and shall consist of clean, hard, durable grains of approved inert materials. Sand shall be well graded to attain a fineness modulus between 1.50 and 2.00. It shall also meet the following requirement.

<u>Sieve Sizes</u>	<u>Percentage Passing by Weight</u>
No. 16	95
No. 200	Not More Than 5

7. Water shall be potable, clean and free from deleterious amounts of acids, alkalis, oils, or organic matter with a ph not less than 6.7.
8. Grout admixtures may be used subject to the approval of the Engineer to improve pumpability, control time of set, hold sand in suspension, and to reduce segregation and bleeding.
9. Grout mixture proportions shall be such as to provide continuous efficient flow to fill all spaces required to be filled.
10. Foaming agents shall comply with ASTM C 869 when tested in accordance with ASTM C 796.
11. Mix Design
 - a. Structural Grout Backfill shall consist of a mixture of water and Portland cement, at a water to cement ratio by weight of 1:1, and admixtures conforming to this Section, additional provisions for controlling set times and anti-washout admixtures to prevent washout of the cement paste. The minimum compressive strength of the structural grout backfill shall be 500 psi at 28 days.

D. Equipment.

1. Microtunneling System:

- a. Closed face slurry pressure balance machine capable of excavating a mixed face condition, providing positive supporting pressure to full excavated area (face) at all times and capability of controlling and measuring pressure at face.
- b. System capable of any adjustment required to maintain face stability for anticipated ground conditions.
- c. Control slurry pressure systems, using slurry spoil transportation, and earth and groundwater pressure at the face by use of variable flow slurry pumps, pressure control valves and minimum of two flow meters, one on feed side and one on return side.
- d. The slurry pressure balance MTBM system shall be capable of excavating, cutting, and transporting in the slurry system excavated soils.
- e. Ability to control axial rotation to within three degrees of normal operating datum.
- f. Ability to articulate and steer to correct vertical and horizontal deviation from alignment datum by remote activation, in a manner that will control the advance of the heading while maintaining line and grade within the specified tolerances.
- g. Means to inject lubricant over lead pipe, if required.
- h. Spoil transportation system that has capacity for removal of spoil in balance with excavation and advance.
- i. Overall control system that enables remote control of all main operating functions of system from one location, either at surface or within jacking shaft.
- j. Main jacking shaft capable of exerting uniform load to casing pipe at a speed commensurate with speed of excavation advance.
- k. Set jacking hydraulics to relieve pressure at maximum safe working capacity of the pipe.

2. Slurry system:

- a. Spoil separation system with sufficient capacity to remove solids from flow while system is excavating spoil.
- b. Operates in such a manner that re-circulated or excess fluid can be discharged safely and with negligible remaining fines.

3. Backfill grouting.

- a. Contractor shall provide all necessary equipment to manufacture, deliver, convey and place the backfill. Contractor shall use equipment for mixing and injecting backfill which is designed for underground backfill grouting service.
- b. Contractor shall maintain equipment in good operating condition, capable of satisfactory mixing, agitating, and placing backfill at a uniform rate under the required pressure.
- c. Batching, mixing and pumping equipment shall be compatible and of sufficient size and capacity to place backfill to distances and volumes proposed by the Contractor. All pumping equipment shall be operated so that a continuous stream of backfill is conveyed to the backfill location. An adequate inventory of spare parts or backup equipment shall be provided to ensure that operable backfill grouting equipment is available at all times during the work.

- d. Contractor shall use hoses or pipes of proper type and diameter to withstand maximum injection pressures used.
- e. At the point of injection, suitable valves and calibrated pressure gauges shall be provided so that the pressure and grout flow at the grout port may be regulated and monitored. Provide at or very near the point of injection, a system of valves in the line transporting the grout that will easy access for collection of test specimens. Provide an automatic bypass valve set to the maximum pressure.
- f. Vent pipes shall be placed through the tunnel lining at high areas of the crown to provide for venting of entrapped air and water.

PART 3 - EXECUTION

3.01 SURFACE WATER AND GROUND CONTROL

- A. Develop and maintain a system for control of surface water and groundwater, keeping excavations free of water until backfill operation is in progress.
- B. Grade the ground surface to preclude surface water runoff into the excavations.
- C. Jacking and receiving shaft subgrade shall be kept continuously free from ground and surface waters during microtunneling operations.
- D. Keep removal of soils particles to minimum.
- E. Should settlement or displacement be detected, notify the Engineer and applicable agency immediately and act to maintain safe conditions and prevent damage.
- F. Water discharge from surface flow diversion or miscellaneous pumping shall be directed into approved receiving basins in accordance with all applicable regulatory requirements

3.02 DAILY ACTIVITY LOG

- A. Maintain a daily activity log during jacking operations for casing and submit to the Engineer for record purposes on a daily basis including:
 - 1. Start and finish time of casing pipe advancement.
 - 2. Total length of casing pipe installed.
 - 3. Horizontal and vertical alignment deviation at not greater than one-foot intervals or period not exceeding five minutes, whichever is most frequent.
 - 4. Maximum jacking force exerted during installation of each casing pipe section including forces required to re-initiate jacking following periods of system shutdown.
 - 5. General description for each discernible ground condition mined.

3.03 PREPARATION

- A. Microtunneling operations shall be continuous and precautions shall be taken to avoid interruptions which might cause the pipe to "freeze" in place.

- B. Maintain clean working conditions inside jacking operation area and remove spoil, debris, equipment, and other material not required for operations.
- C. During construction, maintain access to private and commercial properties at all times, unless approval from property owner has been obtained.
- D. Provide power generation equipment and any other equipment operating on or with fuel or lubrication oils with suitable barriers and safeguards to ensure no loss of oil to drains or waterways or to contaminate ground.

3.04 JACKING/LAUNCH AND RECEIVING SHAFT CONSTRUCTION

- A. Excavate jacking shaft and provide excavation supports as required and as specified in Section 02311. Excavation support shall extend a sufficient depth below the invert of the pipe to resist any pressure developed by the soil outside the jacking shaft. Excavation support shall extend at least 42 inches above existing grade. Alternatively, provide 42-inch high fence, meeting the OSHA requirements around all excavations.
- B. Furnish a level concrete slab at the bottom of the jacking shaft. Steel rails or beams shall be embedded in the concrete slab for placement and alignment of each piece of casing pipe or carrier pipe during installation operations.
- C. Furnish, install and remove, to the extent required, thrust blocks or such other provisions as may be required in driving the casing pipe or carrier pipe forward.

3.05 TOLERANCES

- A. Maintain proper alignment and elevation of the casing pipe consistently throughout the microtunneling. Tolerances for the installation of the casing pipe shall be as follows:
 - 1. Line Tolerance: +/-six inches.
 - 2. Grade Tolerance: +/-one inch.
 - 3. Water shall be free draining between any two points at the pipe invert. No reverse grades will be allowed.

3.06 MICROTUNNELING

- A. Perform microtunneling operations in a manner that will minimize loss of ground and minimize settlement of the ground surface above and adjacent to the tunnel. The shield shall be steered to maintain line and grade within the tolerance specified. This shall be achieved by continuously monitoring line and grade, and making the steering adjustments required during the operation.
- B. Microtunneling shall be performed in a manner to prevent voids from developing outside the casing and/or the carrier pipe.
 - 1. Limit annular space, between excavated material and outside diameter of casing pipe, to maximum of 0.5-inch.

- C. Casing pipes shall be jacked into place without damaging the pipe. In the event a section of pipe is damaged during the jacking operation, the pipe shall be jacked through to the receiving shaft and removed. Other methods of repairing the damaged pipe may be used, subject to approval by the Engineer. Repair any damage to the interior lining in accordance with lining manufacturer's written recommendations. Provide a pipe lubrication system as necessary; to inject bentonite and/or polymer as required minimizing pipe friction and jacking forces.
- D. As a minimum, the thrust force, rate of advance, distance along the drive, deviation from line and grade, and steering jack adjustments shall be monitored and recorded at a minimum of 60-second intervals when actively applying thrust to the cutter wheel.
- E. The thrust block shall be properly designed and constructed to provide the required resistance to the forces developed by the main jacks. Construct the thrust block normal to the pipe alignment. The thrust block shall be designed to support the maximum obtainable jacking pressure developed by the main jacking system.
- F. Restrict the excavation of the materials to the least clearance necessary to prevent binding in order to avoid loss of ground and consequent settlement or possible damage to overlying structures. Control the advance rate and the volume of material excavated to avoid over-excavation and heave.
- G. Properly dispose of all excavated materials away from the construction site on a daily basis. No stockpiling shall be permitted at the jacking shaft site. Slurry shall be pumped into tanker trucks and disposed of at acceptable facilities in accordance with current state regulations for disposal of these materials. Only use the disposal sites identified in the submittals for muck and slurry disposal.
- H. The Contractor shall be responsible for damages resulting from subsidence, collapsed tunnels, or ground losses into the tunnel and for the refilling of voids resulting there from with grout. Where such ground losses are so severe that they result in damage to underground or surface pavement, existing utilities or structures, the Contractor shall be solely responsible for remedying such damage. Where the filling of voids cannot be effectively carried out from below, the Engineer reserves the right to order the Contractor, at no additional cost to the District, to make openings from the surface for the purpose of backfilling the voids. If, in the judgment of the Engineer, a portion of the tunnel requires reinforcing because of such collapse, the Engineer may direct the Contractor to furnish and place such reinforcement at no additional cost to the District. Reinforcement may also be directed when the stability of the soil adjacent to the tunnel has been affected by the loss of ground.
- I. Furnish and install, and later remove to the extent required, thrust blocks or other provisions for backing up the jacks employed in driving the pipe forward.
- J. Immediately following the microtunneling operation, pressure grout the jacked section to fill all voids existing outside of the pipe. Grouting shall be from the interior of the pipe through the grouting holes.

3.07 CONTROL OF LINE AND GRADE

- A. Establish benchmarks and survey control points as specified.

- B. When satisfied that all benchmarks are correct, use these benchmarks to furnish and maintain all reference lines and grades for the tunnel and sewer construction. Use these lines and grades to establish the exact location of the pipe using a laser guidance system on the tunneling machine.
- C. Submit to the Engineer copies of field notes used to establish all lines and grades and provide 24 hours advance notice to allow the Engineer to check laser set up prior to beginning microtunneling. The Contractor shall be fully responsible for the accuracy of his work and corrections, if required.
- D. Use an acceptable laser system to monitor line and grade continuously during pipe jacking operations. Laser supports should be independent of working slab, jacking frame, and thrust block to avoid movement of the laser during jacking. Stop operations and reset laser immediately if movement of laser occurs during the Work. Monitor line and grade continuously during pipe jacking operations and record deviation with respect to design line and grade at least once per foot and submit records to the Engineer as requested. Control line and grade of the pipe to within the specified tolerances.
- E. When the excavation is off line or grade, make the necessary corrections, and return to the plan alignment at a rate of not more than one inch per 25 feet.
- F. If the pipe installation exceeds the specified tolerances, correct the installation, including, if necessary, redesign of the interceptor or structures. All corrective work shall be performed at no additional cost to the District, and is subject to the approval of the Engineer.
- G. The line and grade may be checked by the District. Provide access for the District's Representatives to check the line and grade as requested by the District. Said checking shall not substitute for the Contractor's own line and grade control responsibilities.

3.08 SITE AND WORK SAFETY

- A. Comply with applicable regulations of Federal Government, OSHA 29CFR 1926, and applicable criteria of ANSI A10.16-1995 (R2001), "Safety Requirements for Tunnels, Shafts, and Caissons."
- B. Arrange and conduct a pre-job safety conference, and inform the Engineer of the time and place of the conference at least three days in advance.
- C. The Contractor's site safety representative shall prepare a code of safe practices and an emergency plan in accordance with OSHA requirements. Provide the Engineer with a copy of each prior to starting pipe jacking. Hold safety meetings and provide safety instruction for new employees as required by OSHA.

3.09 TEMPORARY VENTILATION, LIGHTING AND COMMUNICATION SYSTEMS

- A. Furnish and operate (when personnel are underground) temporary ventilation, lighting, air monitoring and communication systems conforming to the requirements of OSHA.
- B. Operate and maintain a ventilation system that provides a sufficient supply of fresh air and maintains an atmosphere free of toxic or flammable gasses in all underground work areas.

3.10 CASING GROUTING

- A. The void between the tunnel liner and the earth shall be grouted after completion of tunneling. Grout shall be forced under pressure into the grouting connections. Grouting shall be performed from the interior of the tunnel. Grouting shall be started in the lowest connections and shall proceed until grout begins to flow from upper connections. The void shall be completely filled.
- B. Apparatus for mixing and placing grout shall be capable of mixing effectively and stirring the grout and then forcing it into the grout connections in a continuous, uninterrupted flow.
- C. After grouting is complete, pressure shall be maintained by means of stopcocks or other suitable device until the grout has set sufficiently in the judgment of the Engineer, or for a minimum of 24 hours, whichever is longer. After the grout is set, grout holes shall be completely filled and finished neatly without evidence of voids or projections.

3.11 CARRIER PIPELINE INSTALLATION IN TUNNEL

- A. After tunnel liner installation is complete and found acceptable by the Engineer, the Contractor shall prepare for installation of the carrier pipe by installing steel plates and spacers as shown in the construction plans, or other methods acceptable to the Engineer, to control the line and grade of the carrier pipe during installation and backfill grouting. Rails, if used, shall be lubricated to minimize sliding friction. The rails shall in no way be connected to or touching the tunnel liner.
- B. The carrier pipes shall be supported securely in such a manner that the pipes are supported on each end and at reasonable intervals along the pipe (as shown on detail 05000.02 in the construction plans) to assure the pipes are installed to the specified line and grade with no damage or stress imparted by the installation or backfill grouting process.
- C. Each pipe segment shall be blocked against the tunnel to prevent displacement during grouting as specified herein.
- D. After the carrier pipe has been installed in the tunnel, the annular space shall be backfill as specified herein.

3.12 FILLING OF ANNULAR SPACE

- A. Contractor shall arrange and route utilities to provide ready and available services during backfill placement.
- B. The Engineer shall be informed at least 24 hours in advance of the times when placement of annular backfill material is scheduled.
- C. Backfill shall be stored in accordance with manufacturer's recommendations.
- D. Bulkheads shall be constructed at the ends of tunnel to be backfilled.
- E. Bulkheads shall be constructed so that the annular space will be completely backfilled.

- F. Bulkheads shall incorporate a minimum one-inch drain pipe in the invert and crown of the tunnel to facilitate drainage of water and air during backfilling. The pipes shall be securely capped and plugged once annular backfill material begins to flow from the drain line.
- G. Contractor shall conform to the requirements of accepted submittals and the foaming agent manufacturer's recommendations.
- H. All backfill shall be mechanically mixed to produce a uniform distribution of the materials with a suitable consistency and the specified limiting requirements.
- I. Alternative method for batching and mixing backfill may be considered but shall require approval from the Engineer.
- J. Prior to backfilling each pipe joint shall be air tested immediately after installation per the appropriate pipe specification. Block pipe as necessary to prevent joint separation during testing. There shall be no exceptions to this requirement. No pipe will be paid for until it has been successfully air tested.
- K. All void spaces outside of the carrier pipe shall be completely filled with annular backfill.
- L. Methods for verifying complete filling the annular space between the pipe and the surrounding ground or initial support shall be acceptable to the Engineer. No standing water shall be allowed where backfill is placed.
- M. Backfill shall be placed though grout piping installed in the crown of the tunnel. Grout placement location shall be spaced no further than 50 feet apart.
- N. Methods for preventing damage to pipe joints due to thermal expansion of the pipe during backfill grouting shall be acceptable to the Engineer. The Contractor is responsible for the repair of any pipe damage caused by thermal expansion during grouting.
- O. Where water inflows or zones of water seepage exceed two gpm, Contractor shall erect panning and an invert drain or pumps to divert groundwater inflows away from backfill placement, at no additional expense to the District.
- P. Contractor shall limit pressure on the annular space to prevent damage or distortion to the carrier pipe or initial support.
- Q. The pipe shall be solidly supported from the tunnel wall in four quadrants (bottom, top and sides) using blocking secured sufficiently to prevent pipe movement during grouting or pressure testing. Bracing shall be located within two feet of each pipe joint and not farther than 20 feet apart. Adjust the elevation and alignment of each pipe with wood shims if necessary before blocking. Pipe alignment tolerance shall be as specified for general pipe installation. Contractor shall not remove bracing and supports for carrier pipe until backfill has achieved initial set as determined by ASTM C403.
- R. The pipe in the shafts shall be solidly supported from the shaft wall using bracing capable of supporting the weight of the pipe and secured sufficiently to prevent pipe movement during grouting or pressure testing. Bracing shall be located within two feet of each pipe joint and not farther than 20 feet apart. Pipe joints shall be adequately restrained to resist pipe pullout. Pipe

alignment tolerance shall be as specified for general pipe installation. Contractor shall not remove bracing and supports for carrier pipe until backfill has achieved initial set as determined by ASTM C403.

- S. Volume of backfill injected shall be calculated on an indirect basis and compared with the anticipated volume per foot of pipe backfilled.

3.13 RESTORATION

- A. All areas disturbed by construction shall be restored to existing or better condition and maintained until accepted by the Engineer.

END OF SECTION

SECTION 02495
GEOTECHNICAL INSTRUMENTATION

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Work described under this section pertains to monitoring of excavations, dewatering, excavation support systems, jack and bore, and/or other construction activities that may cause deformation and vibrations.
- B. Employ an instrumentation specialist (or specialty firm) to review the Contract Work and prepare an instrumentation installation and monitoring plan.
- C. Furnish all materials, equipment, labor, and services required for the complete installation, maintenance, protection, and monitoring of instrumentation and reporting of collected data for all instrumentation on buildings, utilities, and in the ground adjacent to the site or on the site, as specified in this Section and as necessary to monitor construction performance and impacts on adjacent property.
- D. Establish response actions to be taken if the maximum allowable instrument readings are exceeded so that existing structures and utilities are protected from damage. Implement response actions if maximum allowable instrument readings are exceeded.
- E. Dispose of all instruments at the end of the project as instructed by the Engineer.

1.02 RELATED WORK

- A. Dewatering and drainage are included in Section 02140.
- B. Jack and Bore is included in Section 02157.
- C. Excavation, Bedding and Backfill for Pipe is included in Section 02221.
- D. Excavation Below Normal Grade and Bedding Rock Refill is included in Section 02223.
- E. Excavation Support and Protection is included in Section 02311.
- F. Horizontal Directional Drilling is included in Section 02413.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Submit for review by the Engineer the following information four weeks prior to instrument installation:
 - 1. Installation Plan and Schedule: Full details of the proposed plan and schedule for installing and monitoring instruments, including proposed locations, types, installation methods, and monitoring schedule of the instruments.

2. The names, qualifications, and experience of the personnel or subcontractor(s) who will install the instruments, perform optical level survey and vibration monitoring, read the instruments, and report data to the Engineer demonstrating compliance with “Quality Assurance” Article included in this specification.
 3. Layout of monitoring points, observation wells, seismographs and reference points and description of monitoring provisions, including full details of the proposed instruments, proposed plan and schedule for installing the instruments, and schedule for monitoring and data reporting.
 4. Description of methods for installing and protecting all instrumentation including but not limited to seismographs, observation wells, crack gages, monitoring points, and reference points.
 5. Copies of all instrument calibrations and certifications specified.
 6. Groundwater observation well construction details including casing type, filter gradation, screen interval, grout mix, drilling methods, and depth of wells.
 7. Field Calibration: Within 5 working days of performing a field calibration, submit results of the calibration to the Engineer.
 8. Reports and Records: Provide reports of monitoring data to the Engineer. Include the following minimum information:
 - a. Preconstruction survey.
 - b. As-installed location plan, installation records and baseline values for all instrumentation.
 - c. Monitoring data for all instruments with plots against threshold values.
 - d. Weekly records of crack monitors, including photographs with readings.
 - e. Event reports and summary from vibration monitoring.
 - f. Discussion and associated action related to any result exceeding the threshold values set herein.
 9. Certificates: For each seismograph instrument to be furnished submit a certificate issued by the instrument's manufacturer stating that the manufacturer has inspected and tested each instrument before it leaves the factory to confirm that the instrument is working correctly and has no defects or missing parts.
 10. Submit three copies of the pre-construction condition surveys as specified herein.
- C. Submit proposed remedial measures to the Engineer of action to be taken in the event that the instrument Threshold Values are reached.

1.04 DEFINITIONS

- A. Surface Monitoring Points (SMPs): Inscribed marking or approved surveyor's nail installed to measure vertical (elevation) movement.
- B. Deformation Monitoring Points (DMPs): Fixed markers placed on existing utilities and structures to measure both vertical and horizontal movement. Initial coordinate locations and vertical controls are determined by optical survey methods.

- C. Excavation Support Monitoring Points (ESMPs): Inscribed marking or fixed markers placed on excavation support systems to measure horizontal movement of the excavation support system.
- D. Utility Monitoring Points (UMPs): Steel rod inside fully cased hole that is resting on existing utilities or underground structures to measure movement of the existing underground structure or utility.
- E. Groundwater Observation Wells: Screened or slotted pipe with solid riser pipe installed in a drilled hole with the annulus around the pipe backfilled with sand. Near surface groundwater levels are measured in the well.
- F. Seismographs: Electronic recording device with vibration transducer capable of monitoring and recording ground vibrations induced by construction activity.

1.05 QUALITY ASSURANCE

- A. Personnel Qualifications for Instrument Installation.
 - 1. Employ qualified technicians with comparable experience in the installation of geotechnical instrumentation similar to that specified herein.
 - 2. Employ a qualified Geotechnical Instrumentation Engineer who is a professional engineer, with at least 5 years of experience in the installation of instrumentation specified herein, to supervise and direct technicians and be responsible for instrument installation. This person is to be present at the installation site(s) to direct and supervise the installations, oversee the reading of the instrumentation and supervise the interpretations of geotechnical instrumentation data.
- B. Installation of instrumentation shall, at all times, be performed in the presence of the Engineer.
- C. The Contractor shall be responsible for all aspects pertaining to the installation, maintenance and monitoring of the geotechnical instrumentation specified herein.
- D. Provide each instrument or component of instrument specified herein from an approved manufacturer currently engaged in manufacturing geotechnical instrumentation hardware of the specified types.
- E. Surveyor Qualifications: The professional Land Surveyors shall be licensed in the State of Florida and with at least three years of experience in surveying of similar instruments. The professional Land Surveyors shall establish the Deformation Monitoring Points, Surface Monitoring Points, Utility Monitoring Points, and Excavation Support Monitoring Points and take baseline readings.
- F. Perform optical level surveys, instrument readings, and report data. Personnel responsible for this work shall be qualified by a minimum of three years of experience with similar work.
- G. Factory Calibration: A factory calibration shall be conducted on all seismographs prior to shipment. Certification shall be provided to indicate that the test equipment used for this purpose is calibrated and maintained in accordance with the test equipment manufacturer's calibration requirements and that, where applicable, calibrations are traceable to the U.S. National Institute of Standards and Technology.

- H. Vibration monitoring shall be conducted by persons trained in the use of a seismograph and records shall be analyzed and results reported by persons familiar with analyzing and reporting the frequency content of a seismograph record.
- I. Persons responsible for pre-construction surveys shall be professional engineers, licensed in the State of Florida, and shall have had a minimum of 5 years of professional experience in structural evaluation and conditions surveys.

1.06 TOLERANCES

- A. Survey measurements for initial location of each of the instrumentation elements shall consist of determining the elevation and horizontal position with respect to benchmark(s) approved by the Engineer.
- B. Monitoring Points (SMPs, DMPs, UMPs and ESMPs)
 - 1. Elevations of all instrumentation shall be determined to an accuracy of plus/minus 0.01 feet.
 - 2. The horizontal position of surface monitoring points shall be determined to an accuracy of plus/minus 0.1 foot.
 - 3. The horizontal position of deformation monitoring points and excavation support monitoring points shall be determined to an accuracy of plus/minus 0.01 foot.
- C. Should actual field conditions prohibit installation at the location and elevations specified in this Section, obtain prior acceptance from the Engineer for new instrument location and elevation.

1.07 DESIGN AND PROJECT REQUIREMENTS

- A. Project Requirements
 - 1. Install Geotechnical Instrumentation as required herein and as necessary to monitor ground conditions, ground response, and facilities to achieve specified project requirements, and prevent damage to facilities potentially affected.
 - 2. Install the instrumentation in accordance with the approved Instrumentation Schedule.
 - 3. The Engineer's monitoring of the installed instruments does not relieve the Contractor of the obligation to complete the project within the requirements specified herein and the Contractor shall take additional measurements as may be necessary.
- B. Pre-Construction Survey
 - 1. Prior to start of excavation work, installation of excavation support and dewatering work, engage the services of an independent professional engineer, licensed in the State of Florida, to conduct a pre-construction survey of existing structures and conditions within 100 feet of the anticipated excavation work and installation of excavation support.
 - a. Coordinate activities, issue notices, obtain clearances and provide photographic and secretarial assistance necessary to accomplish the survey.
 - b. Give notice in writing, to the property owner and any representative of local authorities required to be present at such survey. Notify in writing the dates on which

surveys are planned so that representatives are present during the examination. Provide copies of notices to the District and Engineer.

2. Record observations of the existing conditions for residences, buildings and other structures, which are affected.
 - a. Provide the survey consisting of a description of interior and exterior conditions. Locate cracks, damage or other defects existing and include information to make it possible to determine the effect, if any, of the construction operations on the defect. Where significant cracks or damage exists, or for defects too complicated to describe in words, photographs shall be taken and made part of the record.
 - b. The records of each property examined must be signed by the representatives present and, if practicable, by the property owner, whether or not they are present at the examinations.
 3. Record of the pre-construction survey shall consist of written documentation, video and photographs of the conditions identified. At the completion of the survey, submit copies of the documentation to the District.
 4. Upon completion of all excavation work and installation of excavation support, complete a similar examination of properties and structures where complaints of damage have been received or damage claims have been filed. Give notice to interested parties so that they may be present during the final examinations. Records of the final examination shall be signed and distributed as the original pre-construction survey.
 5. Retain records in the Contractor's file for at least three years after completion of the Contract. In the event of damage claims, a report shall be prepared by the Contractor on the particular structures as requested by the Engineer from those notes and photographs and submitted to the District. Repair damage attributed to the Contractor's activity promptly and completely to the property owner's satisfaction to restore the conditions of the property to that existing prior to work.
- C. Secure all required permits prior to the installation or removal of observation wells.
- D. Provide and facilitate safe access to the instruments at all times. The Engineer may perform additional monitoring in a manner that will minimize unnecessary work delays. Allow and facilitate instrument monitoring as required by the Engineer. No claim for lost production time due to this activity will be allowed.
- E. Maintain all instrumentation. Replace all damaged instruments within 24 hours. Report all damaged or non-functional instrumentation to the Engineer within 24 hours.
- F. Availability of Data
1. Interpretations developed by the Engineer will be available to Contractor. Contractor may observe readings at any time or take their own supplementary readings.
 2. Monitoring data is the property of the District and is not to be disclosed or published to third parties without the District's written permission.
 3. Contractor is expected to make their own interpretations for their own purposes at no additional cost to the District.

PART 2 PRODUCTS

2.01 SURVEYING INSTRUMENTS

- A. Elevations of all instrumentation shall be determined to an accuracy of plus/minus 0.01 feet.
- B. Horizontal position of all instrumentation shall be determined to an accuracy of plus/minus 0.1 feet.

2.02 MATERIALS

- A. General: All instruments and materials, including readout units, remain the property of the Contractor following completion of the Contract.
- B. Furnish all installation tools, materials, and miscellaneous instrumentation components.
- C. Surface protection for all instruments provided shall be flush with the surface in paved or other ground surface areas, at the time that the work is completed.
- D. Locations and number of instruments shall be determined by the Contractor and approved by the Engineer.

GROUNDWATER OBSERVATION WELLS

- E. Observation wells will be used to monitor the groundwater levels outside the excavation.
- F. Pipe shall consist of one-inch minimum inside diameter Schedule 40 PVC pipe.
- G. Maximum screen size shall be 0.020-in unless otherwise approved by the Engineer.

2.03 MONITORING POINTS

- A. Establish system of control points and monitor in accordance with the requirements herein.
 - 1. Surface Monitoring Points (SMPs)
 - a. SMPs will be used to monitor vertical deformation at or near the ground surface. Clearly identify all points with permanent easily readable letters and numbers as approved by the Engineer.
 - b. Provide SMPs in paved areas consisting of a two-inch-long masonry nail, manufactured from hardened zinc-plated steel. Drive the masonry nail into an asphalt covered surface. Identify each nail individually with an identification tag or surface marking.
 - c. Provide SMPs in non-paved areas consisting of a three-ft-long, 3/4 inch diameter steel rod. Drive the rod into the ground or set in concrete in the ground such that no more than three inches of the rod is exposed above the ground surface. Round the top of the rod and punch-mark it at its center. Identify each rod with a surface marking.
 - d. Provide SMPs on utility manholes consisting of an observable cross mark or welded bead on the top horizontal surface of utility manhole rims. Clean the surface within three inches of the point and mark it to permit easy identification of the exact point. Clearly identify the point shall using fluorescent spray paint adjacent to the point.

2. Deformation Monitoring Points (DMPs)
 - a. DMPs will be used to monitor vertical and horizontal movement of adjacent utilities and structures.
 - b. DMPs shall consist of nails, screws, reinforcing bars, bolts and similar materials with well-defined measurement points as approved by the Engineer. DMP's shall be firmly attached and shall be protected from damage and vandalism. Remove or cover with a protective box or cap as approved by the Engineer all elements of DMPs protruding more than 0.25-in. Clearly identified all DMPs with permanent easily readable letters and numbers as approved by the Engineer.
3. Utility Monitoring Points (UMPs)
 - a. Utility monitoring points (UMPs) will be used to monitor vertical and horizontal deformation of selected utilities and underground structures as specified herein.
 - b. UMP shall include, at a minimum, the following:
 - 1) Three and one-half inch extra strong steel pipe sleeve and one-inch extra strong steel riser pipe, threaded and coupled, ASTM A 53/A 53M Grade B;
 - 2) PVC centralizers, consist of a schedule 40 PVC pipe conforming to ASTM D1785, sized to provide a tight fit on the riser pipe, and spring-formed to a larger diameter to provide a loose fit in the sleeve pipe
 - c. UMPs shall be installed to top of utility or underground structure by vacuum excavation method. The monitoring rod with centralizers shall set on top of the utility or underground structure and extending to within one foot of the ground surface. The utility monitoring point shall be installed with a flush mount roadbox casing at grade and shall be clearly identified by surface marking
4. Excavation Support Monitoring Points (ESMPs)
 - a. ESMPs shall be fixed markers on the vertical elements of the excavation support system and shall be used to monitor horizontal deformation of excavation support system designed by the Contractor. Clearly identified all points with permanent easily readable letters and numbers as approved by the Engineer. Surface within three inches of each point shall be cleaned and clearly identified using fluorescent spray paint adjacent to the point.

B. Non-Shrink Cement Grout shall be suitable for intended application.

2.04 SEISMOGRAPHS

- A. Provide portable seismographs for monitoring the velocities of ground vibrations resulting from construction activities as specified herein. Provide for full-time use on the project during vibration causing construction activities. Provide two (minimum) seismographs which have been calibrated within the previous six months to a standard that is traceable to the National Institute of Standards and Technology. Required characteristics of seismographs are listed below:
 1. Measure the three mutually perpendicular components of particle velocity in directions vertical, radial, and perpendicular to the vibration source.
 2. Measure and display the maximum peak particle velocity continuously during vibration-generating activities.

3. Have a low frequency omnidirectional transducer for measuring air blast overpressure with a flat frequency response within the limits of two Hz to 250 Hz with a tolerance equal to or better than plus or minus 10 percent.
4. Seismic range: 0.01 to four inches per second with an accuracy of plus or minus five percent of the measured peak particle velocity or better at frequencies between 10 Hertz and 100 Hertz, and with a resolution of 0.01 inches per second or less.
5. Acoustic range: 110 to 140 dB (referenced to 20 micro-Pascals) with an accuracy and resolution of plus or minus one dB.
6. Frequency response (plus or minus three dB points): two to 200 Hertz.
7. Two power sources: internal rechargeable battery and charger and 115 volts AC. Battery must be capable of supplying power to monitor vibrations continuously for up to 24 hours.
8. Self-triggering wave form capture mode that provides the following information: plot of wave forms, peak particle velocities, peak overpressure, frequencies of peaks.
9. Continuous monitoring mode must be capable of recording single-component peak particle velocities, and frequency of peaks with an interval of one minute or less.

2.05 CRACK MONITORS

- A. Provide crack gages for monitoring the width of existing cracks and joints as manufactured by Geokon, Inc., Lebanon, NH Model 4420, or equal.
- B. Crack gages shall have threaded anchors with ball joints which can be grouted to each side of the crack in any orientation and a transducer with a range of at least one inch and an accuracy of less than 0.1 percent and a nonlinearity of no more than 0.5 percent. The gage shall be capable of operating in temperatures ranging from minus 20 degrees to 80 degrees (Celsius).
- C. Provide a solid steel cover over each gage which does not touch or otherwise interfere with the operation of the gage.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prior to commencing any installation of excavation support, excavation for both open trench and trenchless crossings, and pile installation and dewatering work, furnish components of instrumentation that are to be installed during construction and conduct pre-construction surveys.
- B. Install instruments.
- C. Protect from damage and maintain instruments installed by the Contractor.
- D. Repair or replace damaged instruments furnished by the Contractor.

- E. Collect, reduce, process, plot and report monitoring data obtained by survey, seismograph data, groundwater levels, and submit to the Engineer.
- F. Coordinate with the Engineer to verify consistency of collected data.
- G. Implement remedial measures based on interpretations of monitoring data program.

3.02 GENERAL REQUIREMENTS

- A. Perform a pre-construction survey prior to any dewatering, excavation, trenchless crossings, installation of piles or installation of excavation support.
- B. Install instruments at locations selected by the Contractor and approved by the Engineer in accordance with the approved installation procedures. The Engineer may modify instrument locations depending on field conditions and monitoring objectives. Install all instrumentation in accordance with the approved installation schedule. Instruments shall be installed and baseline data, acceptable to the Engineer, shall be obtained before construction starts.
- C. Provide the Engineer with access to instrument locations and assistance required in obtaining monitoring data.
- D. All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public. Immediately following installation, the location of the top of all instruments shall be surveyed to provide horizontal and vertical coordinates. Resurveying shall be done as required by the Engineer if there is a question regarding the instrumentation location.
- E. A unique instrument identification number shall be assigned to each instrument and each point. The instrument identification number shall be clearly marked on each instrument in a non-destructible manner.
- F. Initial Reading: Immediately following instrument installation, the Contractor, in the presence of the Engineer, shall take two sets of initial readings to provide baseline readings and to demonstrate the adequacy of the completed installation.
- G. Factory Calibration: A factory calibration shall be conducted on all instruments at the manufacturer's facility prior to shipment. Each factory calibration shall include a calibration curve with data points clearly indicated, and a tabulation of the data. Each instrument shall be marked with a unique identification number.
- H. The instrumentation and monitoring specified here is considered the minimum required. The Contractor shall obtain additional data from the instrumentation and /or furnish, install, and monitor additional instrumentation as necessary to adequately monitor construction performance and safety aspects of the work.

3.03 MONITORING POINTS

- A. Monitoring Points shall include but not be limited to SMPs, DMPs, UMPs and ESMPs. Monitor these control points using surveying methods.

- B. Install SMPs, UMPs and DMPs as described below near excavations, pile installation locations, trenchless crossings, and open trench locations. Additional SMPs, UMPs, and DMPs may be required by the Engineer.
- C. SMPs shall also be installed in the pavement or ground surface, within five feet, along each side of trench excavations that is within 50 feet of structures. The SMPs shall be installed at spacing not more than 50 feet. Locations may be modified to meet site constraints with the approval of the Engineer.
- D. SMPs shall also be installed on the rim of manhole covers of utilities located within 50 feet of trenchless crossings or within 30 ft of open excavations.
- E. Along trenchless crossing alignments, SMPs shall be installed at intervals of not more than 10 feet over the proposed trenchless crossing locations in rows of three; one directly above the alignment and the other two located 10 feet apart on each side oriented perpendicular to the pipe alignment. Locations may be modified to meet site constraints with the approval of the Engineer.
- F. DMPs:
 - 1. DMPs shall be installed on the exterior walls of buildings or structures located within 30 ft of open excavations or 50 feet of shafts or trenchless crossing alignments. As much as practical, DMPs shall be installed on supporting walls or columns. Avoid installation in brick unless absolutely necessary.
 - 2. As a minimum, DMPs shall be installed on the exterior wall corners of buildings, structures, or property boundary walls at not more than 50 feet spacing. The Engineer may require additional DMPs be installed to monitor building movement at other locations.
 - 3. Install DMPs in cooperation with property owners so that installations are inconspicuous and acceptable to the property owners. Existing features of building foundations that are permanent and can be repeatedly surveyed may substituted for DMPs, if approved by the Engineer.
- G. UMPs shall be installed on existing utility over 36 inch in diameter and located within 15 feet from excavation. UMPs shall be located at a spacing of not more than 50 feet.
- H. ESMPs shall be installed on excavation support systems other than trench box along support walls at spacing not more than 25 feet.
- I. Install and obtain SMP, UMP, and DMP monitoring point readings prior to installing excavation support, beginning excavation or operation of groundwater control system, start of pile installation, or start of installation of excavation support at the site. Install ESMPs prior to excavation within the excavation support system. The Contractor shall obtain two sets of measurements for each monitoring point to establish the baseline data within three days of installation. These measurements shall be made at least 24 hours apart but not more than 48 hours apart. Monitoring points with initial surveyed elevations (or offsets as appropriate) differing by more than two mm shall be checked for secure installation and resurveyed.

- J. The reading schedule of all SMPs, UMPs and DMPs surveyed shall be daily during excavation, dewatering, filling and backfilling, pile installation, trenchless excavation and excavation support installation by all methods within 50 feet of the work and then at least twice a week until all excavation, dewatering and backfill has been completed.
- K. Survey of SMPs, UMPs and DMPs for trenchless crossing operation shall include once per day starting at least two days prior to the start of trenchless excavations and extend at least 30 days after the completion of the crossing.
- L. The reading schedule of ESMPs shall be at least daily during associated excavation and twice a week until backfill is completed.

3.04 VIBRATION MONITORING

- A. Seismograph readings shall be taken during pile installation and other ground vibrations including excavation support installation or other activities causing ground vibrations within 50 feet of existing structures to document that peak particle velocities do not exceed the limit criteria as described below.
- B. Seismographs shall be installed by the Contractor near existing structures when vibratory or impact hammers are used for the installation of shoring within 50 feet of existing structures, and as directed by the Engineer. Seismograph locations shall include points on the ground surface between three and six feet from the faces of the nearest building(s). Seismographs shall be firmly mounted on the surface slab of concrete or asphalt or firmly set in undisturbed soils.

3.05 GROUNDWATER OBSERVATION WELLS

- A. At least one monitoring well shall be installed on each side of trenchless crossing to 10 feet below the invert of the casing.
- B. Existing wells may be used if appropriate and approved by the Engineer.
- C. The screened interval of each well shall be set to monitor groundwater levels.
- D. Using approved drilling methods, drill four-in minimum diameter holes for observation wells of the size and depth required, and case with temporary casing. Bentonite drilling mud shall not be used in drilling holes for the observation wells.
- E. Flush all cased holes with clean water through an approved bit. Flush until the discharge water is free of soil particles.
- F. Construct observation well with 10 feet of slotted PVC well screen, filter sand, bentonite seal, couplings, a pipe cap, and a locking cover.
 - 1. Place two feet of filter sand in the bottom of the drilled hole; then place the well screen and surround it with filter sand, as the temporary casing is carefully withdrawn.
 - 2. Insert solid PVC casing and cap and fill the annular space with bentonite pellets then non-shrink cement grout.

3. Protect the observation wells at ground surface by providing a roadway box or outer protective casing with lockable top and padlock. Design the surface protection to prevent damage by vandalism or construction operations and to prevent surface water from infiltrating.
 - a. Provide two keys for each padlock to the Engineer for access to each well.
 - b. Observation wells shall be developed so as to provide a reliable indication of groundwater levels. Wells shall be re-developed if well clogging is observed, in the event of apparent erroneous readings, or as directed by the Engineer.
 - c. Submit observation well installation logs, top of casing elevation, and well locations to the Engineer within 24 hours of completion of well installation.

G. Observation Well Maintenance

1. The Contractor shall maintain each observation well until adjacent structures, box culverts and pipelines are completed and backfilled. Clean out or replace any observation well which ceases to be operable before adjacent work is completed.
2. It is the Contractor's obligation to maintain observation wells and repair or replace them at no additional cost to the District, whether or not the observation wells are damaged by the Contractor's operations or by third parties.

H. Monitoring and Reporting of Observation Well Data

1. The Contractor shall begin daily monitoring of groundwater levels in work areas prior to initial operation of drainage and dewatering system. Daily monitoring in areas where groundwater control is in operation shall continue until the time that adjacent structures, box culverts and pipelines are completed and backfilled and until the time that groundwater control systems are turned off.
2. The Contractor is responsible for processing and reporting observation well data to the Engineer on a daily basis. Data is to be provided to the Engineer on a form, which should include the following information: observation well number, depth to groundwater, top of casing elevation, groundwater level elevation and date and time of reading.

- I. Following construction, abandon new observation wells as directed by the Engineer. Abandon observation wells by removing all material within the original borehole, including the casing, filter, and grout seal in accordance with all applicable permits. Using approved tremie methods completely fill the hole and all voids with non-shrink cement grout prior to removal of the drill casing such that formation materials do not move into the hole prior to grouting. Restore the ground surface to its original condition. Abandon wells within paved areas by removing the vaults and well caps to the pavement subgrade. Remove wells with as discussed above and repair or patch pavement with the same surface type.

3.06 INSTRUMENT PROTECTION, MAINTENANCE AND REPAIR

- A. Protect the instruments from damage. The Contractor shall immediately replace, within 72 hours of damage, any instrument that becomes damaged or is destroyed for whatever reason at no additional cost to the District. If necessary, the contractor will suspend work in the areas being monitored by the damaged instrument and take remedial action.

- B. Maintain the instruments by draining water and flushing debris from under protective covers and keeping covers locked and sealed at all times.

3.07 MONITORING

- A. The Contractor shall collect, tabulate, plot and interpret the survey monitoring data and provide the Engineer with the tabulated and plotted data. Report the status of excavation, bracing, groundwater levels, pile installation operation, stationing of the trenchless casing face/leading edge, and backfilling at the time of data collection with each report.
- B. Monitoring frequency may be modified as directed and approved by the Engineer.
- C. Provide data from readings of all monitoring points to the Engineer within 24 hours of reading. Communicate verbally with the Engineer immediately after visual observations or data collection if excessive movements or other anomalies are indicated.
- D. For seismograph data, a summary report with event summary of peak particle velocity and frequency shall be provided. A strip chart indicates the time and magnitude of maximum single-component peak particle velocity measured during each five-minute interval of the monitoring period shall be submitted. A summary of vibration producing activities for that week shall be listed along with any specific events which caused anomalous readings.
- E. The Contractor shall make visual observations of ground conditions and building conditions in the vicinity of the site and communicate immediately with the Engineer if signs of ground or building movements are observed.
- F. The Engineer may take independent instrumentation measurements. Cooperate with the Engineer during instrumentation monitoring by providing access to the instrumentation locations in a timely manner and by providing and maintaining safe means of access to all instrumentation locations for data collection. Data acquired by the Engineer will be made available to the Contractor in a timely manner.
- G. The Contractor may make his/her own interpretations of monitoring data for his/her own purposes. Data or interpretations shall not be published or disclosed to other parties without advance written permission of the District.
- H. If the Contractor collects data from an instrument that has been installed to replace a damaged instrument, the formal initial reading for the damaged instrument shall be used as an initial reading for the replacement instrument so that data are plotted continuously, without an offset at the time of damage. The time of damage and replacement shall be noted on the plot.

3.08 INTERPRETATION AND RESPONSE VALUES

- A. The Contractor shall make its own interpretations of the data resulting from monitoring programs.
- B. Threshold and Limiting Values for instruments:

<u>Instrument</u>	<u>Threshold Value</u>	<u>Limiting Value</u>
Seismographs	1.0 in/sec over 40 Hz	2.0 in/sec over 40 Hz
	0.75 in/sec at 30- 40 Hz	1.5 in/sec at 30- 40 Hz
	0.5 in/sec at 20-30 Hz	1.0 in/sec at 20-30 Hz

	0.25 in/sec under 20 Hz	0.5 in/sec under 20 Hz
Surface Monitoring Points	0.5 inch	1.0 inch
Deformation Monitoring Points	0.25 inch	0.5 inch
Utility Monitoring Points	0.25 inch	0.5 inch
Excavation Support Monitoring Points	1.0 inch	2 inches
Observation Wells	2 ft below bottom of excavation (including shafts)	at bottom of excavation
Observation Wells	1 ft below bottom of casing for trenchless crossing	at bottom of casing for trenchless crossing

- C. These values are subject to adjustment by the Engineer as indicated by prevailing conditions and/or circumstances.
- D. If a Threshold Value is reached:
1. Engineer and Contractor shall meet to discuss remedial measures.
 2. Contractor shall increase the instrument monitoring frequency as directed by the Engineer.
 3. Contractor shall install and monitor additional instruments as directed.
 4. Contractor shall implement the remedial measures in the event the Threshold Value is reached, so the Limiting Value is not reached.
- E. Contractor to take all necessary steps so that the Limiting Value is not exceeded. Contractor may be directed to suspend activities in the affected area with the exception of those actions necessary to avoid exceeding the Limiting Value.

3.09 DISPOSITION OF INSTRUMENTS

- A. Monitoring Points and Crack Gages: All monitoring points and crack gages shall be removed during the cleanup and restoration work, unless directed otherwise by the Engineer.
- B. Utility Monitoring Points: When required by the Engineer, abandon and remove protective housings and caps in accordance with the required permits. All surfaces affected by installation of instruments shall be restored to their original condition prior to completion of work.
1. Leave in place any casings located within the plan limits of structures or pipelines or within the zone below 1H:1V planes extending downward and out from the edges of foundation elements or from the downward vertical footprint of the pipe, or where removal would otherwise result in ground movements causing adverse settlement to adjacent ground surface, utilities or existing structures.

2. Where casings are pulled, holes shall be filled with sand. Where left in place, casings should be filled with non-shrink cement grout and cut off a minimum of three ft below finished ground level or one ft below foundation level so as not to interfere with finished structures or pipelines.
 3. Remove precast boxes or vaults and reconstruct pavement in paved areas. Restore surface to the conditions existing prior to installation of the instruments.
- C. Seismographs: Units shall be returned to the Contractor following completion of the installation of excavation support and excavation.

END OF SECTION

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SECTION 02612
REINFORCED CONCRETE SEWER PIPE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals necessary and install and test reinforced concrete pipe for sewers complete as shown on the Drawings and as specified herein.
- B. All pipe and fittings shall be manufactured for this project and no pipe shall be furnished from stock.

1.02 RELATED WORK

- A. Testing and cleaning of sewers are included in Section 01445.
- B. Excavation and backfilling are included in Section 02200.
- C. Granular materials are included in Section 02200.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings showing layout and details of reinforcement, joint, method of manufacture and installation of pipe, gasket, specials and fittings, the name of the pipe manufacturer and a schedule of pipe lengths (including the length of individual pipes by diameter) for the entire job.
- B. Submit with the shop drawings documentation that the fine and course aggregates to be used in manufacture of the concrete pipe comply with the requirements of Paragraph 2.01C. Documentation shall be less than six months old and shall indicate the source of the aggregates and the date of the analysis. Similar documentation shall be submitted to the Engineer at least yearly while pipe is being manufactured for this project.
- C. Prior to each shipment of pipe, submit certified test reports that the pipe was manufactured and tested in accordance with the ASTM Standards specified herein.
- D. Submit the results of the compressive strength tests to the Engineer.

1.04 REFERENCE STANDARDS

- A. ASTM International
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
 - 3. ASTM C150 - Standard Specification for Portland Cement.
 - 4. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.

5. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 6. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections or Tile.
 7. ASTM 969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
- 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. The manufacturer shall perform the acceptance tests in accordance with ASTM C76.
- B. Reinforced concrete pipe manufactured for this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory provided by the District. The manufacturer's cooperation in these inspections shall be required. The cost of this inspection of all pipe approved for this Contract, plus the cost of inspection of a reasonable amount of disapproved pipe will be borne by the District.
- C. Inspection of the pipe will be made by the Engineer or other representatives of the District after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

PART 2 PRODUCTS

2.01 REINFORCED CONCRETE PIPE

- A. Except as otherwise specified herein, pipe shall conform to ASTM C76, Class IV, per FDOT Section 449. The pipe interior shall be smooth and even, free from roughness, projections, indentation-s, offsets, or irregularities of any kind. The concrete mass shall be dense and uniform. Minimum reinforcement and wall thickness for sizes not tabulated in ASTM C76 shall be designed by the manufacturer in accordance with Section 7.2 of ASTM C76.
- B. Cement shall be non-air-entraining portland cement conforming to ASTM C150, Type II. The use of any admixture shall be subject to the specific approval of the Engineer.
- C. Fine aggregate shall consist of washed inert sand conforming to the requirements of ASTM C33, except for gradation, with a maximum loss of eight percent when subjected to five cycles of the soundness test using magnesium sulfate. Coarse aggregate shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33, except for gradation, with a maximum loss of eight percent when subjected to five cycles of the soundness test using magnesium sulfate. Documentation that the aggregates to be used in the manufacture of reinforced concrete pipe meet these requirements shall be submitted to the Engineer as stated in Paragraph 1.03 above.
- D. The 28-day compressive strength of the concrete as indicated by cores cut from the pipe or from representative test cylinders taken from the same batch shall be equal to or greater than the

design strength of the concrete. The concrete mass shall be dense and uniform. Reinforcement shall be circular for all concrete pipes. Quadrant steel shall not be used. Reinforcement shall be installed in both the bell and the spigot. At least one circumferential reinforcement wire shall be in both the bell and spigot area and reinforcement in the bell and spigot shall be adequate to prevent damage to concrete during shipping, handling and after installation. The pipe shall be subjected to a three-edge bearing test and hydrostatic testing to 13 psi for 10 minutes in accordance with ASTM C443 to verify strength and water tightness. The District reserves the right to witness the testing.

E. Pipe may be rejected for any of the following reasons:

1. Exposure of any wires, positioning spacers or chairs used to hold the reinforcement in place, or steel reinforcement in any surface of the pipe, except for the ends of the longitudinals, stirrups or spacers specifically permitted by Section 8.2 of ASTM C76.
2. If cores taken show that the transverse reinforcing steel is found to be in excess of 1/4-in out of specified position after the pipe is molded.
3. Any shattering or flaking of concrete at a crack.
4. Voids, with the exception of minor bug holes, on the interior and exterior surfaces of the pipe exceeding 1/4-in in depth unless properly and soundly pointed with mortar or other approved material.
5. Unauthorized application of any wash coat of cement or grout. Pipe dressing procedures shall be subject to approval of the Engineer.
6. A deficiency greater than 1/4-in from the specified wall thickness of pipe 30-in or smaller in internal diameter.
7. A hollow spot (identified by tapping the internal surface of the pipe) which is greater than 30-in in length or wider than three times the specified wall thickness. Repair of such defective areas not exceeding these limitations may be made as specified in Paragraph 2.01M.
8. Defects that indicate imperfect molding of concrete; or any surface defect indicating honeycomb or open texture (rock pockets) greater in size than area equal to a square with a side dimension of two and one-half times the wall thickness or deeper than two times the maximum graded aggregate size; or local deficiency of cement resulting in loosely bonded concrete, the area of which is greater than 30-in in length or wider than three times the specified wall thickness when the defective concrete is removed. Repair of such defects not exceeding these limits may be made as specified in Paragraph 2.01M.
9. Any of the following:
 - a. A crack having a width of 0.005 to 0.01-in throughout a continuous length of 36-in or more.
 - b. A crack having a width of 0.0 to 0.03-in or more throughout a continuous length of one ft or more.
 - c. A crack greater than 0.005-in extending through the wall of the pipe and having a length in excess of the wall thickness.

- d. A crack showing two visible lines of separation for a continuous length of two ft or more, or an interrupted length of three ft or more anywhere in evidence, both inside and outside.
 - e. Cracks anywhere greater than 0.03-in in width.
- F. The pipe shall be clearly marked as required by ASTM C76 in a manner acceptable to the Engineer. The markings may be at either end of the pipe for the convenience of the manufacturer, but for any one size shall always be at the same end of each pipe length. Pipe shall not be shipped until the compressive strength of the concrete has attained as percent of the design strength and not before seven days after manufacture and/or repair, whichever is the longer.
- G. Pipe shall have a minimum laying length of approximately eight ft, except for closure and other special pieces as approved by the Engineer. Have available at the site sufficient pipe of various lengths to affect closure at manholes or structures that cannot be located to accommodate standard lengths. Short lengths of pipe made for closure, etc., may be used in the pipeline at the end of construction if properly spaced. The length of the incoming and outgoing concrete pipe at each structure shall not exceed four ft, except where the joint is cast flush with the exterior wall of the structure or where otherwise noted on the Drawings. Maximum laying length shall not exceed 16-ft, but the installation of 16-ft lengths will depend upon the ability to handle such lengths of pipe in sheeted trenches, comply with trench width requirements, maintain the integrity of the sheeting and avoid disturbance to adjacent ground. If in the opinion of the Engineer the use of 16-ft lengths is impractical, shorter lengths shall be used.
- H. Each length of pipe shall be checked against the length noted on the shop drawings. Pipe more than 1-1/2-in longer than that shown on the shop drawings shall not be used on this project. Variations in length of the same pipe shall not exceed ASTM C76 requirements.
- I. The Engineer shall have the right to cut cores from such pieces of the finished pipe as he/she selects for inspection and for such tests as he/she may wish to apply. Holes left by the removal of cores shall be filled in an approved manner by and at the expense of the manufacturer. Core drilling shall be carried out by the pipe manufacturer at his/her expense. The number of cores shall not exceed the requirements of ASTM C76.
- J. The pipe will be carefully examined for compliance with the appropriate ASTM standard, as specified herein, and shop drawings by the manufacturer prior to shipment. All pipes shall be inspected for general appearance, dimension, "scratch-strength," blisters, cracks, roughness, soundness, etc. All pipes will be checked for soundness by being tapped and scratched at least once on every 50 sq in of pipe surface. The surface shall be dense and close-textured. Cores also shall serve as a basis for rejection of pipe, particularly if lamination or poor bond of reinforcement is apparent.
- K. The manufacturer shall use measuring devices to assure joint assembly is within tolerances of ASTM C76 and as specified herein. If, during construction, the pipes cannot be satisfactorily joined, the manufacturer shall pre-join the pipe at the plant.
- L. Only pipe actually conforming the requirements of ASTM C76 and these specifications shall be shipped. Approved pipe will be so stamped or stenciled on the inside before it is shipped. All pipe which has been damaged after delivery will be rejected and if such pipe already has been laid in the trench, it shall be removed and replaced, entirely at the Contractor's expense.

- M. Pits, blisters, rough spots and other imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Non-shrink cement mortar used for repairs shall have a minimum compressive strength of 6,000 psi at the end of seven days and 8,000 psi at the end of 28 days, when tested in three-in cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.
- N. Supply a length of concrete pipe with three holes of proper diameter cut at the quarter points for each of the Y-saddles required. The holes shall be cut halfway through in the pipe by the manufacturer while the concrete is still "green" leaving the reinforcement intact. These pipes shall be reserved for use with Y-saddles only and the remaining concrete and reinforcement shall be cut in the field only from the hole to be used.
- O. Pipe for use on curved sections shall be fabricated by beveling one or both ends up to five degrees to produce the radius of curvature required. Joint deflection shall not be utilized to produce the radius of curvature required. Reinforced concrete bends shall be cast to the degree of curvature required or fabricated by cutting the pipe at the required angle and rejoining the sections. Bends may be smooth or mitered providing mitered angles do not exceed 22-1/2 degrees and bends have a radius divided by the pipe diameter greater or equal to one.

2.02 JOINTS FOR CONCRETE PIPE

- A. Joints shall be bell and spigot type joint conforming to ASTM C361 or C443 with provisions for using a round rubber O-Ring gasket in a recess in the spigot end of the pipe or profile gasket in a single step joint.
- B. The gaskets shall conform to ASTM C361 or ASTM C443 except as otherwise specified herein. Two gaskets shall be submitted to the Engineer for tests at least 30 days before joining any the pipe.
- C. Specimens shall be heated in a dry oven to 150 degrees F for six-hour duration and five specimens shall be tested by immersion, one each as follows: two-hour immersion in petroleum ether, 72-hour immersion in saturated Hydrogen Sulfide solution, 72-hour immersion in one percent NaOH solution, 72-hour immersion in standard soap solution (80 percent alcohol), 72-hour immersion in 10 percent NaCl solution. The specimens shall show no detrimental change in color, texture, or feeling upon completion of the above tests. Specimens of the gaskets shall be subjected to tensile tests of approximately 100 psi before and after immersion and heating tests and shall show an elongation of at least 25 percent. Upon release from the tensile tests, each specimen shall return to its original length. The manufacturer shall supply test data and affidavits showing compliance with these requirements. Tests shall have been conducted within six months of the start of manufacture of the pipe.
- D. The joint and gaskets shall be designed and manufactured so that the completed joint will withstand an internal water pressure in excess of 13 psi for a period of 10 minutes without showing any leakage by the gasket or displacement of it. The pipe manufacturer shall provide facilities for testing the effectiveness of the joints against leakage and one such test may be required for each 800-ft of pipe for each type of joint manufactured. Such tests shall be made by an internal or external pressure against the joint of at least 13 psi for a period of 10 minutes in accordance with ASTM C443. The completed joint, when installed in place in the work, shall be capable of withstanding a groundwater pressure of 13 psi without exceeding the allowable leakage specified for the pipe testing.

- E. The pipe manufacturer shall furnish information and be on hand during the installation of the first five joints installed under this Contract.
- F. The ends of the pipe shall be made true to form and dimension and the bell shall be made by casting against steel forms. The manufacturer shall inspect all pipe joint surfaces for out-of-roundness and pipe ends for squareness.

PART 3 EXECUTION

3.01 LAYING CONCRETE PIPE

- A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or fittings and the joint surfaces. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective.
- B. As soon as the excavation is completed to the normal grade of the bottom of the trench, place screened gravel bedding in the trench and firmly bed the pipe in this gravel to conform accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted.
- C. Prior to the installation of any pipe, review the proposed method of installation with the Engineer. Jacks or come-alongs shall be used to force the pipes home. The use of other methods, including the use of motor driven equipment, shall be reviewed by the Engineer. The Engineer reserves the right to direct the Contractor to revise his operation at any time within this Contract.
- D. A depression shall be left in the supporting gravel at the joint to prevent contamination of the rubber gasket. Before the pipe is lowered into the trench, the spigot and bell shall be cleaned and free from dirt. Gasket and bell shall be lubricated by a vegetable lubricant which is not soluble in water, furnished by the pipe manufacturer and harmless to the rubber gasket. The pipe shall be properly aligned in the trench to avoid any possibility of contact with the side of the trench and fouling the gasket. As soon as the spigot is centered in the bell of the previously laid pipe, it shall be engaged by approved methods.
- E. After the gasket is compressed, but before the pipe is brought home, each gasket shall be checked for proper position around the full circumference of the joint. Steel inserts shall be used to prevent the pipe from going home until the feeler gauge is used to check the final position of the gasket.
- F. As soon as the pipe is in place and before the come-along is released, backfill shall be placed as indicated on the Drawings and compacted for at least one-half the length of pipe. Not until this backfill is placed shall the come-along be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by a watertight plug or other approved means.
- G. For each of the pieces to be supplied and used for saddles, plug the remaining two holes not used for the service with non-shrink cement mortar.

- H. Regulate the equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured. Any pipe damaged during construction operations shall promptly and satisfactorily be repaired or replaced at the Contractor's expense.

3.02 TESTING AND CLEANING

- A. Testing and cleaning shall be as specified in ASTM C969 and Section 01445.

END OF SECTION

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SECTION 02616
DUCTILE IRON PIPE AND FITTINGS BELOW GRADE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, material, equipment and incidentals required, install, and test below-grade ductile iron pipe (direct-buried or installed in casings) and fittings as shown on the drawings and as specified herein.
- B. Piping shall be located substantially as shown on the Drawings. The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference between pipes, conduits, utilities or for other reasons. Pipe fitting notation is for the Contractor's convenience and does not relieve him/her from installing and jointing different or additional items where required to achieve a complete piping system.
- C. Where the word "pipe" is used it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

1.02 RELATED WORK

- A. Excavation, Bedding and Backfilling for Pipe is included in Section 02221.
- B. Microtunneling is included in Section 02325.
- C. Valves and Appurtenances (for above-grade and below-grade service) are included in Section 15100.
- D. Ductile Iron Pipe and Fitting Above Grade are included in Section 15072.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data for all ductile iron pipe, fittings, and accessories.
- B. Submit anticipated production and delivery schedule

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - 2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
 - 3. ASTM C150 - Standard Specification for Portland Cement.
- B. American Water Works Association (AWWA)

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-In Through 48-In for Water and Other Liquids.
 3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
 5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
 6. AWWA C153 - Ductile- Iron Compact Fittings, 3-In Through 16-In for Water and Other Liquids.
 7. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
- 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. Each length of ductile iron pipe supplied for the project shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture of the pipe wall. Certified test results shall be furnished in duplicate to the Engineer prior to time of shipment.
- B. All ductile-iron pipe and fittings to be installed under this project shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results prior to the shipment of the pipe.
- C. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the District at the District's expense.
- D. Inspection of the pipe and fittings will also be made by the Engineer or representative of the District after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.
- E. All pipe and fittings shall be permanently marked with the following information:
 1. Manufacturer, date.
 2. Size, type, class, or wall thickness.
 3. Standard produced to (AWWA, ASTM, etc).

1.06 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be used in pipe handling.
- B. Materials, if stored, shall be kept safe from damage. The interior of all piping, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.
- C. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations.
- D. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE, FITTINGS AND ACCESSORIES

A. Pipe

- 1. Ductile iron pipe shall conform to AWWA C151 and ANSI A21.51. Pipe shall be supplied in standard lengths as much as possible.
- 2. Thickness design shall be per AWWA C150, except provide minimum Class 350 for piping 12-in and smaller and pipe shall be minimum Class 250 for larger than 12-in. Where welded-on outlets on ductile iron pipe are shown on the Drawings, ductile iron pipe shall be Special Thickness Class 53 minimum. Where threaded taps in ductile iron pipe are shown on the Drawings, ductile iron pipe shall be Special Thickness Class 55 minimum.
- 3. Ductile iron pipe shall be by U.S. Pipe and Foundry Company, Inc.; American Cast Iron Pipe Company or equal. All pipe shall be made in the United States and supplied by a single manufacturer.

B. Joints

- 1. Buried ductile iron pipe shall have rubber-gasket push-on joint, rubber-gasket mechanical joint, or flanged joints as shown on the Drawings. Ductile iron pipe installed in casings shall have restrained push-on joints. All joints shall be restrained. Rubber-gasket joints shall conform to AWWA C111. Gaskets shall conform to AWWA C111 and ANSI A21.1 and shall be EPDM.
- 2. All joint restraint systems shall have factory applied liquid thermoset epoxy coating.
- 3. Joint restraint devices for ductile iron mechanical joint pipe and fittings shall be EBAA Iron Sales Series 1100 Megalug®, or equal.

4. Joint restraint for push-on joint pipe shall be independent of the joint gasket. Restrained push-on joint pipe shall be US Pipe and Foundry TR Flex, American Cast Iron Pipe Company, Flex Ring, or equal..

C. Fittings

1. Except where flanged joints are shown, buried ductile iron pipe fittings shall have restrained mechanical joints. Fittings shall have a pressure rating of 350 psi for 24-in and smaller piping and 250 psi for 30-in and larger piping. Fittings shall meet the requirements of AWWA C110 or AWWA C153 as applicable. Fittings shall have the same pressure rating, as a minimum, of the connecting pipe. Fittings may be made outside the United States, but shall be supplied by one of the named pipe manufacturers or Engineer approved equal.
2. Closures shall be made with mechanical joint ductile iron solid sleeves and shall be located in straight runs of pipe. Location of closures shall be subject to approval of the Engineer.

D. Interior Lining

1. Interior surfaces of all ductile iron pipe shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. Ductile iron fittings shall be double cement lined. Ductile iron pipe fittings need not have the cement-mortar lining applied centrifugally. The lining machines shall be of the type that has been used successfully for similar work. At the option of the supplier, fittings may be lined in accordance with AWWA C550. Every precaution shall be taken to prevent damage to the lining. If the lining is damaged or found faulty at the delivery site, the damaged or unsatisfactory portion shall be repaired in the field in accordance the ANSI/AWWA C104.

E. Exterior Coating

1. Buried pipe shall be coated on the exterior with a one mils thick bituminous coat in accordance with ANSI A21-51. All buried ductile iron pipe shall have a polyethylene wrap with a minimum eight mils thickness and shall conform to ASTM specification D-1248. Wrap for raw water transmission main shall be olive green and imprinted "RAW WATER FORCE MAIN". When imprinted color coated polyethylene wrap is not available, color-coded polyethylene wrap can be used in conjunction with pipe ID tape.

F. Flanged Pipe, Fittings, and Appurtenances

1. Flanged pipe and fittings, where shown on the Drawings, shall be as specified in Section 15072.

- G. All buried ductile iron pipe and fittings shall have a polyethylene wrap with a minimum 8 mils thickness and shall conform to ASTM specifications D-1248. Wrap for raw water main shall be olive green and imprinted "RAW WATER MAIN".

2.02 DUCTILE IRON PIPE DESIGN

- A. Ductile iron pipe shall have a minimum tensile strength of 60,000 psi with a minimum yield strength of 42,000 psi. Design shall be done for external and internal pressures separately using the larger of the two for the net design thickness. Additional allowances shall be made for

service allowance and casting tolerance per AWWA C150. The pipe classes determined for various sizes and conditions shall provide the total calculated thickness at a minimum or conform to minimum pipe class specified in Paragraph 2.01A2 above, whichever is greater.

- B. Design for the net thickness for external loading shall be taken as the greater of the following conditions:
1. 2-1/2-ft of cover with AASHTO H-20 wheel loads, with an impact factor of 1.5.
 2. Depth from existing ground level of future proposed grade (whichever is greater) to top of pipe as shown on the Drawings, with truck load.
 3. Soil Density: 120 lbs/cu ft.
 4. Laying Conditions; AWWA C150, Type 2.
- C. Design for the net thickness shall be based upon the following design internal pressure conditions:
1. Total internal Pressure design: 500 psi (includes 100 psi surge allowance and 2.0 safety factor)
 2. Soil Modulus E.: 300 psi
- D. Copies of design calculations showing that the pipe meets all requirements specified herein shall be furnished to the Engineer for approval during shop drawing review in accordance with Section 01300. A yield strength of 42,000 psi shall be used during design calculations

PART 3 EXECUTION

3.01 GENERAL

- A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Pipe and fittings shall not be dropped. All pipe and fittings shall be examined before laying and no piece shall be installed which is found to be defective. Damage to the pipe coatings shall be repaired per Manufacturer's recommendations.
- B. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work and when installed or laid, shall conform to the lines and grades required.

3.02 INSTALLING DUCTILE IRON PIPE AND FITTINGS

- A. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA C600, Section 02221, and as specified herein. A firm, even bearing throughout the length of the pipe shall be provided by digging bell holes at each joint and by tamping backfill materials at the side of the pipe to the springline per details shown on the Drawings. Blocking will not be permitted.

- B. All pipe shall be sound and clean before laying. When laying is not in progress, open ends of the pipe shall be closed by a watertight plug or other approved means. Sufficient backfill shall be placed to prevent flotation. The deflection at joints shall not exceed 75 percent of allowable deflection recommended by Manufacturer.
- C. All ductile iron pipe laid underground shall have a minimum of three ft of cover unless otherwise shown on the Drawings or as specified herein.
- D. Fittings, in addition to those shown on the Drawings shall be provided, where required, in crossing utilities which may be encountered upon opening the trench. Solid sleeve closures shall be installed at locations approved by the Engineer.
- E. The pipe interior shall be maintained dry and broom clean throughout the construction period.
- F. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged. Field cut ends shall be sealed with approved epoxy in accordance with Manufacturer's instructions.
- G. Jointing Ductile-Iron Pipe
 - 1. All pipe joints shall be made in strict accordance with Manufacturer's instructions and AWWA C600.
 - 2. Mechanical joints shall be assembled with bell ends looking ahead. To assemble the joints in the field, thoroughly clean and lubricate the joint surfaces and rubber gasket. Bolts shall be tightened to the specified torques. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to secure greater leverage.
 - 3. Bolts shall be tightened alternately and evenly.
 - 4. Joint restraints shall be installed according to pipe Manufacturer's instructions.
- H. All blow-offs, outlets, valves, fittings, and other appurtenances required shall be set and jointed as indicated on the Drawings in accordance with the Manufacturer's instructions.
- I. All polyethylene encasement shall be installed per AWWA C105.

3.03 IDENTIFICATION

- A. All buried ductile iron pipe shall be color-coded with a field-applied continuous painted stripe (minimum two-inch wide) running along the crown of the pipe.
- B. Color shall be as follows:
 - 1. Raw Water – Olive Green

3.04 TESTING

- A. After installation, the pipe shall be tested for compliance as specified herein. Furnish all necessary equipment and labor for the pressure test and leakage test on the pipelines.

- B. Submit detailed test procedures and method for Engineer's review. In general, testing shall be conducted in accordance with AWWA C600.
- C. New piping downstream of the intake pump station discharge shall be subjected to a hydrostatic pressure of 200 psi. New piping between the intake streams and the intake pump station suction cans shall be subject to a hydrostatic pressure of 150 psi. This test pressure shall be maintained for a minimum of two hours. The leakage rate shall not exceed those indicated in AWWA C600. Provide suitable restrained bulkheads or blind flanges as required to complete the hydrostatic testing specified.
- D. All valves and valve boxes shall be properly located and installed and operable prior to testing. Bulkheads shall be provided with a sufficient number of outlets for filling and draining the line and for venting air.
- E. Hydrostatic pressure and leakage tests shall conform with Section 4 of AWWA C600. Furnish gauges, meters, pressure pumps and other equipment needed to fill the line slowly and perform the required hydrostatic pressure leakage tests.
- F. The line shall be slowly filled with water and the specified test pressure shall be maintained in the pipe for the entire test period by means of a pump furnished by the Contractor. Provide accurate means for measuring the quantity of water required to maintain this pressure. The amount of water required is a measure of the leakage.
- G. Submit plan for testing to the Engineer for review at least 10 days before starting the test.

3.05 CLEANING

- A. During the course of the work, keep the pipeline clean from dirt, stones, pieces of wood, or other material. All debris shall be removed from the pipeline. At the conclusion of the work the Contractor shall thoroughly clean all of the new pipelines by pigging to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. Debris cleaned from the lines shall be removed from the job site. If, after this cleaning, any obstructions remain, they shall be removed. Provide hoses, temporary pipes, ditches, etc., as required to dispose of flushing water without damage to adjacent properties.

3.06 FIELD PAINTING

- A. All flanged ductile iron pipe and fittings shall be field painted by Contractor per Section 09902.
- B. Flanged pipe and fittings to be located below grade shall be field painted prior to installation.

3.07 THREADED TAPS

- A. Contractor shall be responsible for installing the threaded taps where shown on the drawing or required for testing and disinfection. The threaded taps shall conform to ANSI/ASME B1.20.1.

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SECTION 02623
HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment and incidentals required to install high density polyethylene (HDPE) pipe and fittings complete, tested, and ready for use, as shown on the Drawings and as specified herein.

1.02 SUBMITTALS

- A. Submit, in accordance with Section 01300, completely detailed working drawings and schedules of all high density polyethylene (HDPE) pipe and fittings required.
- B. Submit the name and address of pipe manufacturer.
- C. Submit complete description of method of pipe installation.
- D. Submit description of the method of testing the pipe and fittings
- E. Submit the manufacturer's recommendations for handling, storing and installing the pipe and fittings.
- F. Submit certification that the stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacturing of the pipe for this contract in accordance with ASTM D2837.
- G. Prior to each shipment, submit certified test reports that the pipe and fittings for this contract were manufactured and tested in accordance with the ASTM Standards specified herein.
- H. Submit the name and qualifications of the technicians proposed to perform the heat fusion of the pipe joints.

1.03 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.
 - 2. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 3. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity-Flow Applications.
 - 4. ASTM D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

5. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
6. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
7. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
8. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
9. ASTM F2164 – Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure

B. American Water Works Association (AWWA)

1. AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
2. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4-in Through 63-in, for Water Distribution and Transmission.

C. American National Standards Institute (ANSI)

1. ANSI B16.1 - Cast Iron Flanges and Flanged Fittings.
2. ANSI B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
3. ANSI/NSF 61- Drinking Water System Components-Health Effects

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

1.04 DELIVERY, STORAGE AND HANDLING

- A. The delivery, storage and handling of the pipe and fittings shall be done in accordance with the manufacturer's recommendations.
- B. Pipe shall be stored on clean, level ground to prevent any scratching or gouging of the pipe. The handling of the pipe shall be done in a manner to avoid dragging the pipe over any hard or sharp objects to avoid cutting of the pipe's exterior. If gouges/scratches are made in the pipe during handling the depth of the gouge/scratch shall be measured by an independent testing lab at no cost to the District and the results shall be certified in writing to the District.
1. if the gouge is less than five percent of the wall thickness, the gouge does not require remediation.
 2. if the gouge is equal to or more than five percent of the wall thickness, the pipe shall be rejected and a section of the pipe shall be removed and re-fused or replaced.

- C. The pipe shall be inspected prior to installation. The Engineer and District reserve the right to reject any and all gouges/scratches regardless of measured depth and or apparent cause. All decisions made by the Engineer and District are final; the Contractor shall remove and repair any rejected pipe sections.
- D. Handling of the pipe shall be done in a manner to avoid all undue stress in the pipe caused by bending of the pipe.
- E. The interior of the pipe shall be free of cuts, gouges and scratches.

1.05 QUALITY ASSURANCE

- A. All HDPE pipe and fittings shall be manufactured in strict accordance with ASTM F714 and shall be from a manufacturer who is fully experienced, reputable and qualified in the manufacture of the polyethylene pipe and fittings to be furnished. All HDPE pipe and fittings shall be supplied by a distributor who is fully experienced, reputable, and qualified with the distribution of the pipe and fittings to be furnished. The pipe shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these specifications. All pipe and fittings shall be NSF 61 approved.
- B. All pipes under this contract shall be manufactured from a polyethylene resin that has been specifically stress regression tested to provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1600 psi, as determined in accordance with ASTM D2837.
- C. All HDPE pipe to be installed under this Contract may be inspected at the factory for compliance with this Section by an independent testing laboratory provided by the District. The manufacturer's cooperation shall be required in these inspections. The cost of these plant inspections of all pipe approved for this Contract will be borne by the District.
- D. Inspection of the pipe may also be made by the Engineer or other representatives of the District after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specified requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.06 WARRANTY

- A. The pipe manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of 10 years after the final acceptance of the project by the District. The manufacturer shall replace, at no additional cost to the District, any defective pipe material within the warranty period.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General

- 1. HDPE pipe is a flexible conduit and shall be designed to transfer imposed loads to the surrounding embedment medium. The pipe and fittings shall be free from all defects

including indentations, delaminations, cracks, bubbles and pinholes, which due to their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe. Any pipe or fittings with such defects which, in the judgement of the Engineer, will affect the strength and serviceability shall be repaired or rejected.

2. HDPE pipe resins shall be high molecular weight, high density polyethylene with a cell classification number of PE445574C and PE445576C or higher cell classification in accordance with ASTM D3350 and shall be listed in the name of the pipe and fitting manufactured in PPI (Plastics Pipe Institute).

B. Pipe and Fittings

1. Pipe shall have ductile iron pipe size outside dimensions and shall be furnished in minimum thickness meeting the requirements as shown below..

Nominal Diameter (in)	Outside Dimensions	Dimension Ratio
4	DIPS	DR11

2. All polyethylene pipes shall meet the requirements of ASTM F714. Pipe and fittings shall be NSF 61 approved.
3. Pipe greater than four-inch nominal diameter shall be furnished in standard laying lengths not exceeding 50-ft.
4. Joining system: The pipe and fittings shall be joined with thermal butt fusion joints (or electrofusion couplings on a case by case basis with Engineer’s approval). All joints shall be made in strict compliance with the manufacturer's recommendations and ASTM 2657.
5. All fittings shall be restrained joint ductile iron mechanical joint fittings as specified in Section 02616 and. shall have a polyethylene wrap with a minimum eight mils thickness and shall conform to ASTM specification D-1248.
6. Polyethylene pipe will be as manufactured by Performance Pipe; JM Eagle; CSR polypipe or equal.
7. The polyethylene compound will be suitably protected against degradation by ultraviolet light as required by ASTM D1603.

2.02 PIPE IDENTIFICATION

- A. At five-ft intervals along the pipe, the pipe shall be marked with the name of the manufacturer, size and class (pressure and DR), and manufacturing reference to ASTM F714.
- B. The HDPE pipe installed outside of a casing shall be laid with two strands of insulated six gauge wire with two-three mil coating and a stainless steel core. It is to be installed at every valve box through a two-inch PVC pipe to 12-inches minimum above the top of the concrete slab. The two-inch PVC pipe shall be the same length as the adjustable valve box, and the two-inch PVC pipe shall be plugged with a two-inch removable brass plug with recessed nut. This

wire is to be continuous with splices made only by direct bury 3M brand splice kit approved by the Engineer. This wire is to be secured to all valves, tees and elbows. See Section 02413.

2.03 ADAPTORS

- A. Polyethylene flange or mechanical joint adaptors with stainless steel stiffeners will be used for connecting polyethylene pipe to ductile iron pipe or other material. For flanged connections, the polyethylene end or will be backed up by a ductile iron flange backup ring conforming to ANSI B16.1 shaped as necessary to suite outside dimension of the HDPE pipe. For mechanical connections, accessories shall include ductile iron gland ring conforming to ANSI/AWWA C110, C111 & C153. Ductile iron coatings shall be ANSI/AWWA C104/A21.4 (asphaltic paint – NSF 61 approved) Gaskets shall be ANSI/AWWA C111/A21.11 Buna N, Neoprene or Nytryl-based rubber product approved by the Engineer. Corrosion resistant bolts and nuts of Type 304 stainless steel as specified in ASTM A276 and ASTM A307.
- B. Polyethylene adaptors will be as manufactured by Orion; Integrity Fusion Products; Specified Fittings or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All pipe and fittings shall be installed in accordance with the manufacturer's instructions and ASTM D2774.
- B. All fusion joints shall be done by a factory qualified technician as designated by the manufacturer with a minimum of five years of experience with the fusion equipment to be used. Installer certification is needed from the Contractor installing thermal butt fused HDPE pipe.
- C. Joining of the pipe by heat fusion shall be done in accordance with ASTM D2657. Prior to the start of pipe installation, one test joint shall be made and tested. No joints shall be made until a successful test joint has been made.
- D. When cutting pipe is required, the cutting shall be done by machine specifically designed for the cutting of HDPE pipe. The cut shall leave a smooth cut at right angles to the axis of the pipe.
- E. Fittings shall be connected to HDPE pipe in accordance with manufacturer's recommendations.
 - 1. A high density polyethylene flange or mechanical adapter, made by the manufacturer from the same resin as the pipe, and fully pressure rated to match the pipe DR pressure rating, thermally butt-fused to the stub end of the pipe. Bolts shall be tightened alternatively and evenly to the manufacturer's specified torques. After installation a bitumastic coating shall be applied to bolts and nuts.

3.02 TESTING FOR TRACING WIRE

- A. Contractor shall perform a 12-volt DC electrical continuity test on each of the tracer wires. No more than one volt of loss per 1000 feet of mainline pipe will be acceptable. The locator wire system shall pass the 12-volt DC electrical continuity test for at least one wire prior to final acceptance. Any cuts or breaks in the wire shall be repaired by the Contractor at his expense. The

locator wire shall be tested by the Contractor at the time of pressure testing. If this test fails, the Contractor is responsible for repairing the locator wire and the pressure test will be reschedule when the wire will pass.

3.03 CLEANING AND TESTING

- A. During the installation, the piping shall be plugged or capped to prevent the intrusion of water, soil, or debris.
- B. Upon completion of installation (but prior to grouting of the microtunnel casing annular space), pipes shall be air-pressure tested to 200 psi in the presence of the Engineer. Provide all labor, equipment and material required for testing.

END OF SECTION

SECTION 02830
CHAIN LINK FENCE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals necessary and install the chain link fence and cantilevered slide gate complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Earth excavation and backfill is included in Section 02200.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings showing layout and details of construction and erection of fence and accessories required.

1.04 REFERENCE STANDARDS

- A. FDOT
 - 1. FY 2021-22 Standard Plans for Road Construction.
 - 2. Standard Specifications for Road and Bridge Construction (latest edition).

PART 2 PRODUCTS

2.01 CHAIN LINK FENCE MATERIALS

- A. General: Chain link fence shall be nominal six-foot height. Details and materials of construction shall be per FDOT Indexes 550-002 (Fence Type B) and as specified herein. Fence shall include barb wire attachment per FDOT Index 550-002.
- B. Line posts shall be 2.0-inch nominal diameter aluminum alloy pipe in accordance with FDOT Index 550-002 – Line post option (3).
- C. Corner, end, and pull posts shall be 2.5-inch nominal diameter aluminum alloy pipe in accordance with FDOT Index 550-002 – Corner, end, and pull posts option (3).
- D. Rails shall be 1.25-inch nominal diameter aluminum alloy pipe in accordance with FDOT Index 550-002 – Rail option (3).
- E. Chain link fabric shall be aluminum-coated steel, No. 9 gage in accordance with FDOT Index 550-002 – Chain link fabric option (2).
- F. Tension wire shall be aluminum alloy wire in accordance with FDOT Index 550-002 – Tension wire option (2).

- G. Tie wire shall be aluminum alloy wire in accordance with FDOT Index 550-002 – Tie wire and hog ring option (2).
- H. Barb wire shall be aluminum in accordance with FDOT Index 550-001.
- I. Vertical privacy slats shall UV-light stabilized fiberglass reinforced plastic, not less than 0.06-inch thick, sized to fit mesh specified.

2.02 CANTILEVERED SLIDE GATE MATERIALS

- A. Cantilevered slide gate frame, support posts, latch posts, and truss rods shall conform to FDOT Index 550-003.
- B. Fence fabric, barb wire, stretcher bars, tension bars, tension wire, tie wire, and privacy slats shall meet the requirements of Paragraph 2.01.
- C. Cantilevered slide gate shall have a 20-foot opening width, a 10-foot back frame, a height of six feet, and barb wire extension.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 CHAIN-LINK FENCE INSTALLATION

- A. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

- D. New posts for all fences shall be anchored directly into new concrete footings as shown on the Drawings.
- E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
 - 1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within six inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
- G. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave one-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.
- I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
- J. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

3.04 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.05 GROUNDING AND BONDING

- A. Fence and Gate Grounding:
 - 1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
 - 2. Install ground rods and connections at maximum intervals of 1500 feet.

3. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
4. Ground fence on each side of gates and other fence openings.
 - a. Bond metal gates to gate posts.
 - b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is six inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
 1. Retain one or both subparagraphs below if applicable.
 2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
- E. Connections:
 1. Make connections with clean, bare metal at points of contact.
 2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 4. Make above-grade ground connections with mechanical fasteners.
 5. Make below-grade ground connections with exothermic welds.
 6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- F. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.
- G. Comply with requirements in Section 264113 "Lightning Protection for Structures."

3.06 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout

entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION

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SECTION 02900 TURF AND GRASSES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. FDOT Standard Specifications for Road and Bridge Construction include additional requirements for seeding and sodding.

1.02 SUMMARY

- A. Section Includes:

- 1. Seeding.
- 2. Sodding.

1.03 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See drawing designations for planting soils.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.04 SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Identification of source and name and telephone number of sod supplier.
- B. Product Certificates: For fertilizers, from manufacturer.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.05 QUALIFICATIONS

- A. **Installer Qualifications:** A qualified landscape installer whose work has resulted in successful turf establishment.
 - 1. **Professional Membership:** Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
 - 2. **Experience:** Three years' experience in turf installation.
 - 3. **Installer's Field Supervision:** Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. **Personnel Certifications:** Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawn Care Manager.
 - c. Landscape Industry Certified Lawn Care Technician.
 - 5. **Pesticide Applicator:** State licensed, commercial.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. **Seed and Other Packaged Materials:** Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. **Bulk Materials:**
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.07 FIELD CONDITIONS

- A. **Weather Limitations:** Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 PRODUCTS

2.01 SEED

- A. **Grass Seed:** Fresh, clean, dry, new-crop seed complying with Association of Official Seed Analysts (AOSA's) "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. State-certified Bahia grass seed.
2. Quality: Not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed.

2.02 SOD

- A. Sod shall be Bahia and shall comply with requirements of FDOT Standard Technical Specifications for Road and Bridge Construction (latest edition).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 3. Uniformly moisten excessively dry soil that is not workable, or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

3.02 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil
- B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.
1. Reduce elevation of planting soil to allow for soil thickness of sod.

- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.05 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of two lb./1000 sq. ft..
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:4 by spreading straw mulch. Spread uniformly at a minimum rate of two tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
 - 2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.06 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, re-planting, and performing other operations as required to establish healthy, viable turf. Roll, re-grade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Convey water from offsite sources and to keep turf uniformly moist to a depth of four inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of one inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow bahia grass turf-type to a height of two to three inches.
- D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that provides actual nitrogen of at least one lb/1000 sq. ft. to turf area.

3.07 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Engineer:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding five by five inches.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.08 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Engineer's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.09 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 - 1. Seeded Turf and Sodded Turf: 60 days from date of planting completion.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION

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 complete as shown on the Drawings and as specified herein.
- B. Secure to forms or set for embedment all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts, and other items furnished under other Sections and required to be cast into concrete.

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. Concrete finishes are included in Section 03350.
- E. Grout is included in Section 03600.
- F. Miscellaneous metals are furnished under Sections 05500.
- G. Anchor bolts for equipment are furnished under Divisions 15 and 16.

1.03 SUBMITTALS

- A. Submit, 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
 - 3. Location and sequence of concrete placement.
 - 4. Formwork and shoring design calculations; fabrication and erection documents for formwork; and shoring, stripping criteria and reshoring procedures. These items shall be signed and sealed by the Registered Design Professional (RDP) specified under Paragraph 1.05B for review and approval.
- B. Review will be for appearance, performance and strength of the completed structure only. Approval by the Engineer will not relieve the Contractor of responsibility for the strength, safety or correctness of methods used, the adequacy of equipment, or from carrying out the work as shown on the Drawings and as specified herein.

C. Sample Substrate

1. Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not impair the bond of paint, sealant, waterproofing, dampproofing, or other coatings and will not affect the forming materials.

D. Certificates

1. Submit completed PE Certification Form for design of formwork in accordance with Section 01300. The PE Certification Form shall be completed and stamped by a professional engineer registered in the State of Florida.

1.04 REFERENCE STANDARDS

A. American Concrete Institute (ACI)

1. ACI 301 - Specifications for Structural Concrete
2. ACI 303R - Guide to Cast-in-Place Architectural Concrete Practice
3. ACI 318 - Building Code Requirements for Structural Concrete
4. ACI 347 - Guide to Formwork for Concrete

B. APA - The Engineered Wood 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. Structural design responsibility: Contractor shall provide all forms and shoring designed by a professional engineer registered in the State of Florida. Design and erect formwork in accordance with the requirements of ACI 301, ACI 318 and ACI 347. Comply with all applicable regulations and codes. 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, General

1. Make forms for cast-in-place concrete of wood, steel or other approved materials, except as specified in Paragraph 2.02B. Construct wood forms of sound lumber or plywood free

from knotholes and loose knots. Construct steel forms to produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Section 03350.

B. Forms for Exposed Structural Concrete

1. Make forms for all exposed and non-submerged exterior and interior concrete of new and unused Plyform exterior grade plywood panels manufactured in compliance with the APA and bearing the APA trademark. Provide B grade or better veneer with High Density Overlay on all faces to be in contact with concrete. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Section 03350.
2. Provide rigid forms that will not deflect, move, or leak. Design forms to withstand the high hydraulic pressures resulting from rapid filling of the forms and heavy high frequency vibration of the concrete. Limit deflection to 1/400 of each component span. Lay out form joints in a uniform pattern.
3. Dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Tape, gasket, plug, and/or caulk all joints and gaps in forms to provide watertight joints that will withstand placing pressures without exceeding specified deflection limit or creating surface patterns.
4. Provide 3/4-inch chamfer on all corners unless otherwise indicated.

C. Column Forms

1. Form rectangular columns as specified for exposed structural concrete. Provide 3/4-in chamfer on all corners unless otherwise indicated.

D. Provide rustications as indicated. Mill and plane smooth moldings for chamfers and rustications. Provide rustications and chamfer strips of nonabsorbent material, compatible with the form surface and fully sealed on all sides to prevent the loss of paste or water between the two surfaces.

E. Form Release Agent. Coat all form surfaces in contact with concrete with an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise indicated or specified. Form release agent shall not impair the bond of paint, sealant, waterproofing, dampproofing or other coatings.

F. For concrete surfaces which are to be painted, use forms with high density overlay or a similar material which does not require a form release agent unless the Contractor can substantiate to the satisfaction of the Engineer that the form release agent will not remain on the formed surface after it is stripped.

G. Form Ties

1. Coil and Wire Ties: Provide ties manufactured so that, after removal of the projecting part, no metal remains 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 plastic or wooden cone at least 1/2-in diameter and 1-1/2-in long. Provide cone washer type form ties in concrete exposed to view.
2. Flat Bar Ties for Panel Forms: Provide ties that have plastic or rubber inserts with a minimum depth of 1-1/2-in and manufactured to permit patching of the tie hole.
3. Do not use common wire for form ties.
4. 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. Install in forms so that large end is, where applicable, on the liquid or backfilled side of the wall. Clean, fill and seal form tie hole with non-shrink cement grout to provide watertight form tie holes and make all repairs needed to make watertight.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide forms for all cast-in-place concrete including sides of footings. Construct and place forms to provide concrete of the shape, lines, dimensions and appearance indicated.
- B. Provide removable panels at the bottom of forms for walls and columns to allow cleaning, inspection and joint surface preparation. Provide closable intermediate inspection ports in forms for walls. Provide tremies and hoppers for placing concrete and to allow concrete sampling, prevent segregation and prevent the accumulation of hardened concrete on the forms and reinforcement above the fresh concrete.
- C. Place molding, bevels, or other types of chamfer strips to produce blockouts, rustications, or chamfers as indicated on the Drawings or as specified herein. Provide chamfer strips at horizontal and vertical projecting corners to produce a 3/4-in chamfer. Provide rectangular moldings at locations requiring sealants where shown on the Drawings or specified herein.
- D. Provide rigid forms to withstand construction loads and vibration and meeting specified deflection limits and tolerances. Construct forms so that the concrete will not be damaged by form removal.
- E. Accessories which remain embedded in the concrete after formwork removal will be subject to the approval of the Engineer. Permanent embedments shall have sufficient concrete cover or be of suitable materials for the exposure condition as approved by the Engineer. Remove unsatisfactory embedded items at no additional cost to the District.

3.02 FORM TOLERANCES

- A. Design, construct and surface forms in accordance with ACI 347 and meet the following additional requirements for the specified finishes.

- B. Forms for Exposed Structural Concrete: Edges of all form panels in contact with concrete flush within 1/8-in and forms for plane surfaces plane within 1/8-in in four ft. Maximum deviation of the finished surface at any point not to exceed 1/4-in from the intended surface indicated. Arrange form panels symmetrically and orderly to minimize the number of seams. Provide tight forms to prevent the passage of mortar, water, and grout.
- C. Formed Surface Not Exposed to View or Buried: Class "C" Surface per ACI 347.
- D. Formed Surface Including Mass Concrete, Pipe Encasement, Electrical Raceway Encasement and Other Similar Installations: No minimum requirements for surface irregularities and surface alignment. The overall dimensions of the concrete shall be plus or minus one in. from the intended surface indicated.
- E. Rustications Exposed to View: Straight, plumb and true with a variation of no more than 1/8-in in 10-ft measured in any direction.
- F. Formed Surfaces to be Painted: Surface irregularities limited to 1/16-in at any point. Variation in alignment not to exceed 1/16-in per four ft. The maximum deviation of the finish surface at any point not to exceed 1/4-in from the intended surface indicated.

3.03 FORM PREPARATION

- A. Clean, repair, remove projecting nails and fill holes, and smooth protrusions on all form surfaces to be in contact with concrete before reuse. Do not reuse forms for exposed concrete unless a "like new" condition of the form is maintained that will produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels.
- B. Coat wood forms in contact with concrete using form release agent prior to form installation.
- C. Clean steel forms by sandblasting or other method to remove mill scale and other ferrous deposits from the contact surface of all forms. Coat steel forms in contact with concrete using form release agent prior to form installation.

3.04 REMOVAL OF FORMS

- A. Be responsible for all damage resulting from removal of forms and make repairs at no additional cost to the District. Leave in place forms and shoring for horizontal structural members in accordance with ACI 301 and ACI 347. Conform to the requirements for form removal specified in Section 03300.

3.05 INSPECTION

- A. Notify the Engineer when the forms are complete and ready for inspection, at least six working hours prior to the proposed concrete placement. The Engineer will inspect the forms to ensure overall conformance with the contract documents.
- B. Failure of the forms to comply with the requirements specified, or to produce concrete complying with requirements specified shall be grounds for rejection of that portion of the concrete work. Repair or replace rejected work as directed by the Engineer at no additional cost to the District. Such repair or replacement shall be subject to the requirements of these Specifications and approval of the Engineer.

END OF SECTION

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, including dowels embedded into concrete for masonry.
- B. Furnish only deformed steel reinforcement required to be entirely built into masonry construction specified in Section 04200.

1.02 RELATED WORK

- A. Concrete formwork is included in Section 03100.
- 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.
- E. Masonry is included in Section 04200.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Reinforcing steel. Drawings for fabrication, bending, and placement of concrete reinforcement shall conform to the recommendations of ACI 315 for placement drawings and as specified herein.
 - a. Placement drawings. For walls, show elevations from the outside, looking towards the structure, at a minimum scale of 1/4-in to one foot. For slabs, show top and bottom reinforcement on separate plan views, as needed for clarity. For beams and columns, show schedules with sections and/or elevations and stirrup/tie spacing. Show additional reinforcement around openings, at corners and at other locations indicated, diagrams of bent bars, arrangements and assemblies, all as required for the fabrication and placement of concrete reinforcement. Reference bars to the same identification marks shown on the bar bending details. Identify bars to have special coatings and/or to be of special steel or special yield strength.
 - b. Bar bending details. Reference bars to the same identification marks shown on the placement drawings. Identify bars to have special coatings and/or to be of special steel or special yield strength.

B. Submit, in accordance with Section 01300, Test Reports of each of the following items.

1. Certified copy of mill test on each heat of each steel proposed for use showing the physical properties of the steel and the chemical analysis.
2. Welder's certification in accordance with AWS D1.4 when welding of reinforcement is indicated, specified, or approved.

1.04 REFERENCE STANDARDS

A. ASTM International

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A184 - Standard Specification for Welded 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 Carbon-Steel Bars for Concrete Reinforcement.
7. ASTM A704 - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.

B. American Concrete Institute (ACI)

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 315 - Details and Detailing of Concrete Reinforcement.
3. ACI 318 - Building Code Requirements for Structural Concrete.
4. SP-66 (ACI 315) 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

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 DELIVERY, HANDLING AND STORAGE

- A. Provide reinforcement free from mill scale, rust, mud, dirt, grease, oil, ice, or other foreign matter.
- B. Ship and store reinforcement with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placement drawings. Tags for ASTM A706 reinforcing and for ASTM A615 reinforcing meeting the requirements of Paragraph 2.01C.1 shall indicate that the reinforcing is weldable.
- C. Store reinforcement off the ground, protect from moisture and keep free from rust, mud, dirt, grease, oil, ice, or other injurious contaminants.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Provide new materials of domestic manufacture complying with the following material specifications.
- B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.
- C. Welded Steel Wire Fabric: ASTM A185. Provide in flat sheets.
- D. Welded Deformed Steel Wire Fabric: ASTM A497.
- E. Fabricated Deformed Steel Bar Mats: ASTM A184 and ASTM A615 Grade 60 deformed bars.
- F. Reinforcing Steel Accessories
 - 1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.
 - 2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.
 - 3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.
 - 4. Provide galvanized supports for galvanized reinforcement or embedded steel items in contact with galvanized reinforcement.
- G. Tie Wire
 - 1. Tie Wires for Reinforcement: 16-gauge or heavier black annealed wire.

H. Mechanical Reinforcing Steel Coupling System

1. Use only where indicated. Mechanical reinforcing steel coupling system 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. Coupling system shall meet all ACI 318 requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Provide with cap on female end to exclude dirt, debris and wet concrete. Couplers shall be torqued to manufacturer's recommended value.
2. Unless otherwise noted on the Drawings, mechanical reinforcing steel coupling system shall produce a splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcing bar. Base yield strength on Grade 60 reinforcing unless otherwise indicated or specified.
3. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar.

2.02 FABRICATION

- A. Comply with the CRSI Manual of Standard Practice.
- B. Bend bars cold. Do not straighten or rebend bars.
- C. Bend bars around a revolving collar having a diameter not less than that recommended by the CRSI or ACI 318.
- D. Saw cut bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded. Terminate saw cut ends 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. Comply with the CRSI Manual of Standard Practice for surface condition, bending, spacing and tolerances of placement for reinforcement. Provide the amount of reinforcing indicated at the spacing and clearances indicated on the Drawings.
- B. Determine clear concrete cover based on exposure to the environment. Unless indicated otherwise on the Drawings, provide the following minimum clear concrete cover over reinforcement:
 1. Concrete cast against and permanently exposed to earth: three in.
 2. Concrete exposed to soil, water and/or weather:
 - a. Slabs (top and bottom cover), walls: two in.
 - b. Beams and columns (ties, spirals and stirrups): two in.

3. Concrete not exposed to soil, water and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells and folded plate members: one in.
 - b. Beams and columns (ties, spirals and stirrups): 1-1/2-in
- C. Coat uncoated reinforcement which will be exposed for more than 60 days after placement with a heavy coat of neat cement slurry.
- D. Do not weld reinforcing steel bars either during fabrication or erection unless indicated on the Drawings or as specified herein, or unless prior written approval has been obtained from the Engineer. Remove immediately all bars that have been welded, including tack welds, without such approval. Comply with AWS D1.4 when welding of reinforcement is shown on the Drawings, specified, or approved.
- E. Reinforcing steel interfering with the location of other reinforcing steel, piping, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Obtain the approval of the Engineer if greater displacement of bars to avoid interference is needed. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.
- F. Secure, support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- G. Do not field bend reinforcing unless indicated or specifically authorized in writing by the Engineer. Cold-bend bars indicated or authorized to be field bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. Replace, repair by cutting out damaged bars and splicing new bars using coupling sleeves filled with ferrous material, or otherwise repair damaged reinforcing bars as directed by the Engineer at no additional cost to the District. Do not bend reinforcement after it is embedded in concrete unless indicated on the Drawings.

3.02 REINFORCEMENT AROUND OPENINGS

- A. Provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by the opening unless indicated otherwise on the Drawings. Extend each end of each bar beyond the edge of the opening or penetration by the tension development length for that bar size.

3.03 SPLICING OF REINFORCEMENT

- A. Provide splices as shown on the Drawings and as specified herein.
- B. Splices Indicated as Compression Splices: Provide lap splice of 30 bar diameters, but not less than 12-in unless indicated otherwise on the Drawings. For f'_c less than 3000 psi, lap length shall be increased by one-third per ACI 318. Base the lap splice length for column vertical bars on the bar size in the column above.
- C. All Other Splices: Provide tension lap splices in compliance with ACI 318. Stagger splices in adjacent bars where possible. Provide Class B tension lap splices at all locations unless otherwise indicated.

- D. Tension Members: Avoid splicing of reinforcing steel in concrete elements indicated as "tension members." However, if splices are required for constructability, splices in the reinforcement subject to direct tension shall be butted and joined with complete penetration welds to develop, in tension, at least 125 percent of the specified yield strength of the bar. Offset splices in adjacent bars the distance of a Class B splice or 30-in, whichever is greater.
- E. Lap splices in welded wire fabric in accordance with the requirements of ACI 318 but not less than 12-in. Tie the spliced fabrics together with wire ties spaced not more than 24-in on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
- F. Mechanical reinforcing steel coupling system shall be used only where shown on the Drawings. Offset splices in adjacent bars by at least 30 bar diameters. Mechanical reinforcing steel coupling system is 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 to support the reinforcement providing the spacing and clearances indicated on the Drawings 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. Use plastic protected bar supports or steel supports with plastic tips where the reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid . Use stainless steel protected bar supports in walls, beams and elevated slabs. Use stainless steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.
- D. Provide #5 minimum size support bars. Do not reposition upper bars in a bar mat for use as support bars.
- E. 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. Notify the Engineer when the reinforcing is complete and ready for inspection, at least six working hours prior to the proposed concrete placement. Do not cover reinforcing steel with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been inspected by the Engineer and the Engineer's release to proceed with the concreting has been obtained. Keep forms open until the Engineer has completed inspection of the reinforcement.

END OF SECTION

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 complete 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. Bituminous dampproofing is included in Section 07115.
- H. Joint Sealants are included in Section 07920.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data for:
 - 1. Plastic Waterstops: Product data including sample, catalogue cut, dimensions, technical data, storage requirements, splicing methods, conformity to CRD standards, detailed drawings and samples of factory fabrications.
 - 2. Premolded joint fillers: Product data including location of use, sample, catalogue cut, technical data, storage requirements, installation instructions, and conformity to ASTM standards.
 - 3. Preformed expansion joint material: Product data including location of use, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to ASTM standards.
 - 4. Bond breaker: Product data including location of use, catalogue cut, technical data, storage requirements, and application instructions.
 - 5. Sealant: Product data including location of use, catalogue cut, technical data, storage requirements, mixing and application instructions, and conformity to ASTM standards.

6. Neoprene bearing pads: Product data including location of use, sample, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to AASHTO standards.

B. Certifications

1. Certify that all materials used within the joint system are compatible with each other.

1.04 REFERENCE STANDARDS

A. ASTM International

1. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
3. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
4. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
5. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC 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. American Association of State Highway and Transportation Officials (AASHTO)

1. Standard Specifications for Highway Bridges

D. Federal Specifications (FS)

1. FS SS-S-210A - Sealing Compound for Expansion Joints.

- 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 DELIVERY, STORAGE AND HANDLING

- A. Deliver products in original, unopened containers displaying the manufacturer's label showing manufacturer name, product identification and batch number.
- B. Store products as recommended by the manufacturer.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials used together in a given joint shall be compatible with one another. Coordinate selection of suppliers and products to provide compatibility. Do not use asphaltic bond breakers or asphaltic joint fillers in joints receiving sealant.

2.02 MATERIALS

A. Plastic Waterstops

1. Waterstops for non-expansion joints and other locations shown on the Drawings: six in. by 3/8 in. ribbed type waterstops conforming to CRD C572 and 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 1750 psi. Waterstops shall incorporate an integral fastening system, or be provided with grommets or prepunched holes between the outermost ribs at a spacing of 12 inches on center. Waterstops shall be style FR-6380 by Paul Murphy Plastics Co., Roseville, MI; style 679 by Greenstreak Plastic Products, St. Louis, MO; style R6-38 by Vinylex Corp., Knoxville, TN, or equal.
2. Factory fabrications: provide factory fabrications for all waterstop changes of direction, transitions, and intersections (vertical ells, flat ells, vertical tees, flat tees, vertical crosses, flat crosses, and special unusual or complicated intersections including intersections of waterstops of different sizes or configurations, and intersections due to joint offsets). Factory fabrications shall be made and inspected by the waterstop manufacturer. Provide stub ends of sufficient length to leave only straight butt joints for splicing in the field.

B. Premolded Joint Filler

1. Premolded Joint Filler – Structures: Self-expanding cork premolded joint filler conforming to ASTM D1752, Type III. Provide one-in. thickness unless otherwise indicated on the Drawings.

C. Bond Breaker

1. Bond Breaker Tape: Adhesive-backed glazed butyl or polyethylene tape which will adhere to the premolded joint filler or concrete surface. Provide tape the same width as the joint.
2. Bond breaker for concrete other than where tape is indicated on the Drawings or specified: Either bond breaker tape or a non-staining type bond prevention coating such as Crete-Lease Bond Breaker for Tilt-Up by Cresset Chemical Co.; Sure-Lift J-6 WB by Dayton Superior; Silcoseal Select by Nox-Crete, or equal.

D. Preformed Expansion Joint Material

1. A non-extrudable watertight strip material used to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 68 degrees F and subsequently recovering at least 20 percent of its original

thickness in the first 1/2 hour after unloading. Preformed expansion joint material shall be Physzite 380 by Chase Construction Products, Albany, NY or equal.

E. Sealant

1. Provide sealant for joints in horizontal surfaces conforming to ASTM C920, Type S or M, Grade P or NS, Class 25. Provide sealant for joints in sloping and vertical surfaces conforming to ASTM C920, Type S or M, Grade NS, Class 25. Provide Use T sealant in pedestrian and vehicular traffic areas and Use NT in non-traffic areas.
2. Provide gray colored sealants unless otherwise indicated on the Drawings, specified, or approved.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops - General

1. Install waterstops for all joints as shown on the Drawings. Provide waterstops continuous around all corners and intersections so that a continuous seal is provided.
2. Provide a minimum number of connections or splices. Replace connections or splices that do not meet the specified requirements at no additional cost to the District.
3. Secure waterstops in joints before concrete is placed.
4. Install plastic waterstops so that half of the width will be embedded on each side of the joint. Provide waterstops completely embedded in void-free concrete.
5. Terminate waterstops two in. below the exposed top of walls.
6. Protect waterstops from damage in the intervals between placing waterstops and subsequent placing of concrete. Replace damaged or punctured waterstops at no additional cost to the District.
7. Protect plastic waterstops from sunlight when they will be exposed more than 30 days between concrete placements.
8. Provide waterstops free from form release agent, bond breaker, dirt, concrete splatter, ice, mortar, paint, or any other material which could reduce or destroy bond between the waterstop and the concrete to be placed around it.

B. Plastic Waterstops

1. Only straight butt joints are allowed for field splices. Make splices on a bench. Use a power saw and guide to cut straight ends to be spliced. Heat fuse weld splices using a Teflon coated thermostatically controlled waterstop splicing iron following the manufacturer's recommendations. The finished splices shall provide a cross-section that is dense and free of porosity. Engineer may conduct destructive tests of splices by cutting along one half of the splice length and by cutting perpendicular to the splice at several

locations on the remaining half of the splice length. The right of the Engineer to make such tests shall not be construed as creating any obligation to make such tests, and not exercising this right to do so shall not relieve the Contractor from meeting the requirements of these Specifications. Completed splices shall exhibit a continuous and uniform bead of excess melted material. The welded material shall not look noticeably different from the parent material. Splices shall not show misalignment of ribs greater than 1/16-in, lack of fusion, porosity, pinholes, cracks, charred or burnt material, bubbles, or separation of cooled splice when bent by hand. If a splice displays any of these defects, reject the splice, recut back at least one in. from rejected splice on each side, and reweld.

2. Secure waterstops in wall joints before concrete is placed. If waterstop does not incorporate an integral fastening system, grommets or prepunched holes, drill holes in waterstops between the outermost ribs at each edge. Center the waterstop in the joint. Tie both edges of the waterstop to reinforcing steel with tie wire as specified for tying reinforcing steel. Secure the waterstop centered on and perpendicular to the joint and to maintain this position during concrete placement.
3. Space waterstop ties to match the spacing of the adjacent reinforcing, but ties need not be spaced closer than 12-in on center.
4. Clamp horizontal waterstops in slabs in position with the form bulkhead (unless previously set in concrete). Lift the edge of the waterstop while placing concrete below the waterstop. Manually force the waterstop against and into the placed concrete and cover with fresh concrete, to provide complete encasement of the waterstop in concrete.

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. Do not eliminate construction joints.
2. Locate additional or relocated joints 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. Unless indicated otherwise, provide joints perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings.
4. At all construction joints and at concrete joints indicated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points and side to side) of 1/4-in with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate the joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to the consistency

of very heavy paste. The surfaces shall receive a coating at least 1/8-in thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.

5. Do not use keyways in construction joints unless specifically shown on the Drawings or approved by the Engineer.

D. Partial Contraction Joints

1. Make partial contraction joints at locations shown on the Drawings. Do not eliminate or relocate partial contraction joints.
2. Provide waterstops, sealant grooves, and sealants in wall and slab partial contraction joints in liquid retaining structures and at other locations shown on the Drawings.
3. Extend every other bar of reinforcing steel through partial contraction joints or as indicated on the Drawings. Coat the concrete surface with a bond breaker prior to placing new concrete against it as shown on the Drawings. Do not coat reinforcement or waterstops with bond breaker. Mask waterstops and reinforcing passing through the joint to prevent bond breaker from running or dripping on to them. Remove masking prior to concrete placement.

E. Sealant

1. Install sealants in clean dry recesses free of frost, oil, grease, form release agent, loose material, laitance, dirt, dust and other materials which will impair bond at the locations shown on the Drawings. Apply sealant conforming to the manufacturer's recommendations including concrete cure, temperature, moisture, mixing, primer, primer cure time, joint and recess preparation, tooling, and curing. Apply masking tape to each side of the joint prior to the installation of the sealant and remove afterwards along with any spillage to leave a sealant installation with neat straight edges.

F. Preformed Expansion Joint Material

1. Install preformed expansion joint material in conformance with the manufacturer's recommendations; including surface preparation, adhesive installation, heat welding and set time.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and incidentals required and install cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the Contractor. Provide field sampling, testing, inspection and related laboratory tests.

1.02 RELATED WORK

- A. Concrete 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. Concrete finishes are included in Section 03350.
- E. Grout is included in Section 03600.
- F. Concrete electrical raceway encasement is included in Section 03800.
- G. Steel roof deck is included in Section 05321.
- H. Miscellaneous metals are included in Section 05500.
- I. Bituminous dampproofing is included in section 07115.
- J. Joint Sealants are included in Section 07920.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, product data for:
 - 1. Sources of cement, fly ash, aggregates, and batched concrete. Indicate name and address of mill or quarry, as applicable.
 - 2. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

4. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.
5. Safety Data Sheets (SDS) for all concrete components and admixtures.
6. Cold weather and hot weather concreting plans demonstrating how concrete will meet the requirements of this Section including but not limited to concrete mixes, placement, curing and protection.
7. High-range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.
8. Liquid membrane forming curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.

B. Samples

1. Fine and coarse aggregates if requested for examination by the Engineer.

C. Test Reports

1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.
2. Cement and fly ash: Conformance to ASTM standards, including chemical analysis and physical tests.
3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash. Provide either Paragraph a. or b., below, for each mix proposed.
 - a. Standard deviation data for each proposed concrete mix based on statistical records.
 - b. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:
 - 1) Date of sampling and name of testing laboratory.
 - 2) Name of concrete batch plant.
 - 3) Water cementitious ratio.
 - 4) Slump of batch.
 - 5) Air content of batch.
 - 6) Compressive strengths of all cylinders tested at that age in that batch.
 - 7) If available, temperature and unit weight of batch.
 - 8) Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.

- c. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at seven, 14, and 28 days for laboratory concrete mix designs.

D. Certifications

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certify that cement is produced by a manufacturer that does not use hazardous waste derived fuel as an energy source for its kilns.
3. Certificate of conformance for concrete production facilities from the NRMCA.
4. Certify that the Contractor is not associated with the independent testing laboratory, nor does the Contractor or its officers have a beneficial interest in the laboratory.

1.04 REFERENCE STANDARDS

A. ASTM International

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33 - Standard Specification for Concrete Aggregates.
3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
6. ASTM C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
7. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
8. ASTM C150 - Standard Specification for Portland Cement
9. ASTM C156 - Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compound for Concrete
10. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete
11. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

13. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 14. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 15. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 16. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use in Portland Cement Concrete.
 17. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
 18. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 19. ASTM C1017 - Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete.
 20. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
 21. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
 22. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
- B. American Concrete Institute (ACI).
1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
 2. ACI 232.2R - Use of Fly Ash in Concrete.
 3. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.
 4. ACI 304.2R - Placing Concrete by Pumping Methods.
 5. ACI 305R - Hot Weather Concreting.
 6. ACI 306R - Cold Weather Concreting.
 7. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
 8. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- C. National Ready Mixed Concrete Association (NRMCA)
1. Quality Control Manual, Section 3 - Certification of Ready Mixed Concrete Production Facilities.

- D. Truck Mixer Manufacturers Bureau (TMMB)
 - 1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.
- 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. Comply with ACI 318 and other stated specifications, codes and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.
- B. Use only one source of cement and aggregates for the project. Provide concrete uniform in color and appearance.
- C. At least 10 working days before the first concrete placement hold a preconstruction meeting to review the requirements for concrete placement, waterstop placement, jointing, concrete curing, hot weather concreting, cold weather concreting and finishing. Review, with the attendance of the plasticizer manufacturer, the properties and techniques of batching and placing concrete containing high-range water-reducing admixture. Notify all parties involved, including the Engineer, of the meeting at least 10 working days prior to its scheduled date. Prepare an agenda for the meeting. Take meeting minutes and distribute to all attendees.
- D. If, during the progress of the work, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. Make all changes so ordered at no additional cost to the District.
- E. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, make, at no additional cost to the District, new acceptance tests of materials and establish new concrete mixes with the assistance of an independent testing laboratory.
- F. Provide all field testing and inspection services and related laboratory tests. Methods of testing shall comply with the latest applicable ASTM methods. The following items shall be tested to verify conformity with this Section.
 - 1. Concrete placements - compressive strength (cylinders), compressive strength (cores), temperature, slump, and air content.
 - 2. Other materials that may require field testing.
- G. Provide laboratory tests of samples of constituents and of concrete as-placed. All materials incorporated in the work shall conform to accepted samples.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to prevent warehouse set.

- B. Aggregate: Arrange and use stockpiles to prevent segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.
- C. Sand: Arrange and use stockpiles to prevent contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen sand.
- D. Admixtures: Store in closed containers to prevent contamination, evaporation or damage. Provide agitating equipment to uniformly disperse ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.
- E. Fly Ash: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination.
- F. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.
- G. Liquid Membrane Forming Curing Compounds: Store in closed containers.

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. Materials shall comply with this Section and any applicable State or local requirements.
- B. Cement: Domestic portland cement conforming to ASTM C150. Do not use air entraining cements. Do not use cement produced by a manufacturer that uses hazardous waste derived fuel as an energy source for its kilns. Cement brand must be approved by the Engineer and one brand shall be used throughout the work. Provide the following type(s) of cement:
 - 1. All Concrete - Type I with the addition of fly ash resulting in C3A being below 8 percent of total cementitious content, Type II or Type III limited to 8 percent C3A.
- C. Aggregates:
 - 1. Fine Aggregate: Washed inert natural sand conforming to ASTM C33.
 - 2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C33. Grading requirements as listed in ASTM C33, Table 2 for the specified coarse aggregate size number listed in Table 1 herein. Limits of deleterious substances and physical property requirements as listed in ASTM C33, Table 3 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.

- D. Water: Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.
- E. Admixtures: Use admixtures free of chlorides and alkalis (except for those attributable to drinking water). The admixtures shall be from the same manufacturer when it is required to use more than one admixture in the same concrete mix.
 - 1. Air Entraining Admixture: Conforming to ASTM C260. Proportion and mix in accordance with manufacturer's recommendations.
 - 2. Water Reducing Admixture: Conforming to ASTM C494, Type A. Proportion and mix in accordance with manufacturer's recommendations.
 - 3. High-Range Water-Reducing Admixtures (Plasticizer): Conforming to ASTM C494, Type F resulting in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cementitious ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of two hours. Proportion and mix in accordance with manufacturer's recommendations.
 - 4. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixtures when so approved.
- F. Fly Ash: Class F fly ash complying with ASTM C618, including the requirements of Table 1 but with the Loss on Ignition (LOI) limited to three percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.
- G. Sheet Curing Materials: Waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all conforming to ASTM C171.
- H. Liquid Membrane-Forming Curing Compound. Compound conforming to ASTM C309, Type 1-D (clear or translucent with fugitive dye) and containing no wax, paraffin, or oil. Curing compounds shall be non-yellowing and have a unit moisture loss no greater than 0.039 gm/cm² at 72 hours as measured by ASTM C156. Curing compound shall comply with Federal, State and local VOC limits.

2.03 MIXES

- A. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce placeable, durable concrete conforming to these specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.
- B. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.
 - 1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents

in accordance with ACI 318 and based on the modification factors for standard deviation tests contained in ACI 318.

2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and seven, 14 and 28 day compressive strengths of concrete made using the proposed materials. Determine curves by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. The cementitious content of the concrete mixes to be used, as determined from the curve, shall correspond to the required average compressive strength in Table 5.3.2.2 of ACI 318. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 1.
- C. Test the fly ash and concrete mixture to provide test data confirming that the fly ash in combination with the cement to be used meets all strength requirements and is compatible with the other concrete additives.
 - D. Test aggregates for potential alkali reactivity in accordance with ASTM C1260. If initial testing indicates aggregates are not potentially reactive repeat test at three-month intervals.
 - E. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.
 - F. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.
 1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal specified under Paragraph 1.03.
 - G. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducing admixture (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from seven to 10-in.
 - H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

TABLE 1

Class	Design Strength	Cement	Fine Aggregate	Coarse Aggregate	Cementitious Content
	1	2	3	3	4
A	2500	Type II	Sand	57 (9)	440
B	3000	Type II	Sand	57	480
E2	4500	Type II	Sand	57	610
E3	4500	Type II	Sand	67	600

Class	W/C Ratio	Fly Ash	AE Range	WR	HRWR	Slump Range
	5	6	7	8	10	Inches
A	0.62 max.	Yes	3.5 to 5	Yes	No	1-4
B	0.54 max.	Yes	3.5 to 5	Yes	No	1-3
E2	0.42 max.	Yes	3.5 to 5	Yes	No	3-5
E3	0.42 max.	Yes	3.5 to 5	Yes	No	3-5

TABLE NOTES:

- a. Minimum compressive strength in psi at 28 days
- b. ASTM designation in ASTM C150
- c. Size Number in ASTM C33
- d. Minimum cementitious content in lbs per cubic yard (where fly ash is used cementitious content is defined as cement content plus fly ash content)
- e. W/C is Maximum Water Cementitious ratio by weight
- f. Fly ash content in the range of 20-25 percent of the total cement content plus fly ash content, by weight
- g. AE is percent air entrainment
- h. WR is water reducing admixture
- i. Except as specified in Section 03800 for concrete electrical raceway encasement
- j. HRWR is high-range water-reducing admixture

PART 3 EXECUTION

3.01 MEASURING MATERIALS

- A. Provide concrete composed of portland cement, fly ash, fine aggregate, coarse aggregate, water and admixtures as specified and produced by a plant complying with ACI 318 and ASTM C94. Batch all constituents, including admixtures, at the plant. High-range water reducing admixtures may be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Use scales last certified by the local Sealer of Weights and Measures within one year of use.
- C. Weigh cement and fly ash in individual weigh batchers that are separate and distinct from the weigh batchers used for other materials. When cement and fly ash are weighed in a cumulative weigh batcher, the cement shall be weighed first.
- D. Measure the amount of free water in fine aggregates within 0.5 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as-batched on printed batch tickets.
- E. Dispense admixtures either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.

2. Inject multiple admixtures separately during the batching sequence.

3.02 MIXING AND TRANSPORTING

- A. Provide ready-mixed concrete produced by equipment complying with ACI 318 and ASTM C94 and produced by a plant certified by the NRMCA. Do not hand-mix. All truck mixers shall carry a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.
- C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Engineer. Incorporate water directed to be added by additional mixing of at least 50 revolutions at mixing speed after the addition of all water. Meter all added water and show the amount of water added on each delivery ticket.
- D. Comply with ACI 318 and ASTM C94 for all central plant and rolling stock equipment and methods.
- E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Do not retemper (mix with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened.
- G. Handle concrete from mixer to placement providing concrete of specified quality in the placement area and not exceeding the maximum time interval specified in Paragraph 3.02 I.4. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms. Remix for a minimum of five minutes prior to discharge or testing.
- H. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.
- I. Temperature and Mixing Time Control
 1. In cold weather (see Paragraph 3.07D) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.

2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
3. In hot weather (see Paragraph 3.07E), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.
4. The maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the values shown in the following TABLE 2:

AIR OR CONCRETE TEMPERATURE (WHICHEVER IS HIGHER)	MAXIMUM TIME
(27 Degree C) 80 Degree F to 90 Degree F (32 Degree C)	45 minutes
(21 Degree C) 70 Degree F to 79 Degree F (26 Degree C)	60 minutes
(5 Degree C) 40 Degree F to 69 Degree F (20 Degree C)	90 minutes

5. If an approved high-range water-reducing admixture (plasticizer) is used to produce plasticized concrete, the maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed 90 minutes.

3.03 INSPECTION AND COORDINATION

- A. Batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Engineer at all times. Advise the Engineer of readiness to proceed at least six working hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness and tightness of formwork. Do not place concrete without the inspection and acceptance of the Engineer.

3.04 EMBEDDED ITEMS

- A. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.
- B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.
- C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
- D. Do not embed piping in concrete unless shown on the Drawings.
- E. Do not embed electrical conduits in concrete unless shown on the Drawings.

- F. Fabricate piping and conduit such that the cutting, bending, or relocation of reinforcing steel is not required. Pipes and conduits embedded within a slab or wall (other than those merely passing through) shall satisfy the following, unless otherwise shown on the Drawings or approved:
 - 1. Maximum outside dimension of pipe or conduit shall not be greater than one third the overall thickness of the slab or wall.
 - 2. Spacing of pipes or conduits shall be greater than or equal to three diameters or widths on center.
- G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.
- H. Ensure all specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure all mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.
- I. Position embedded anchor bolts using templates.
- J. Check location, alignment, and support of anchor bolts, piping, electrical conduits, and other items which will be fully or partially embedded in concrete before depositing concrete. Correct mislocated and misaligned items and secure items which have become loose before depositing concrete.
- K. Correct all embedded items not installed in the location or alignment needed or displaced by concrete placement at no additional cost to the District.

3.05 CONCRETE APPEARANCE

- A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Reject remixed concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Make, at no additional cost to the District, changes in the concrete mix design for future deliveries only by adjusting one or more of the following if the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed:
 - 1. The gradation of aggregate.
 - 2. The proportion of fine and coarse aggregate.
 - 3. The percentage of entrained air, within the allowable limits.
- B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified in Section 03350.

3.06 PLACING AND COMPACTING

A. Placing

1. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement who can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Do not place concrete on frozen subgrade, snow, or ice.
2. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Place concrete continuously at a rate that allows the concrete previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, slump will be determined at point of truck discharge and air content will be determined at point of placement.
4. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval has been obtained.
5. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained design strength.
6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar against the form. Prevent the formation of surface voids.
7. Slabs
 - a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edgeform, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.
 - b. Avoid delays in placement. If there is a delay in placement, spade and consolidate the concrete placed after the delay at the edge of the previously placed concrete to avoid cold joints. Bring concrete to correct level and strike off with a straightedge. Use bullfloats or darbies to smooth the surface, leaving it free of humps or hollows.
 - c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist to prevent cold joints.

8. Formed Concrete

- a. Place concrete in forms using tremie tubes taking care to prevent segregation. Maintain bottom of tremie tubes in contact with the concrete already placed. Do not permit concrete to drop freely more than four ft. Place concrete for walls in 12-in to 24-in lifts, keeping the surface horizontal. If a high-range water-reducing admixture is used do not permit concrete to drop freely more than 15-ft; maximum lift thickness not to exceed seven ft.

9. Bollards

- a. Conform to requirements specified above for formed concrete and completely fill pipe with concrete as indicated.

B. Compacting

1. Consolidate concrete by vibration and puddling, spading, rodding or forking so that concrete is completely worked around reinforcement, embedded items and openings and into corners of forms. Continuously perform puddling, spading, rodding and forking along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.
2. Compact all concrete with mechanical vibrators. Do not order concrete until vibrators (including standby units in working order) are on the job.
3. Use mechanical vibrators having a minimum frequency of 8000 vibrations per minute. Insert vibrators and withdraw at points from 18-in to 30-in apart. Vibrate sufficiently at each insertion to consolidate concrete, generally from five to 15 seconds. Do not over vibrate so as to segregate. Keep standby vibrators on the site during concrete placing operations.
4. Concrete Slabs: Vibration for concrete slabs less than eight in. thick shall be by vibrating screeds. Vibration for concrete slabs eight in. and thicker shall be by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.
5. Walls and Columns: Use internal vibrators (rather than form vibrators) unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down (level) the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. Insert vibrators vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Use vibrators to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:
 - a. Frequency of vibrator returns to normal.
 - b. Surface appears liquefied, flattened and glistening.
 - c. Trapped air ceases to rise.
 - d. Coarse aggregate has blended into surface, but has not disappeared.

3.07 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Curing Methods
 - 1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain a temperature of at least 50 Degrees F at the concrete surface for a minimum of seven days after placement. Use the following curing methods as specified:
 - a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit the surface of the concrete to dry out at any time during the curing period. Temperature of curing water shall be within 20 Degrees F of the concrete temperature.
 - b. Sheet Material Curing: Cover entire surface with sheet material. Anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing: Apply over the entire concrete surface except as follows. Curing compound shall NOT be placed on any concrete surface where additional concrete or grout is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Apply curing compound as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Apply in compliance with the manufacturer's recommendations.
 - 2. Specified applications of curing methods:
 - a. Slabs on Grade and Footings (not used to retain liquids): Water curing or sheet material curing or liquid membrane curing.
 - b. Structural Slabs (other than Liquid Retaining Structures): Water curing or liquid membrane curing.
 - c. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.
 - d. Formed Surfaces: None if nonabsorbent forms are left in place seven days. Water curing if absorbent forms are used. Water curing if forms are removed prior to seven days. Sheet cure or liquid membrane cure if forms are removed prior to seven days. Exposed horizontal surfaces of formed walls or columns shall be water cured for seven days or until next placement of concrete is made.
 - e. Surfaces of Concrete Joints: Water curing or sheet material curing.
- C. Protect finished surfaces and slabs from the direct rays of the sun to prevent checking and crazing.
- D. Cold Weather Concreting
 - 1. For this Specification, "cold weather" is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F.

Calculate average daily temperature as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Batch, deliver, place, cure and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.
3. Review the cold weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete and the procedures to be implemented upon abrupt changes in weather conditions or equipment failures.
4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 3
Concrete Temperatures Minimum
Dimension of Section

	<u>< 12-in</u>	<u>12 to 36-in</u>
Min. conc temp:	55 Degree F	50 Degree F

5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.
 - a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., seven days at an average 50 degrees F = 350 degree-days).
 - b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
6. Do not use salt, manure or other chemicals for protection.
7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated and air dry concrete for at least 3 days prior to first exposure to freezing temperatures.
8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

E. Hot Weather Concreting

1. For this Specification, "hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour (lb/sq ft/hr).

2. Batch, deliver, place, cure and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.
 - a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.
 - b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.02I.4. Provide vibration immediately after placement.
 - c. The Engineer may direct the Contractor to immediately cover concrete with sheet curing material.
3. Review the hot weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during hot weather including production, placement, and curing.

3.08 REMOVAL OF FORMS

- A. Do not remove forms before the concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 4	
Forms for	Degree Days
Beams and slabs	500
Walls and vertical surfaces	100

(See definition of degree-days in Paragraph 3.07D).

- B. Do not remove shores until the concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and the construction live loads upon it.
- C. In cold weather, when temperature of concrete exceeds ambient air temperature by 20 Degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

3.09 FIELD AND LABORATORY TESTS

- A. Take field control cylinder specimens during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 100 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. Specimens shall be formed in six-in. diameter by 12-in. long non-absorbent cylindrical molds.
 1. A "set" of test cylinders shall consist of five cylinders: one to be tested at seven days, one to be tested at 14 days, and two to be tested and their strengths averaged at 28 days. The fifth may be used for a special test at three days or to verify strength after 28 days if 28 day test results are low.

2. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day or 14-day strengths (where proper relation between seven, 14 and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the District.
- B. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the testing lab. Protect the specimens against injury or loss through construction operations.
 - C. Test slump immediately prior to placing the concrete. Test shall be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.
 - D. Test for air content shall be conducted on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement.

3.10 FIELD CONTROL

- A. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve the Contractor from meeting the requirements of these Specifications.
- B. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes with non-shrink grout as specified in Section 03600. The work of cutting, testing and repairing the cores will be at the expense of the Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of the District.

3.11 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1.05E. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Table 1. The cost of such additional curing shall be at no additional cost to the District. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the District. In such cases of failure to meet strength requirements the Contractor and District shall confer to determine what adjustment, if

any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in C94 is the Contractor.

- B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In cases where tests of cores fall below the values given in Table 1, the Engineer, in addition to other recourses, may require load tests on any one of the slabs, walls, beams, and columns piles, pile caps in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. All coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the District.
- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced at no additional cost to the District.

3.12 PATCHING AND REPAIRS

- A. It is the intent of these Specifications to require quality work including forming, mixture and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.
- B. As soon as the forms have been stripped and the concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- C. Immediately after removal of forms remove tie cones and metal portions of ties as specified in Section 03100. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a one to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
- D. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Do not damage or stain the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.
- E. Defective concrete and honeycombed areas: Chip down square and at least one in. deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-in wide all around the steel. For areas less than 1-1/2-in deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require

build-up in successive 1-1/2-in layers on successive days, each layer being applied (with slurry, etc.) as described above.

- F. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

<u>Material</u>	<u>Volumes</u>	<u>Weights</u>
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

- G. The Contractor may use a pre-packaged patching compound, such as: Poly-Patch by Euclid Chemical Company; Sikatop 122 Plus by Sika Chemical Corporation or equal only if approved by the Engineer for use and for color match.

3.13 SCHEDULE

- A. The following (Table 5) are the general applications for the various concrete classes and design strengths:

TABLE 5

<u>Class</u>	<u>Design Strength</u> (psi)	<u>Description</u>
A	2,500	Concrete fill, concrete fill for bollards, electrical raceway encasement and pipe encasement.
B	3,000	Where specified or noted.
E2	4,500	Structural concrete foundation mats and slabs on grade, walls, grade beams, and all other structural concrete greater than 10-in in thickness.
E3	4,500	Structural concrete 10-in or less in thickness including walls, steel roof deck, slabs on grade, elevated slab and beam systems, columns and all other structural concrete 10-in or less in thickness.

END OF SECTION

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 specified herein and as indicated on the Drawings.

1.02 RELATED WORK

- A. Concrete and finishing for walkway and pavements is included in Division 2.
- B. Concrete formwork is included in Section 03100.
- C. Patching and repair of defective and honeycombed concrete is included in Section 03300.
- D. Grout is included in Section 03600.
- E. Bituminous dampproofing is included in Section 07115.
- F. Joint Sealants are included in Section 07920.
- G. Painting, toppings and special surfaces are included in Division 9.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Concrete sealer. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations and Material Safety Data Sheet. Also submit confirmation that the sealer is compatible with additionally applied coatings.
 - 2. Chemical hardener. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations and Material Safety Data Sheet. Also submit confirmation that the hardener is compatible with sealer.

1.04 REFERENCE STANDARDS

- A. ASTM International
 - 1. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar
- 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 RESPONSIBILITY FOR CHANGING FINISHES

- A. The surface finishes specified for concrete to receive coatings or other finish materials are those required for the proper application of the products specified under other Sections. Where

products different from those specified are approved for use determine if changes in finishes are required and provide the proper finishes to receive these products.

- B. Perform changes in finishes made to accommodate products different from those specified at no additional cost to the District. Submit the proposed new finishes to the Engineer for approval.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cementitious and component materials required for finishing concrete surfaces: As specified in Section 03300.
- B. Chemical hardener: Lapidolith by BASF Building Systems; Hornolith by Tamms; Surfhard by the Euclid Chemical Co. or equal fluosilicate base material.
- C. Concrete sealer: A penetrating silicate-based liquid densifier and sealer. Euco Diamond Hard by the Euclid Chemical Company; Protocrete Densifier by Applied Concrete Technology Inc.; Sikagard 701W by Sika Corp.; or equal.
- D. Concrete sealer: "Kure-N-Seal", by BASF Building Systems or equal acrylic sealer.

PART 3 EXECUTION

3.01 FORMED SURFACES

- A. Form removal: Conform to Sections 03100 and 03300.
- B. Do not damage edges or obliterate the lines of chamfers, rustications or corners when removing the forms or doing any other work adjacent thereto.
- C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- D. Off-Form Finish
 - 1. Remove fins and other projections and fill tie cones and defects as specified in Section 03300.
- E. Rubbed Finish
 - 1. Immediately upon stripping forms and before concrete changes color, carefully remove all fins with a hammer. While the surface is still damp apply a thin coat of medium consistency neat cement slurry using bristle brushes to provide a bonding coat within all pits, air holes or blemishes in the parent concrete. Do not coat large areas of the surface with this slurry.
 - 2. Before the slurry dries or changes color, apply a dry (almost crumbly) grout consisting of one volume cement to 1-1/2 volumes of clean masonry sand having a fineness modulus of approximately 2.25 and complying with the gradation requirements of ASTM C144. Apply grout uniformly using damp (neither dripping wet nor dry) pads of coarse burlap approximately six-in. square used as a float. Scrub grout into the pits and air holes to provide a dense mortar in the imperfections to be patched.

3. Allow the mortar to partially harden for one or two hours depending upon the weather. If the air is hot and dry, keep the surface 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 perpendicular edge of a steel trowel without damaging the grout in the small pits or holes, cut off all grout that can be removed with a trowel. Grout allowed to remain on the surface too long will get too hard and will be difficult to remove.
4. Allow the surface to dry and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout should 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 grout to dry after it has been cut off with the trowel so it can be wiped off clean with the burlap.
5. On the day following the repair of pits, air holes and blemishes, the surfaces again shall 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, a built-up film remains, use a fine abrasive stone to remove all such material without breaking through the surface film of the original concrete. Scrub lightly to remove excess material without working up a lather or mortar or changing the texture of the concrete.
6. Follow the final bagging or stoning operation with a thorough wash-down with stiff bristle brushes to remove extraneous materials from the surface. Spray the surface with a fine fog spray periodically to maintain a continually damp condition for at least three days after the application of the repair grout.
7. The Rubbed Finish application may be deleted by the Engineer if the unfinished concrete surface is of superior quality and without surface voids.

3.02 FLOORS AND SLABS

- A. Consider the potential for longer setting time in concrete containing fly ash.
- B. Compact with internal vibrators as specified in Section 03300 and screed to the established grades. Provide floors and slabs level with a tolerance of 1/8-in when checked with a 12-ft straightedge, except where drains occur, in which case pitch floors to drains as indicated. Failure to meet either of above shall be cause for removal, grinding, or other correction as directed by the Engineer, at no additional cost to the District.
- C. Following screeding as specified above, float the slabs as approved by the Engineer. Continue floating operation until sufficient mortar is brought to the surface to fill all voids. Test the surfaces with a straightedge to detect high and low spots which shall be eliminated. Do not overwork the concrete as evidenced by excess water and fine material on the surface.
- D. Do not use "jitterbugs" or other special tools designed for the purpose of forcing the coarse aggregate away from the surface and allowing a layer of mortar to accumulate on any slab finish. Do not dust surfaces with dry materials. Round off all edges of slabs and tops of walls with a steel edging tool. Use steel edging tool with radius of 1/4-in for all slabs subject to wheeled traffic.

E. Measure floor flatness the day after a concrete floor is finished and before the shoring is removed, in order to eliminate any effects of shrinkage, curling and deflection. A 12-ft long straightedge shall be supported at each end with steel gauge blocks whose thickness are equal to tolerance specified. Floor surface shall not have crowns so high as to prevent 12-ft straightedge from resting on the two end blocks, nor low spots so low that a third block of twice the tolerance in thickness can pass under the supported straightedge. Compliance with the designated limits in four of five consecutive measurements will confirm compliance, unless obvious faults are observed. A check for adequate slope and drainage will also be made to confirm compliance.

F. Descriptions

1. Steel Trowel Finish. Finish by screeding and floating with straightedges to bring the surfaces to the elevations indicated. While the concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, the surface shall be wood floated to a true, even plane with no coarse aggregate visible. Apply sufficient pressure on the wood floats to bring moisture to the surface. After surface moisture has disappeared, hand steel trowel to produce a smooth, impervious surface, free from trowel marks. Trowel the surface again for the purpose of burnishing. The final troweling shall produce a ringing sound from the trowel. Do not use dry cement or additional water in troweling.
2. Wood Float Finish. Finish by screeding with straightedges to bring the surfaces to the elevations indicated. Use a wood float to compact and seal surface. Remove all laitance and leave a clean surface.
3. Light Broomed Finish. Steel trowel finish the concrete, as specified above but omit the final troweling and finish the surface by drawing a fine-hair broom lightly across the surface. Broom in the same direction and parallel to expansion joints, or in the case of inclined slabs, perpendicular to the slope, or except as directed otherwise.
4. Broomed Finish. Steel trowel finish the concrete, as specified above but omit the final troweling. While the concrete is still soft enough, finish the surface with a stiff coarse fiber broom to produce the pattern and depth of scoring as approved by the Engineer.
5. Power Machine Finish. In lieu of hand steel trowel finishing, an approved power machine for finishing concrete floors and slabs may be used in accordance with the directions of the machine manufacturer and as approved by the Engineer. Do not use a power machine until the concrete has attained the necessary set to allow finishing without introducing high and low spots in the slab. Hand steel trowel the areas of slabs not accessible to power equipment. Provide a final steel troweling done by hand over all areas.

G. Concrete Sealer

1. Prepare and seal surfaces indicated on the Drawings to receive a sealer as follows:
 - a. Finish concrete as specified in the preceding paragraphs and in accordance with the Schedule of Finishes 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 workers.

- 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. Existing Concrete: Restore surface soundness by patching, grouting, and filling cracks and holes. 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. Application: Apply sealer so as to form a continuous, uniform film by spray, soft-bristle pushbroom, long-nap roller, lambswool applicator, or ordinary garden-type sprayers.
- f. For curing only, two coats are required. 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 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. Refinish or rework unsatisfactory finishes until approved by the Engineer, at no additional cost to the District.
- C. Hardened unsatisfactory finishes will require removal, grinding, or other appropriate correction approved by the Engineer, at no additional cost to the District.

3.05 SCHEDULE OF FINISHES

- A. Finish concrete in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material under another Section. Where products different from those specified are approved for use comply with the requirements of Paragraphs 1.05A and 1.05B.
- B. Finishes to the base concrete for the following conditions shall be as scheduled below and as further specified herein:
 - 1. Exposed exterior concrete excluding slabs and walking surfaces - Rubbed finish. (Rub open tank walls above and to one ft below normal water line).
 - 2. Concrete for exterior on stairs and other horizontal areas - Broomed finish, non-slip.

3. Exposed interior concrete including underside slabs, beams and stairs and sides of openings, beams and stairs - Rubbed finish.
4. Concrete for interior walking surfaces excluding stairs – wood float finish.
5. Concrete for interior stairs and metal pan stairs - Light broomed finish, non-slip.
6. Concrete stairs, landings and platforms below normal water level in liquid retaining structures – Broomed finish, non-slip.
7. Tops of curbs and pads - Steel trowel finish.
8. Concrete on which liquids flow or are contained - Steel troweled finish.
9. Concrete not exposed in the finished work and not scheduled to receive an additional applied finish or material - Off-form finish at vertical surfaces, consolidate and screed to grade at horizontal surfaces.
10. Concrete to receive dampproofing - Off-form finish.
11. Concrete to receive capillary waterproofing - Off-form finish at vertical and overhead surfaces, light broomed finish at horizontal surfaces.
12. Concrete to receive cementitious slurry waterproofing - Off-form finish at vertical surfaces, light broomed finished horizontal surfaces.
13. Concrete to receive chemical hardener - Light broomed finish, non-slip, except at electrical rooms and areas and generator room provide wood float, non-slip.
14. Concrete to receive paint - Rubbed finish.
15. Concrete to receive floor sealer - See Paragraph 3.02G above.
16. Concrete to receive rubberized asphalt sheet membrane waterproofing - Wood float finish at horizontal surfaces, rubbed finish at vertical surfaces.
17. Concrete to receive roof insulation - Consolidate, screed and wood float to required grades.

END OF SECTION

SECTION 03390
UNDER-SLAB VAPOR RETARDERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and design and deliver under-slab vapor retarders for the Project as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Cast-In-Place Concrete is included in Section 03300.
- B. Vapor retarders installed in walls, ceilings and roof assemblies is included in Division 7.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Product Data: For each type of product indicated.
- C. Material Certificates: For under-slab vapor retarders.

1.04 REFERENCE STANDARDS

- A. ASTM International
 - 1. ASTM C 33 - Specification for Concrete Aggregates
 - 2. ASTM D 448 - Classification for Sizes of Aggregate for Road and Bridge Construction
 - 3. ASTM E 1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
 - 4. ASTM E 1745 - Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
- B. Where reference is made to one of the above or other referenced standards, the revisions in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain under-slab vapor retarders from single source and obtain admixtures from single source from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle under-slab vapor retarders to prevent bending and damage.

PART 2 PRODUCTS

2.01 UNDER-SLAB VAPOR RETARDERS

- A. Under-Slab Vapor Retarders: ASTM E 1745, Class A, except with maximum perm rating of 0.01. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
 - b. Fortifiber Building Systems Group; Moistop Ultra 15.
 - c. Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
 - d. Meadows, W. R., Inc.; Perminator 15 mil.
 - e. Raven Industries Inc.; Vapor Block 15.
 - f. Stego Industries, LLC; Stego Wrap 15 mil Class A.
 - g. Or equal.
 - 2. Thickness: Minimum 15 mils.
- B. Accessories: Seam tape and mastic materials approved in writing by the manufacturer for use with under-slab vapor retarder.
- C. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least five percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 UNDER-SLAB VAPOR RETARDERS

- A. Under-Slab Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints six inches and seal with manufacturers recommended tape.
- B. Granular Course: Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
 - 1. Place and compact a 1/2-inch-thick layer of fine-graded granular material over granular fill.

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.
- B. Perform all sampling and furnish all testing of materials and products by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.

1.02 RELATED WORK

- A. Concrete 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. Masonry grout is included in Section 04200.
- F. Miscellaneous metals are included in Section 05500.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of surface preparation, mixing and installation for:
 - 1. Commercially manufactured non-shrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.
 - 2. Commercially manufactured non-shrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.
- B. Samples
 - 1. Submit samples of commercially manufactured grout products when requested by the Engineer.
 - 2. Submit samples of aggregates proposed for use in grout mixes when requested by the Engineer.

C. Certifications

1. Certify that the Contractor is not associated with the independent testing laboratory, nor does the Contractor or its officers have a beneficial interest in the laboratory.

D. Qualifications

1. Submit documentation that grout manufacturers have a minimum of at least 10 years experience in the production and use of the grouts proposed.
2. Independent Testing Laboratory
 - a. Name and address
 - b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.
 - c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
 - d. Names and qualifications of the supervising laboratory technicians.
 - e. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by the Engineer.
 - f. Submit as required above for other organizations that will provide external technical services.

1.04 REFERENCE STANDARDS

A. ASTM International

1. ASTM C33 - Standard Specification for Concrete Aggregates
2. ASTM C150 - Standard Specification for Portland Cement
3. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes
4. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
5. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
6. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
7. ASTM E329 - Standard specification for agencies engaged in the testing and/or inspection of materials used in construction

- 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. Qualifications

1. Grout manufacturers shall have a minimum of 10 years experience in the production and use of the type of grout proposed.
2. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.

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. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.
- C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material at no additional cost to the District.
- D. Deliver non-shrink cementitious grout as a pre-portioned blend in prepackaged mixes requiring only the addition of water.
- E. Deliver non-shrink epoxy grout as a pre-proportioned, prepackaged, three component system requiring only mixing as directed by the manufacturer.

1.07 DEFINITIONS

- A. Non-shrink 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. Non-shrink Cementitious Grout

1. Non-shrink cementitious grouts: Conform to ASTM C1107. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage

compensating agents and require only the addition of water. Non-shrink 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 non-shrink cementitious grout: Conform to the standards stated above. SikaGrout 212 by Sika Corp.; Set Grout by BASF Building Systems; NS Grout by The Euclid Chemical Co.; Five Star Grout by Five Star Products, Inc., or equal.
- b. Flowable (Precision) non-shrink cementitious grout: Conform to the standards stated above. Masterflow 928 by BASF Building Systems; Hi-Flow Grout by The Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout by Five Star Products, Inc., or equal.

B. Non-shrink Epoxy Grout

1. Non-shrink epoxy grout: Grout shall be pre-proportioned, prepackaged, three component, 100 percent solids system consisting of epoxy resin, hardener and blended aggregate. It shall have a compressive strength of 10,000 psi in seven days when tested in conformity with ASTM C579 and have a maximum coefficient of thermal expansion of 30×10^{-6} in/in/degrees F when tested in conformity with ASTM C531. Masterflow 648 CP by BASF Building Systems; Five Star HP Epoxy Grout by Five Stars Products, Inc; Sikadur 42 Grout-Pak by Sika Corp.; E3-G Epoxy Grout by the Euclid Chemical Co. or equal.

C. Water

1. Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

- A. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by the Engineer.
- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, dust, grease, oil, form release agent, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other dry mechanical means to bond the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
 1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- D. Remove all loose rust, oil or other deleterious substances which may affect the bond or performance of the grout from metal embedments or bottom of baseplates prior to the installation of the grout.

- E. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of non-shrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, or flooding the surface. Upon completion of the 24 hour period, remove visible water from the surface prior to grouting.
- F. Non-shrink epoxy grouts do not require saturation of the concrete substrate. Do not wet concrete surfaces to receive non-shrink epoxy grout. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- G. Provide forms for grout. Line or coat forms with release agents recommended by the grout manufacturer. Provide forms anchored in place and shored to resist the forces imposed by the grout and its placement.
 - 1. Forms for all grout other than concrete 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 or the recommendations of the equipment manufacturer, as applicable.
- I. Support equipment 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 bond breaking coatings and removed after grouting unless otherwise approved by the Engineer. Grout voids created by the removal of shims, wedges and blocks.

3.02 INSTALLATION - GENERAL

- A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and these specifications.
- B. Provide staffing 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 base plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the grout manufacturer, whichever is longer. Do not allow 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 40 to 90 degrees F range.
- E. Install grout to 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 - NON-SHRINK 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. Do not mix by hand. Mix in a mortar mixer with moving blades. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
- C. Placements greater than 3-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. Provide forms as specified in Paragraph 3.01G. Place grout into the designated areas and prevent segregation and entrapment of air. Do not vibrate grout to release air or to consolidate the material. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. Place grout rapidly and continuously to avoid cold joints. Do not place grout 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 ordered and approved by the Engineer. Finish this surface with a wood float or 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, until grout compressive strength reaches 1000 psi or as recommended by the manufacturer, whichever is longer. Saturate the grout surface by use of saturated burlap bags, soaker hoses or ponding. Provide sunshades. 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 – NON-SHRINK EPOXY GROUTS

- A. Mix in accordance with manufacturer's recommendations. Mix full batches only, to maintain proper proportions of resin, hardener and aggregate. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Do not entrain air bubbles by mixing too quickly.
- 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 rapidly and continuously to avoid cold joints. Place grout in lifts in accordance with manufacturer's recommendations.
- D. Provide forms as specified in Paragraph 3.01G. Place grout into the designated areas and prevent entrapment of air. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. 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.

- F. 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.
- G. 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 placement, until grout compressive strength reaches 1000 psi or as recommended by the manufacturer, whichever is longer.
- H. Provide grout control joints as indicated on the Drawings.

3.05 SCHEDULE

- A. The following list indicates where the particular types of grout are to be used:
 - 1. General purpose non-shrink cementitious grout: Use at all locations where non-shrink grout is indicated on the Drawings, except for base plates greater in area than three-ft wide by three-ft long.
 - 2. Flowable (precision) non-shrink cementitious grout: Use under all base plates greater in area than three-ft wide by three-ft long. Use at all locations indicated on the Drawings to receive flowable non-shrink grout. Flowable (precision), non-shrink, cementitious grout may be substituted for general purpose non-shrink cementitious grout.
 - 3. Non-shrink epoxy grout: Use at all locations specifically indicated on the Drawings to receive non-shrink epoxy grout.

END OF SECTION

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SECTION 03800
CONCRETE ELECTRICAL RACEWAY ENCASEMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install concrete encasement around underground electrical raceways as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Excavation, backfilling, fill and grading are included in Division 2.
- B. Concrete formwork is included in Section 03100.
- C. Concrete joints and joint accessories are included in Section 03250.
- D. Cast in place concrete is included in Section 03300.
- E. Furnishing and installing electrical conduit is included in Division 16.
- F. Furnishing and placing polyethylene warning tape in the backfill above encasement is included in Division 16.

PART 2 PRODUCTS

2.01 MATERIALS

- A. 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 2500 psi.

PART 3 EXECUTION

3.01 GENERAL

- A. Concrete shall conform to the requirements Section 03300 and as specified herein.
- B. Provide not less than four in. of concrete between the outside of a raceway and the earth. Provide not less than two in. of concrete between adjacent raceways. Form as specified in Section 03100 for buried concrete.
- C. All raceway concrete placements shall be continuous between manholes or handholes and between manholes or handholes and structures.
- D. Where raceways pass through concrete walls, concrete encasement shall be extended through the finished structure flush with inside surfaces. Watertight construction joints with waterstops conforming to Section 03250 shall be provided.
- E. Encasements shall be reinforced as and where indicated on the Drawings.

- F. Encasements shall be laid in trenches on mats of screened gravel not less than six in. thick.
- G. The minimum cover for raceway banks shall be 24-in.

END OF SECTION

SECTION 04200
UNIT MASONRY

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install unit masonry complete as shown on the Drawings and as specified herein.
 - 1. Concrete masonry units (CMUs).
 - 2. Decorative concrete masonry units.
 - 3. Mortar and grout.
 - 4. Masonry joint reinforcement.
 - 5. Ties and anchors.
 - 6. Embedded flashing.
 - 7. Miscellaneous masonry accessories.
 - 8. Cavity-wall insulation.

1.02 RELATED WORK

- A. Reinforcing steel is included in Section 03301
- B. Steel lintels and shelf angles are included in Section 05500.
- C. Dampproofing applied to cavity face of backup wythes of cavity walls is included in Section 07115.
- D. Sealing control and expansion joints in unit masonry Section 07920.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, detailed information on materials proposed and installation methods.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

- D. Samples: For the following:
1. Decorative concrete masonry units, in the form of small-scale units.
 2. Weep holes/vents.
 3. Accessories embedded in masonry.
- E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Engineer and approved in writing.
- F. Qualification Data: For testing agency.
- G. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
1. Masonry units.
 - a. Include data on material properties.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 2. Cementitious materials. Include brand, type, and name of manufacturer.
 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 4. Grout mixes. Include description of type and proportions of ingredients.
 5. Joint reinforcement.
 6. Anchors, ties, and metal accessories.
- H. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
 2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

- I. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- J. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.04 REFERENCES

- A. American Concrete Institute/American Concrete Institute
 - 1. ACI 315 - Details and Detailing of Concrete Reinforcement
- B. American Concrete Institute/American Concrete Institute; American Society of Civil Engineers; and The Masonry Society
 - 1. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures
- C. ASTM International
 - 1. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 2. ASTM A 240/A 240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 3. ASTM A 276 - Specification for Stainless Steel Bars and Shapes
 - 4. ASTM A 580/A 580M - Specification for Stainless Steel Wire
 - 5. ASTM A 641/A 641M - Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
 - 6. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
 - 7. ASTM A 666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
 - 8. ASTM A 951/A 951M - Specification for Masonry Joint Reinforcement
 - 9. ASTM A 996/A 996M - Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
 - 10. ASTM A 1008/A 1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
 - 11. ASTM B 32 - Specification for Solder Metal
 - 12. ASTM B 370 - Specification for Copper Sheet and Strip for Building Construction

13. ASTM C 90 - Specification for Loadbearing Concrete Masonry Units
14. ASTM C 140 - Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
15. ASTM C 143/C 143M - Test Method for Slump of Hydraulic Cement Concrete
16. ASTM C 144 - Specification for Aggregate for Masonry Mortar
17. ASTM C 150 - Specification for Portland Cement
18. ASTM C 199 - Test Method for Pier Test for Refractory Mortars
19. ASTM C 207 - Specification for Hydrated Lime for Masonry Purposes
20. ASTM C 270 - Specification for Mortar for Unit Masonry
21. ASTM C 404 - Specification for Aggregates for Masonry Grout
22. ASTM C 476 - Specification for Grout for Masonry
23. ASTM C 494/C 494M - Specification for Chemical Admixtures for Concrete
24. ASTM C 578 - Specification for Rigid, Cellular Polystyrene Thermal Insulation
25. ASTM C 744 - Specification for Prefaced Concrete and Calcium Silicate Masonry Units
26. ASTM C 780 - Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
27. ASTM C 920 - Specification for Elastomeric Joint Sealants
28. ASTM C 1019 - Test Method for Sampling and Testing Grout
29. ASTM C 1093 - Practice for Accreditation of Testing Agencies for Unit Masonry
30. ASTM C 1289 - Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
31. ASTM C 1314 - Test Method for Compressive Strength of Masonry Prisms
32. ASTM C 1329 - Specification for Mortar Cement
33. ASTM C 1506 - Test Method for Water Retention of Hydraulic Cement-Based Mortars and Plasters
34. ASTM E 514 - Test Method for Water Penetration and Leakage Through Masonry

D. National Concrete Masonry Association

1. NCMA TEK 8-4A - Removal of Stains from Concrete Masonry Walls

E. Sheet Metal and Air Conditioning Contractors' National Association

1. Architectural Sheet Metal Manual.

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

1.05 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.
- B. CMU(s): Concrete masonry unit(s).

1.06 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths ($f'm$) at 28 days.
- B. Determine net-area compressive strength ($f'm$) of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
 1. For concrete masonry unit construction: $f'm = 1500$ psi.

1.07 QUALITY ASSURANCE

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.09 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.
 - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 PRODUCTS

2.01 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.02 CONCRETE MASONRY UNITS (CMUS)

1. CMU shall conform to ASTM C90, normal weight, hollow, load bearing units of 12-in by 8-in by 16-in nominal size and 8-in by 8-in by 16-in nominal size (parapet).
 2. CMU shall be free from substances that will cause staining or pop-outs and shall be fine, even texture with straight and true edges. All units shall be air cured in covered storage for not less than 28 days before delivery.
 3. Minimum compressive strength on the net area (average of three units) when tested in accordance with ASTM C140 shall be 2000 psi on the net area resulting in a minimum fm' of 1500 psi. Minimum compressive strength of any individual unit shall be not less than 90 percent of the required three-unit average.
 4. Water absorption shall not exceed 10 lb/cu ft (average of three units) when tested in accordance with ASTM C140.
 5. Moisture content at time of delivery to job site shall not exceed 35 percent of total absorption.
 6. No overall dimension (width, height, or length) shall differ by more than 1/16-in from the specified standard dimension.
 7. Oven dry weight of the concrete shall not be less than 125 lbs/cu ft.
 8. Units shall be obtained from one Manufacturer to ensure even color and texture.
 9. Provide special units required by the Drawings, including but not necessarily limited to solid, corner, pilaster, bond beam, lintel, and jamb units.
- B. Shapes: Provide shapes indicated and as follows:
 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners, unless otherwise indicated.

C. Integral Water Repellent: Provide units made with integral water repellent for exposed units .

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.
 - a. Products:
 - 1) ACM Chemistries; RainBloc.
 - 2) BASF Aktiengesellschaft; Rheapel Plus.
 - 3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.
 - 4) Or equal.

D. Split-Face Concrete Masonry Units (SFCMU)

1. SFCMU shall conform to ASTM C90, normal weight, hollow, non-load-bearing units of eight-in by four-in by 16-in nominal size.
2. Minimum compressive strength on the net area (average of three units) when tested in accordance with ASTM C140 shall be 1900 psi on the net area resulting in a minimum f_m' of 1500 psi. Minimum compressive strength of any individual unit shall be not less than 80 percent of the required three-unit average.
3. Water absorption shall not exceed 10 pounds per cubic foot (average of three units) when tested in accordance with ASTM C140.
4. Moisture content at time of delivery to job site shall not exceed 35 percent of total absorption.
5. No overall dimension (width, height, or length) shall differ by more than 1/16-in from the specified standard dimension, except that dimensions measured to a splitface or end shall not be held to this tolerance.
6. Oven dry weight of the concrete shall not be less than 130 lbs/cu ft.
7. Provide all internal corner units, external corner units (split face - both outside planes), solid units (split face on face-of-wall plane only) and other special units as shown or required. Saw cut units as required to provide special cut units required.
8. Units shall be colored with integrally mixed, alkali-stable, lightfast, weather-resistant pigment. Color shall be maintained uniformly throughout the job within the normal manufacturing tolerances.
 - a. Color to be selected from manufacturer's full range of colors.
9. Provide a list of not less than three projects utilizing integrally-colored units manufactured by the same supplier.
10. Include Integral water repellent as specified below.

E. Ground face concrete masonry units (GFCMU)

1. GFCMU shall be steam cured, ground face, hollow, non-load-bearing concrete masonry architectural facing units conforming to ASTM C90 and as approved. Sizes shall be eight-in by four-in by 16-in nominal size.
2. Minimum compressive strength on the net area (average of three units) when tested in accordance with ASTM C140 shall be 1900 psi on the net area resulting in a minimum fm' of 1500 psi. Minimum compressive strength of any individual unit shall be not less than 80 percent of the required three-unit average.
3. Cementitious and pozzolanic (or siliceous) materials, admixtures and normal weight aggregates shall conform to pertinent ASTM standards and shall be suitable for use in autoclaved concrete.
4. Masonry units conforming to the requirements specified herein shall be cured in a saturated steam atmosphere at an average temperature exceeding 350 degrees F for a period of time sufficient to assure that the units will meet the requirements for drying shrinkage of 0.03 percent per ASTM C426.
5. Color, surface texture and aggregate exposure shall be uniform within the normal range established by agreement between manufacturer and purchaser and as represented by the sample wall panel, erected at the job site.
 - a. Color to be selected from manufacturer's full range of colors.
6. All exposed faces of unit shall be treated with silicone applied under pressure, by the manufacturer, prior to shipment, to impart resistance to staining from masonry mortar during erection.
7. All ground face masonry units shall be sound and free of cracks or other defects that would interfere with the proper placing of the units or impair the strength or permanence of the construction.
8. Minor cracks or defects incidental to the usual method of manufacture, or minor chipping resulting from customary methods of handling in shipment and delivery may be grounds for rejection as determined by the Engineer. Units, which contain chips larger than 1/4-in in faces or in any edge or corner on the faces, will be rejected. Units showing unacceptable colors of aggregate or other defects unacceptable to the Engineer will be rejected also.
9. Include Integral water repellant as specified below.

F. Insulation for cavity walls shall be extruded closed cell polystyrene foam board with integral high-density skins of the same material. Thicknesses shall be as shown. Insulation shall have a K factor of 0.20 at 75 degrees F and 0.18 at 40 degrees F. Density shall be 2.1 lbs/cu ft with a compressive strength of 25 psi. Water absorption shall be 0.1 percent with a water vapor transmission of 0.6 perm-in.

G. Provide Karnak 920, Sonneborn 700, Meadows Trowel Mastic (Type 3) or equal fibrated, asbestos-free asphalt emulsion compatible with insulation for adhering the foam board insulation to backup material and for covering steel encasing in masonry. Emulsion shall be non-bleeding when set.

- H. Precast lintels shall be minimum 6,000 psi concrete with reinforcing placed all as shown.
- I. Integral water repellent shall be Dry-Block Block Admixture, a liquid polymeric admixture resistant to water penetration to achieve a Class E rating in accordance with ASTM E514-74 by W. R. Grace & Co.-Conn or approved equal.

2.03 CONCRETE LINTELS

- A. General: Provide precast concrete lintels as shown on the Drawings.

2.04 MORTAR AND GROUT MATERIALS

- A. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S.
- B. Colored mortar shall be pre-blended, containing portland cement, lime, dried masonry sand and color pigment. Mortar shall be colored to match the existing buildings' mortar color at SFCMU and GFCMU respectively. Where the two block types meet, the mortar bed separating the two shall be the color of the GFCMU.
- C. Colored Cement Product: Packaged blend made from portland cement and lime and mortar pigments, all complying with specified requirements, and containing no other ingredients. Do not use mortar cement or masonry cement in blend.
 - 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 - 2. Pigments shall not exceed 10 percent of portland cement by weight.
 - 3. Pigments shall not exceed five percent of masonry cement or mortar cement by weight.
 - 4. Products: Colored Portland Cement-Lime Mix: Provide one of the following:
 - a. Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
 - b. Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
 - c. Lafarge North America Inc.; Eaglebond.
 - d. Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
 - e. Or equal.
- D. Aggregate for Mortar: ASTM C 144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4-inch-thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

- E. Aggregate for Grout: ASTM C 404.
- F. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 - 1. Products:
 - a. Euclid Chemical Company (The); Accelguard 80.
 - b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.
 - d. Or equal.
- G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
 - 1. Products:
 - a. ACM Chemistries; RainBloc for Mortar.
 - b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
 - c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - d. Or equal.
- H. Water: Potable.

2.05 REINFORCEMENT

A. Joint Reinforcement

- 1. Reinforcement for masonry joints shall be welded wire units prefabricated in straight lengths of not less than 10-ft with matching corner and tee units fabricated from cold-drawn steel wire complying with ASTM A82, with deformed continuous side rods and plain cross-rods, butt welded to side rods and a unit width of 1-5/8-in less than thickness of wall or partition. Units shall be galvanized after fabrication conforming to ASTM A153, Class B-2, 1.5 oz/sq ft.
- 2. Reinforcement shall be ladder or truss type (as approved), fabricated with single pair of galvanized nine gauge side rods and continuous nine gauge straight cross-rods spaced not more than 16-in o.c.
- 3. Reinforcement shall be manufactured by Dur-O-Wal; Hohmann and Barnard; AA Wire Products or equal.

- B. Compressible filler for use in conjunction with masonry shall be three-lb density, unfaced, semi-rigid, asphalt and tar free fiberglass strips. Thickness shall be 3/8-in or as otherwise shown by width required for joint and wall conditions.

2.06 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

2.07 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick.
 2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
 3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at three-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.
 - a. Products:
 - 1) Cheney Flashing Company; Cheney Flashing (Dovetail) or Cheney 3-Way Flashing (Sawtooth).
 - 2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.
 - 3) Sandell Manufacturing Co., Inc.; Mechanically Keyed Flashing
 - 4) Or equal.
 4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
 5. Fabricate through-wall flashing with drip edge , unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
 6. Fabricate through-wall flashing with sealant stop , unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
 7. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least three inches (76 mm) into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.
 8. Metal Drip Edges: Fabricate from stainless steel. Extend at least three inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
 9. Metal Flashing Terminations: Fabricate from stainless steel. Extend at least three inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (six mm) to form a stop for retaining sealant backer rod.
 10. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

- B. Flexible Flashing: For flashing not exposed to the exterior, use one of the following, unless otherwise indicated:
1. Copper-Laminated Flashing: Seven-oz./sq. ft. (two-kg/sq. m) copper sheet bonded with asphalt between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. Products: Provide one of the following:
 - 1) Advanced Building Products Inc.; Copper Fabric Flashing.
 - 2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
 - 3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
 - 4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
 - 5) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
 - 6) York Manufacturing, Inc.; Multi-Flash 500.
 - 7) Or equal.
- C. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to receive counterflashing, use metal flashing.
 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.
 4. Where flashing is fully concealed, use metal flashing or flexible flashing.
- D. Solder and Sealants for Sheet Metal Flashings:
1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
 2. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
 3. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.08 MISCELLANEOUS MASONRY ACCESSORIES

- A. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

- B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- C. Weep/Vent Products: Use the following, unless otherwise indicated:
 - 1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
- D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Provide one of the following configurations:
 - a. Sheets or strips not less than one inch (25 mm) thick and installed to full height of cavity with additional strips 4 inches high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.
 - 2. Products:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. Archovations, Inc.; CavClear Masonry Mat.
 - c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
 - d. Mortar Net USA, Ltd.; Mortar Net.
 - e. Or equal.
- E. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.
 - 1. Products:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
 - b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
 - c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
 - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.
 - e. Or equal.

2.09 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 1. Manufacturers:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

d. Or equal.

2.10 MORTAR AND GROUT MIXES

- A. Ingredients shall be accurately measured by volume in boxes especially constructed for the purpose. Measurement by shovel will not be allowed. Measure materials in a damp, loose condition.
- B. Portland cement mortar shall conform to ASTM C270, Type S. Provide test data as required to substantiate strength requirements of 1,800 psi at 28 days.
- C. Colored mortar shall be pre-blended, containing portland cement, lime, dried masonry sand and color pigment. Mortar shall be colored to match the SFCMU and GFCMU respectively. Where the two block types meet, the mortar bed separating the two shall be the color of the GFCMU.
- D. Grout for constructing CMU lintel blocks and for grouting cores to receive embedded anchors or reinforcing shall conform to ASTM C476, Fine Grout, proportioned by volume: one part portland cement, 0 to 1/10 part lime and sand equal to 2-1/4 to three times the sum of the volumes of cement and lime materials. Strength shall be 2,500 psi minimum at 28 days. Mix grout to have a slump of 10-in plus or minus one-in., at time of placement.
- E. Nonshrink grout where required shall be mixed as recommended by the Manufacturer to give the necessary consistency for placing and to give a minimum compressive strength of 3,000-lb/sq in three days.
- F. All other grout shall be one part portland cement, one part sand.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

3.03 TOLERANCES

A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (six mm).
- 2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
- 3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (six mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (six mm in three m), or 1/2 inch (12 mm) maximum.
- 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (three mm in three m), 1/4 inch in 20 feet (six mm in six m), or 1/2 inch (12 mm) maximum.
- 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (six mm in three m), 3/8 inch in 20 feet (nine mm in six m), or 1/2 inch (12 mm) maximum.
- 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (three mm in three m), 1/4 inch in 20 feet (six mm in six m), or 1/2 inch (12 mm) maximum.
- 5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (six mm in three m), 3/8 inch in 20 feet (nine mm in six m), or 1/2 inch (12 mm) maximum.
- 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (six mm in three m), or 1/2 inch (12 mm) maximum.

7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (three mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (three mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (three mm). [Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (three mm).]
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.04 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal four-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than four inches (100-mm)]. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal four-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. All CMU shall be laid in a full bed of mortar, applied to shells only. Butter the vertical joint of unit already set in the wall and all contact faces of the unit to be set. Each unit shall be placed and shoved against the unit previously laid so as to produce a well-compacted vertical mortar joint for the full shell thickness. Units shall set with all cells in a vertical position. The moisture content of the units when laid shall not exceed 35 percent of the total absorption as determined by laboratory test.
 1. Lay units using the best concrete masonry practices. Install only quality units; reject all defective units as defined by ASTM C90. Lay blocks with the faces level, plumb and true to the line strung horizontally at the ground face. Units shall have uniform, 3/8"-wide joints both horizontally and vertically on the finished side of the wall. Tool joints neatly after they are finger-hard to make them straight and uniform. Size and place cut pieces

appropriately to maintain consistency and bond. Complete masonry construction using procedures and workmanship consistent with the best masonry practices.

E. Laying SFCMU and GFCMU:

1. Draw blocks from more than one pallet at a time during installation. All exterior mortar shall include CMU manufacturer approved matching water-repellent additive added to each batch in the appropriate dosage rates for mortar type per manufacturer's instructions. Refer to NCMA TEK Notes for Hot and Cold weather construction practices.

F. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, before laying fresh masonry.

G. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

H. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.

I. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

J. Fill cores in hollow concrete masonry units with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

K. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c., unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.05 MORTAR BEDDING AND JOINTING

A. Lay hollow concrete masonry units as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.

4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

3.06 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. (0.25 sq. m) of wall area spaced not to exceed 24 inches (610 mm) o.c. horizontally and 16 inches (406 mm) o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches (305 mm) of openings and space not more than 36 inches (915 mm) apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches (610 mm) o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.
 - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type ties to allow for differential movement regardless of whether bed joints align.
2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
 - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
3. Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not over three inches (76 mm) into each wythe. Space headers not over eight inches (203 mm) clear horizontally and 16 inches (406 mm) clear vertically.
4. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Bond wythes of cavity walls together using bonding system indicated on Drawings.

C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

D. Parge cavity face of backup wythe in a single coat approximately 3/8-inch-thick (10 mm). Trowel face of parge coat smooth.

E. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches (300 mm) o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.07 MASONRY-CELL INSULATION

- A. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.08 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 1. Space reinforcement not more than 16 inches (406 mm) o.c.
 2. Space reinforcement not more than eight inches (203 mm) o.c. in foundation walls and parapet walls.
 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, pipe enclosures, and other special conditions.

3.09 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to concrete and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
 1. Fasten screw-attached and seismic anchors to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Embed tie sections in masonry joints. Provide not less than two inches (50 mm) of air space between back of masonry veneer and face of sheathing.
 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 4. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally with not less than one anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

3.10 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
 - 1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.
- C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod, but not less than 3/8 inch (10 mm).
 - 1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 LINTELS

- A. Install steel lintels where indicated.
- B. Provide precast concrete lintels where shown and where openings of more than 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of eight inches (200 mm) at each jamb, unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of eight inches (200 mm), and through inner wythe to within 1/2 inch (13 mm) of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately two inches (50 mm) on interior face.
 3. At lintels and shelf angles, extend flashing a minimum of six inches (150 mm) into masonry at each end. At heads and sills, extend flashing six inches (150 mm) at ends and turn up not less than two inches (50 mm) to form end dams.
 4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant for application indicated.
 5. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant for application indicated.
 6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
 7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
 8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Space weep holes 24 inches (600 mm) o.c., unless otherwise indicated.
 3. Space weep holes formed from plastic tubing or wicking material 16 inches o.c.
 4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 5. Trim wicking material flush with outside face of wall after mortar has set.

- F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than two inches (50 mm), to maintain drainage.
 - 1. Fill cavities full height by placing pea gravel in cavities as masonry is laid so that at any point masonry does not extend more than 24 inches (600 mm) above top of pea gravel.
- G. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
- H. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
 - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.13 FIELD QUALITY CONTROL

- A. Testing and Inspecting: District will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Level 1 special inspections according to the "International Building Code."
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.14 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

END OF SECTION

SECTION 05210
STEEL JOISTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals and install steel joists, bridging, and accessories complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Composite steel roof deck is included in Section 05321.
- B. Miscellaneous metal is included in Section 05500.
- C. Bearing plates are furnished under Section 05500 and installed under Section 04200.
- D. Shop painting is included in Section 09901.
- E. Field painting, except as specified herein, is included in Section 09902.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, design calculations for special joists, shop drawings and product data, showing:
 - 1. Location and size of all joists, bridging (including erection bridging), and accessories.
 - 2. Materials and details of construction of all members, including camber.
 - 3. Details of installation of all members.
 - 4. Size and length of all field welds to supports.
 - 5. Erection marks. Mark each field piece to correspond to the shop drawings.
 - 6. Uniform, concentrated and varying loads used to design the special joists indicated on the Drawings.
 - 7. Product data for shop primer. Certify compatibility with additional coatings specified in Sections 09901 and 09902.
- B. Certificates
 - 1. Certification from the Steel Joist Institute showing that the manufacturer's products conform to the Institute's standards and load tables for the type of member provided.
 - 2. Certification for welders.

C. Weld Procedure Qualifications

1. Written Welding Procedure Specifications (WPS's) in accordance with AWS D1.1 for each different welded joint proposed for use whether prequalified or qualified by testing. WPS's shall identify actual electrodes to be used, not just electrode classification.
2. Electrode manufacturer's data for actual electrodes proposed. Data shall include manufacturer's recommended welding parameters for each electrode to be used.

1.04 REFERENCE STANDARDS

A. Steel Joist Institute (SJI)

1. Standard Specifications for Open Web Steel Joists, K-Series.
2. Standard Specifications for Longspan Steel Joists, LH-Series.

B. ASTM International

1. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
2. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

C. American Welding Society (AWS)

1. AWS D1.1 - Structural Welding Code - Steel.

D. Steel Structures Painting Council (SSPC):

1. SSPC-Paint 15 - Paint Specification No. 15 Steel Joist Shop Paint.

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. Steel joists, bridging and accessories shall be fabricated in accordance with the standards of the Steel Joist Institute by a manufacturer certified by the Steel Joist Institute. Steel joists shall be of welded construction and top and bottom chords shall be constructed of hot rolled shapes. Rods, reinforcing bars, or cold formed shapes will not be allowed for top and bottom chords.

B. Field welding shall be done by certified welders in accordance with AWS D1.1.

1. Qualify welders in accordance with AWS D1.1 for each process and joint configuration.
2. WPSs for each joint type shall indicate proper AWS qualification and be available where welding is performed.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Handle material with cranes and derricks. Do not dump material off cars or trucks, or handle in any way likely to cause damage.
- B. Store material on skids and not on the ground. Pile and block stored material to prevent bending or other damage.
- C. Materials with excessive damage, in the opinion of the Engineer, shall not be incorporated in the work. Remove and replace them with new undamaged materials at no additional cost to the District.

1.07 PROJECT/SITE REQUIREMENTS

- A. Verify at the site both the dimensions and work of other trades adjoining the work of this Section before installation of the items specified.
- B. Coordinate locations of openings and weight of equipment mounted on steel joists.
- C. Provide steel framing around openings and miscellaneous steel as required to erect the joists.
- D. Provide additional web members at all concentrated loads not occurring at panel points.
- E. See Drawings for loads applied to special joists. Locations and loads shown on the Drawings for equipment and appurtenances supported by special joists are approximate. Coordinate with the manufacturer(s) of the approved equipment and appurtenances to obtain the actual locations and operating loads for the design of special joists. Design joists using load combinations prescribed in the design code specified on the Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Open web steel joists shall conform to SJI Standard for Open Web Steel Joists, K-Series, size and location as shown on the Drawings.
- B. Longspan steel joists shall conform to SJI Standard for Longspan Steel Joists, LH-Series, size and location as shown on the Drawings.
- C. Provide top chord extensions, extended ends, bottom chord extensions, sloped bearings where shown on the Drawings.
- D. Bridging
 - 1. Provide diagonal and horizontal bridging designed and installed in compliance with the requirements of the SJI Standard Specifications for the particular series used.
 - 2. Connect all bridging to end walls unless otherwise shown on the Drawings.
 - 3. Provide bridging as required to adequately brace bottom chords against lateral movement under a net uplift pressure indicated on the Drawings.

4. In no case shall the spacing between rows of bridging exceed that noted in the SJI Standard Specifications. Spacing between rows of bridging shall be approximately equal.

E. High strength steel bolts shall conform to ASTM A325 and shall be mechanically galvanized in accordance with ASTM B695, Class 50, Type II.

2.02 FINISHES

A. Apply shop primer in accordance with SSPC Paint Specification No.15.

2.03 SURFACE PREPARATION AND SHOP COATINGS PAINTING

A. Prepare surfaces and apply shop paint in accordance with Section 09901.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install steel joists in accordance with the SJI Standard Specifications, approved shop drawings and the Drawings. Weld or bolt joists to supports as shown on the Drawings.

B. Weld or bolt bridging to joists as shown on the Drawings. Bridging and bridging anchors shall be completely installed before construction loads are placed on the steel joists.

C. Do not attach supports or braces for equipment, piping, conduits, ductwork, or other utilities to steel joists, bridging, or accessories unless the steel joists have been designed and fabricated to support all loads due to the equipment, piping, conduits, ductwork, or other utilities.

3.02 FIELD PAINTING

A. Field Painting

1. After erection, prepare shop primed surfaces as approved and touch-up all steel surfaces which have become abraded or where paint has been omitted or removed due to welding or other erection procedure with the shop primer used.

3.03 INSPECTION

A. The Engineer reserves the right to inspect joists, bridging, and accessories in the field for compliance with the Steel Joist Institute standards, this section and the approved shop drawings. The Engineer may reject or require repair or re-fabrication of any joists, bridging or accessories not meeting these requirements.

END OF SECTION

SECTION 05321
COMPOSITE STEEL ROOF DECK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install composite steel roof deck complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Cast-in-place concrete is included in Section 03300.
- B. Steel joists are included in Section 05210.
- C. Miscellaneous metal is included in Section 05500.
- D. Field painting is included in Section 09902.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data showing the following:
 - 1. Location and size of all members.
 - 2. Materials, finishes and details of construction of all members.
 - 3. Manufacturer's load table including design thickness in inches and section properties.
 - 4. Fastener types and layout patterns.
 - 5. Erection marks. Mark each bundle to correspond to the shop drawings.

- B. Certification for Welders

1.04 REFERENCE STANDARDS

- A. Steel Deck Institute (SDI)
 - 1. SDI Specifications and Commentary for Composite Steel Floor Deck.
- B. ASTM International
 - 1. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

3. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

C. American Iron and Steel Institute (AISI)

1. AISI SG-673 - Cold-Formed Steel Design Manual.

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

1.05 QUALITY ASSURANCE

- A. Composite steel roof deck: Conform to the requirements of the SDI Standard Specifications for Composite Steel Floor Deck.
- B. Field welding: Shall be performed by certified welders and in accordance with the AISI SG-673 standard. Certification shall be by test within the past six months to perform type of work required in conformance with the AISI Specification. Testing to be conducted and witnessed by an independent testing laboratory provided by the Contractor.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Handle material with cranes and derricks. Do not dump materials off cars or trucks, or handle in any way that will cause damage.
- B. Store materials off the ground with one end elevated to provide drainage. Protect from the elements with a waterproof covering, ventilated to avoid condensation.
- C. Remove and replace damaged material with new undamaged materials.

1.07 PROJECT/SITE REQUIREMENTS

- A. Notify the Engineer of any inaccuracies in alignment or level of structural steel in writing and correct before the deck is placed at no additional cost to the District.

1.08 DEFINITIONS

- A. Transverse supports - supports which are perpendicular to the direction of the deck ribs.
- B. Longitudinal support - supports which are parallel to the direction of the deck ribs.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Composite Steel Roof Deck and Accessories
1. Composite steel roof deck shall be 1.5 VL by Nucor Corporation-Vulcraft Division; or approved equal. For a proposed deck to be considered equal, the deck gauge, fastening pattern to supports, and side lap connections shall be sufficient to provide diaphragm shears greater than or equal to those published in ICC Evaluation Report 1227 for the deck specified using the same spans, welding pattern, and type and spacing of side lap

connections shown on the Drawings. An ICC Evaluation Report will be required to substantiate all values. Deck sheets shall be 36-in wide with nestable side laps. Gauge shall be as shown on the Drawings.

2. Composite steel roof deck and accessories shall be galvanized in accordance with ASTM A653, coating designation G90.
 3. Composite steel roof deck and accessories shall be manufactured from steel conforming to ASTM A653 SQ, Grade 33, 40 or 80.
 4. Accessories: Provide minimum 20 gauge galvanized cell closures, flat closure plates, girder fillers, column closures and pour stops as shown on the Drawings and as specified herein.
 5. Support fasteners shall be as indicated on drawings for the composite roof deck.
- B. Screws shall be self-drilling, self-tapping hex washer head No. 10 TEKS screws with corrosion resistant coating.
- C. Provide galvanize touch-up to repair damaged surfaces. Use Endupor, zinc-rich coating by Dampney Manufacturing Co., Everett, MA; ZiRP, zinc-rich coating by Duncan Galvanizing Corp, Everett, MA; ZRC Cold Galvanizing Compound by ZRC Chemical Products Co., Division of Norfolk Corp., Quincy, MA, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install composite steel roof deck as shown on the Drawings, in accordance with manufacturer's instructions and in accordance with approved shop drawings. Extend deck sheets over three or more spans.
- B. End laps of composite steel roof deck shall be at least two in. long and shall occur over transverse supporting members. End bearing length of composite steel roof deck shall be at least two in.
- C. Provide temporary shoring for composite steel roof deck in accordance with the SDI Specifications and the manufacturer's written instructions.
- D. Fasten deck to all supporting steel to accommodate diaphragm action as specified below:
1. Fasten steel roof deck to all interior and exterior transverse supports and at side laps and longitudinal supports. Deck fasteners and fastener spacings shall be as indicated on the design drawings.
 2. Fasten at interior and end transverse supports with support fasteners noted on design drawings at the bottom of every rib at each support and at a spacing not to exceed six in. with one fastener always occurring at the side laps. Fasten partial sheets (those less than 36-in wide) at the bottom of every rib.

3. Connect the deck sheets along their side laps with fasteners and fastener spacings per the design drawings. Maintain contact between deck sheets and between deck sheets and steel supports while fastening composite steel roof deck to eliminate eccentricities between the connected parts.
- E. Install fasteners using tools that prevent fracturing screws or pins, damaging screw heads or stripping threads due to overdriving.
- F. Install another fastener adjacent to fractured or stripped fasteners. Remove fasteners where eccentricities exist between deck sheets and between deck sheets and steel supports and install another fastener nearby while maintaining contact between the parts to be connected.
- G. Coordinate indicated penetration size, location and details with other trades and details of approved equipment. Pipe and conduit openings in the steel roof deck shall be reinforced according to the manufacturer's recommendation.
 1. Cutting and Fittings
 - a. Cut and fit steel roof deck units and accessories around projections through steel deck.
 - b. Cuts shall be square and free of burrs.
 - c. Cut openings in steel deck true to dimensions. Do not use cutting torches if deck is to be exposed in the finished condition.
 - d. Reinforce openings greater than six in. and less than 12-in in greatest dimension with a 24-in by 24-in flat plate, minimum 20 gauge thickness, centered on the opening.
 - H. Fasten accessories directly to composite steel roof deck.
 1. Flat Closure Plates, Girder Fillers and Column Closures
 - a. Fasten to top surface of composite steel roof deck and supporting steel at no more than 12-in on center.
 - b. Lap end joints not less than three in.
 2. Cell Closures
 - a. Install cell closures at all open uncovered ends and edges of composite steel roof deck and in voids between deck and other construction.
 - b. Fasten to top surface of composite steel roof deck at not more than 12-in on center.
 3. Pour Stops
 - a. Provide pour stops at the perimeter of composite steel roof deck.
 - b. Provide minimum two-in. bearing on supporting steel. Fasten to supporting steel at a maximum spacing of 12-in.
 - I. Do not attach suspended ceilings, light fixtures, ducts, piping, conduits or other utilities to composite steel roof deck.

3.02 PREPARATION FOR CONCRETING

- A. After erection, remove metal cuttings and construction debris from cells for entire length. Remove grease, oil, ice, snow, water, and other foreign material. Leave deck and cells in clean condition for obtaining bond with concrete fill, spray fireproofing and/or paint coatings as shown on the Drawings and as specified herein.

3.03 TOUCH-UP PAINTING

- A. Clean and repair all steel surfaces which have become abraded or where galvanizing has been damaged due to welding and/or erection procedures.
- B. Repair abraded or damaged areas using the touch-up material specified above to produce a dry film thickness of not less than six mils. Conduct all repairs of galvanizing in accordance with ASTM A780.

3.04 INSPECTION

- A. The Engineer will inspect composite steel roof deck in the field for compliance with this Section and the approved shop drawings. The Engineer shall reject and require repair or replacement of any composite steel deck or accessories not meeting the requirements of this Section at no additional cost to the District.

END OF SECTION

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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. Steel joists and steel roof deck are included in Division 5.
- D. Metal doors and frames are included in Section 08111.
- E. Painting is included in Division 9.
- F. Louvers are included in Division 15.
- G. Equipment anchor bolts are included in the respective Sections of Divisions 15 and 16.

1.03 SUBMITTALS

- A. Submit, 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 manufacturer's load and deflection tables for grating.
 - 2. Submit manufacturer's specifications and data including recommended design values and physical characteristics for expansion anchors and adhesive anchor system.
- D. Test Reports
 - 1. Certified copy of mill test reports on each steel, stainless steel, 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 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 Concrete Institute (ACI):

1. ACI 318 - Building Code Requirements for Structural Concrete.
2. ACI-CRSI Adhesive Anchor Installer Certification.

C. ASTM International

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 A276 - Standard Specification for Stainless Steel Bars and Shapes.
8. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
9. ASTM F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel Heat Treated, 120 ksi and 105 ksi Minimum Tensile Strength.
10. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

11. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
 12. ASTM A536 - Standard Specification for Ductile Iron Castings.
 13. ASTM A570 - Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
 14. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 15. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 16. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
 17. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 18. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
 19. ASTM F2329 - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon Screws, Washers, Nuts, and Special Threaded Fasteners
- D. American Institute of Steel Construction (AISC)
1. Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design.
- E. American Welding Society (AWS)
1. AWS D1.1 - Structural Welding Code - Steel.
 2. AWS D1.2 - Structural Welding Code - Aluminum.
 3. AWS D1.6 - Structural Welding Code - Stainless Steel
- F. Federal Specifications
1. FS-FF-B-575C - Bolts, Hexagonal and Square
- G. Occupational Safety and Health Administration (OSHA)
- H. Florida Building Code, 6th Edition (2017)
- I. International Code Council Evaluation Services (ICC ES):
1. AC01 - Expansion Anchors in Masonry Elements.

2. AC58 - Adhesive Anchors in Masonry Elements.
3. AC193 - Mechanical Anchors in Concrete Elements.
4. AC308 - Post-Installed Adhesive Anchors in Concrete Elements.

J. 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 and welding of stainless steel shall conform to AWS D1.6.

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. Store materials on skids and not on the ground and block up so that they will not become bent or otherwise damaged. Handle materials with cranes or derricks. Do not dump material off cars or trucks nor handle in any other way that will cause damage.
- C. Repair items that 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 Wide flange shapes: ASTM A992
2. Other shapes; plates; rods and bars: ASTM A36
3. Structural Steel Tubing ASTM A500, Grade B
4. 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
5. Steel Sheets ASTM A1008
6. Gray Iron Castings ASTM A48, Class 35
7. Ductile Iron Castings ASTM A536, Grade 65-45-12
8. Aluminum Extruded Pipe ASTM B429, Alloy 6063 T6 and Alloy 6061 T6 as indicated
9. Aluminum Extruded Shapes ASTM B221, Alloy 6061 T6
10. Aluminum Sheet and Plate ASTM B209, Alloy 6061 T6
11. Stainless Steel Plates, Sheets, and Structural Shapes
 - a. Exterior, Submerged or Industrial Use ASTM A240, Type 316 (Type 316L for welded)
 - b. Interior and Architectural Use ASTM A240, Type 304
12. Stainless Steel Bolts, Nuts, and Washers ASTM A276, Type 316
13. Carbon Steel Bolts and Studs (nuts and washers where noted) ASTM A307, Grade A (hot dip galvanized)
14. High Strength Steel Bolts, Nuts and washers ASTM F3125 (mechanically galvanized per ASTM B695, Class 50, where noted)
 - a. Elevated Temperature Exposure Type I
 - b. General Application Type I or Type II
15. Galvanizing minimum Ni ASTM A123, Zn w/0.05 percent
16. Galvanizing, hardware minimum Ni ASTM A153, Zn w/0.05 percent

- | | |
|---|-------------------------------|
| 17. Galvanizing, anchor bolts
minimum Ni | ASTM F2329, Zn w/0.05 percent |
| 18. Welding electrodes, steel | AWS A5.1 E70xx |

2.03 ANCHORS, BOLTS AND FASTENING DEVICES

- A. Unless otherwise noted, anchor bolts shall be ASTM F1554, Grade 36. Provide standard headed bolts with heavy hex nuts and Grade A washers. Where galvanized anchor bolts are shown or specified, provide standard headed bolts with heavy hex nuts and Grade A washers, all galvanized in accordance with ASTM F2329.
- 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 expansion anchors are shown or specified. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion cone portion of the bolt at least one in. behind the concrete reinforcing steel. Anchors shall meet ICC ES AC01 or ICC ES AC193. Expansion anchors shall be Hilti, Kwik-Bolt TZ; Simpson Strong-Tie Strong Bolt Wedge-All; Powers Power-Stud+ SD1 (Powers Power-Stud+ SD6 for stainless steel) or approved equal. Unless otherwise noted, anchorage designs shown on the Drawings are based on Hilti Kwik-Bolt TZ.
- D. Adhesive anchor system, for fastening to solid concrete substrate, shall be a system manufactured for the installation of post installed studs including anchoring hardware and chemical dispenser. Injection adhesive shall be a two-component epoxy system including a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep the two components separate. Side-by-side cartridges shall be designed to accept a static mixing nozzle which thoroughly blends the two components and allows injection directly into the drilled hole. Provide zinc plated carbon steel or Type 316 stainless steel stud assemblies as indicated on the Drawings consisting of an all-thread anchor rod with nut and washer. Adhesive anchor system shall meet ICC ES AC308. All holes shall be hammer drilled. Adhesive anchor system shall be Hilti HIT-RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or approved equal. Unless otherwise noted, anchorage designs shown on the Drawings are based on Hilti HIT- RE 500 V3.
- E. Adhesive anchor system, for fastening to hollow concrete block or brick, or hollow-core precast concrete planks shall be a three-part stud, screen tube and chemical dispenser anchoring system. Adhesive cartridges shall contain pre-measured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Provide zinc plated carbon steel or Type 316 stainless steel stud assemblies as indicated on the Drawings consisting of an all-thread anchor rod with nut and washer. Adhesive anchor system shall meet ICC ES AC58. Anchors shall be Hilti HIT HY-270 System or approved equal.

- F. 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 approved equal.
- G. 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.
- H. Toggle bolts shall be Hilti, Toggler Bolt or approved equal.

2.04 RAILINGS

- A. Handrail 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 shall be 6063-T6 alloy. Posts shall be 6061-T6 alloy. Splice and reinforcing sleeves, brackets, end caps, toeboards, etc, shall be aluminum alloy 6063-T6 or 6061-T6. Railing system fastening hardware shall be Type 316 stainless steel. Aluminum shall have a mill finish.
- C. Railings shall be two rail welded railing systems, as shown on the Drawings, fabricated with 1-1/2-in nominal diameter pipe. Posts shall be Schedule 80 pipe, minimum and rails and handrail shall be Schedule 40 pipe, minimum. Posts and top rails shall be continuous. Spacing of posts shall not exceed five ft on center and shall be uniformly spaced except as otherwise shown on the Drawings. All railing posts shall be vertical.
- D. Welds shall be circumferential welds ground smooth and even to produce a railing that is neat in appearance and structurally sound. Welding methods shall be in conformity with AWS standards for the materials being joined. For welding aluminum, use a weld filler alloy that is compatible with the alloys to be joined, that will not discolor the pieces to be joined and that will not be discolored by anodizing. All rails to post connections shall be coped and fastened by continuous welds. There shall be no burrs, sharp edges or protrusions on any weld on any part of the handrail system. After fabrication, the welds and surrounding area shall be cleaned and hand buffed to blend with the adjacent finish. All mechanical fasteners shall be unobtrusively located in countersunk holes with the top flush with the surface of the rail. Bends in the railing shall be as indicated by the Drawings. No distortion of the circular railing shape will be allowed. Bends and terminal sections shall be made without the use of fittings. Corner bends shall be mitered and welded bends.
- E. 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.
 - 1. Field splices shall use internal splice sleeves located within eight 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.

- F. The bases or supports for railing posts and handrail shall be the types indicated on the Drawings.
 - 1. Posts shall be placed with the centerline four in. from the edge of the concrete except that posts shall be set at the centerline of concrete curbs.
 - 2. 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 expansion anchors. The horizontal projection of the handrail support off the wall shall provide 2-1/2-in minimum clearance below the bottom of the handrail.
- G. Toeboards shall be provided on all railing adjacent to a drop in elevation of four ft or more. Toeboards are not required on the inclined portion of stairway railings or where concrete or steel curbs, four in. or more in height, are present. Toeboards shall be four-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 1/4-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.
- H. 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.

2.05 ACCESS HATCHES

- A. Prefabricated roof scuttles shall be single or double leaf type of the sizes shown on the Drawings or specified. Cover and curb shall be 11 gauge mill finish aluminum with a welded three-in. beaded flange. The cover shall have at least one in. of insulation covered on the inside with an aluminum liner panel. Curb shall be at least 12-in in height with a flange having holes for bolts to firmly secure scuttle in place. Provide rigid insulation on the exterior of the curb at least one in. in thickness. The insulation shall be fully covered by metal. The cover and curb perimeters shall be provided with a positive seal and entire scuttle shall be watertight. Supply spring operators for easy opening along with automatic cover hold open. Hardware shall be Type 316 stainless steel. Roof scuttles shall be the Types as indicated on the Drawings by Bilco Company, New Haven, CT or equal.

2.06 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. 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 316 stainless steel. Plates shall have a mill finish.
- F. Stair treads for aluminum stairs shall be as specified for grating and shall have cast 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.

2.07 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. 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, hold-down 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 three 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 two oz/sq ft of surface.

2.08 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. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

2.09 CASTINGS

- A. Casting shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. All matching surfaces shall be machined to a true plane surface to allow contact surfaces to seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from dimensions. The Contractor shall provide facilities for weighing castings in the presence of the Engineer.

- B. Frames, covers, cast grates and trench drains for structures shall be gray iron castings except as otherwise specified or indicated on the Drawings. Sizes shall be as shown on the Drawings. Covers shall have letters "WATER," "SANITARY SEWER," or "DRAIN," as applicable, embossed on top.
- C. Frames and covers for installation in slabs shall be heavy duty, R-6013-R-6099 Series as manufactured by Neenah Foundry Co., or equal.
- D. Electrical and telephone manhole and handhole frames and covers shall be ductile iron castings. The covers shall be watertight. Covers shall have the word "ELECTRIC," "HIGH VOLTAGE," "LOW VOLTAGE," "SIGNAL," "TELEPHONE," as applicable, embossed on or cast into the top in letters two-in. high. The clear opening shall be 36-in unless otherwise indicated on the Drawings.

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 anchors shall be checked for tightness a minimum of 24 hours after initial installation.
- F. Install adhesive anchor system in strict compliance with the manufacturer's recommendations, including drill bit diameter, surface preparation, temperature, moisture conditions, injection and installation of bolts. Use oil free compressed air to blast out loose particles and dust from the drilled holes. Studs must be clean and free of dirt, oil, grease, ice or other material which would reduce bond.
- G. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.
- H. All railings shall be erected to line and plumb.

- 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 gratings, 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 06100
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install rough carpentry complete as shown on the drawings and as specified herein.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 - 3. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.03 REFERENCES

- A. American Wood Protection Association (AWPA)
 - 1. AWPA U1 – Preservative Treatment by Pressure Process
 - 2. AWPA M4 - Care of Preservative-Treated Wood Products
- B. ASTM International
 - 1. ASTM A 153/A 153M - Specification for Zinc-Coating (Hot-Dip) of Iron and Steel Hardware
 - 2. ASTM A 563 - Specification for Carbon and Alloy Steel Nuts
 - 3. ASTM B 633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 - 4. ASTM E 488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements
 - 5. ASTM F 1667 - Specification for Driven Fasteners: Nails, Spikes, and Staples
- C. The Southern Pine Inspection Bureau
 - 1. Standard Grading Rules for Southern Pine Lumber.

D. U.S. Department of Commerce, National Institute of Standards and Technology

1. DOC PS 20 - American Softwood Lumber Standard

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

1.04 DEFINITIONS

- A. Dimension Lumber: Lumber of two inches nominal or greater but less than five inches nominal in least dimension.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 PRODUCTS

2.01 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all rough carpentry.

2.03 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content of any species.
- C. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.04 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
 - 1. Provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
 - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate blocking, and similar supports to comply with requirements for attaching other construction.
- B. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

- C. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- D. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- E. Securely attach carpentry work to substrate by anchoring and fastening as indicated.

3.02 WOOD BLOCKING INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.03 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 07115
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to complete bituminous dampproofing as shown on the Drawings and as specified herein.
- B. Section Includes:
 - 1. Cold-applied, emulsified-asphalt dampproofing.

1.02 RELATED WORK

- A. Water Repellents on CMU surfaces are included in Section 07190.

1.03 REFERENCES

- A. ASTM International
 - 1. ASTM C 272 - Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
 - 2. ASTM D 41 - Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
 - 3. ASTM D 4263 - Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
 - 4. ASTM D 6506 - Specification for Asphalt Based Protection for Below-Grade Waterproofing
- B. Code of Federal Regulations
 - 1. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings.
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SUBMITTALS

- A. Provide in accordance with Section 01300.
- B. Product Data: For each type of product.
- C. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

- A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course and auxiliary materials recommended in writing by manufacturer of primary materials.
- B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.02 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Manufacturers: Provide products by the following
 1. BASF Construction Chemicals - Building Systems; Sonneborn Brand Products.
 2. Euclid Chemical Company (The); an RPM company.
 3. Karnak Corporation.
 4. Meadows, W. R., Inc.
 5. Or equal.
- B. Trowel Coats: ASTM D 1227, Type II, Class 1.
- C. Brush and Spray Coats: ASTM D1227, Type III, Class 1.
- D. VOC Content: 30 g/L or less.

2.03 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.
- B. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.
 1. Primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
- D. Patching Compound: Asbestos-free fibered mastic of type recommended in writing by dampproofing manufacturer.
- E. Protection Course: ASTM D 6506, 1/8-inch-thick, semi-rigid sheets of fiberglass or mineral-reinforced-asphaltic core, pressure laminated between two asphalt-saturated fibrous liners.

- F. Protection Course: Fan folded, with a core of extruded-polystyrene board insulation faced on both sides with plastic film, nominal thickness 1/4 inch, with a compressive strength of not less than 8 psi per ASTM D 1621, and maximum water absorption by volume of 0.6 percent per ASTM C 272.
- G. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch thick.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.
 - 1. Test for surface moisture according to ASTM D 4263.
- B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
- B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.
- C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.03 APPLICATION, GENERAL

- A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.
 - 1. Apply dampproofing to provide continuous plane of protection.
 - 2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
- B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of six inches over outside face of footing.
 - 1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.

2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an eight-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.
- C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
1. Lap dampproofing at least 1/4 inch onto shelf angles supporting veneer.

3.04 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Concrete Foundations: Apply one trowel coat at not less than four gal./100 sq. ft.
- B. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than one gal./100 sq. ft.

3.05 INSTALLATION OF PROTECTION COURSE

- A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.
 1. Support protection course over cured coating with spot application of adhesive type recommended in writing by protection-board manufacturer.
 2. Install protection course within 24 hours of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.06 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

- A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.
 1. Install protection course before installing drainage panels.

3.07 CLEANING

- A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

SECTION 07190
WATER REPELLENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install water repellents complete as shown on the Drawings and as specified herein.
- B. Section includes water-repellent treatments for the following vertical and horizontal surfaces:
 - 1. Concrete unit masonry.

1.02 RELATED WORK

- A. Integral water-repellent admixture for unit masonry assemblies is included in Section 04200.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Product Data: For each type of product indicated.
 - 1. Include manufacturer's printed statement of VOC content.
 - 2. Include manufacturer's standard colors.
 - 3. Include manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat.
 - 4. Printout of current "MPI Approved Products List" for each product category specified in Part 2 that specifies water repellents approved by MPI, with the proposed product highlighted.
- C. Samples: For each type of water repellent and substrate indicated, 12 by 12 inches in size, with specified water-repellent treatment applied to half of each Sample.
- D. Qualification Data: For qualified Applicator.
- E. Product Certificates: For each type of water repellent, from manufacturer.
- F. Preconstruction Testing Reports: For water-repellent-treated substrates.
- G. Field quality-control reports.
- H. Warranty: Special warranty specified in this Section.

1.04 REFERENCES

A. ASTM International

1. ASTM C 140 - Test Methods of Sampling and Testing Concrete Masonry Units and Related Units
2. ASTM D 1653 - Test Methods for Water Vapor Transmission of Organic Coating Films
3. ASTM D 6532 - Test Method for Evaluation of the Effect of Clear Water Repellent Treatments on Water Absorption of Hydraulic Cement Mortar Specimens
4. ASTM E 96/E 96M - Test Methods for Water Vapor Transmission of Materials
5. ASTM E 514 - Test Method for Water Penetration and Leakage through Masonry
6. ASTM E 1857 - Guide for Selection of Cleaning Techniques for Masonry, Concrete, and Stucco Surfaces
7. ASTM G 154 - Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

B. Master Painters Institute

1. MPI Approved Products List. Updated quarterly. (See www.paintinfo.com/mpi/approved/index.htm.)

C. Where reference is made to one of the above or other referenced standards, the revisions in effect at the time of bid opening shall apply.

1.05 PERFORMANCE REQUIREMENTS

A. General Performance: Water repellents shall meet performance requirements indicated without failure due to defective manufacture, fabrication, or installation.

1. Water Repellents: Comply with performance requirements specified, as determined by testing on manufacturer's standard substrate assemblies representing those indicated for this Project.

B. Water Absorption: Minimum 90 percent reduction of water absorption after 24 hours in comparison of treated and untreated specimens.

1. Concrete Masonry Units: ASTM C 140.

C. Water-Vapor Transmission: Comply with one or both of the following:

1. Maximum 10 percent reduction in rate of vapor transmission in comparison of treated and untreated specimens, according to ASTM E 96/E 96M.
2. Minimum 80 percent water-vapor transmission in comparison of treated and untreated specimens, according to ASTM D 1653.

- D. Water Penetration and Leakage through Masonry: Minimum 90 percent reduction in leakage rate in comparison of treated and untreated specimens, according to ASTM E 514.
- E. Durability: Maximum 5 percent loss of water-repellent properties after 2500 hours of weathering according to ASTM G 154 in comparison to water-repellent-treated specimens before weathering.

1.06 QUALITY ASSURANCE

- A. Applicator Qualifications: An employer of workers trained and approved by manufacturer.
- B. MPI Standards: Comply with MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."

1.07 PROJECT CONDITIONS

- A. Limitations: Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to manufacturers' written instructions and warranty requirements:
 - 1. Concrete surfaces and mortar have cured for not less than 28 days.
 - 2. Building has been closed in for not less than 30 days before treating wall assemblies.
 - 3. Ambient temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C) and will remain so for 24 hours.
 - 4. Substrate is not frozen and substrate-surface temperature is above 40 deg F (4.4 deg C) and below 100 deg F (37.8 deg C).
 - 5. Rain or snow is not predicted within 24 hours.
 - 6. Not less than 24 hours have passed since surfaces were last wet.
 - 7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer and Applicator agree(s) to repair or replace materials that fail to maintain water repellency specified in "Performance Requirements" Article within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PENETRATING WATER REPELLENTS

- 1. Waterproofing shall be a clear silane-siloxane, water-based product with solids in complete solution equal to Hydrozo Enviroseal Double 7 H.D. by Hydrozo Division of ChemRex Inc. or equal. The solution shall be non-staining and compatible with all types of paints and

sealants. The solids shall be of a non-diminishing type and shall become an integral part of masonry.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements and conditions affecting performance of the Work.
 - 1. Verify that surfaces are clean and dry according to water-repellent manufacturer's requirements. Check moisture content in three representative locations by method recommended by manufacturer.
 - 2. Inspect for previously applied treatments that may inhibit penetration or performance of water repellents.
 - 3. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.
 - 4. Verify that required repairs are complete, cured, and dry before applying water repellent.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Cleaning: Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to water-repellent manufacturer's written instructions.
 - 1. Concrete Unit Masonry: Remove oil, curing compounds, laitance, and other substances that inhibit penetration or performance of water repellents according to ASTM E 1857.
- B. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.
- C. Coordination with Mortar Joints: Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water-repellent treatment has been installed and cured.
- D. Coordination with Sealant Joints: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
 - 1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those required.

3.03 APPLICATION

- A. Installation of materials shall not commence until the structure has passed the watertightness test specified elsewhere in these documents, where applicable.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect the substrate before application of water repellent and to instruct Applicator on the product and application method to be used.
- C. Apply a heavy-saturation coating of water repellent, on surfaces indicated for treatment, using roller to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Comply with manufacturer's written instructions for application procedure unless otherwise indicated.
- D. Apply a second saturation coating, repeating first application. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.04 FIELD QUALITY CONTROL

- A. Testing of Water-Repellent Material: District reserves the right to invoke the following procedure at any time and as often as District deems necessary during the period when water repellent is being applied:
 - 1. District will engage the services of a qualified testing agency to sample water-repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 - 2. Testing agency will perform tests for compliance of water-repellent material with product requirements.
 - 3. District may direct Contractor to stop applying water repellents if test results show material being used does not comply with product requirements. Contractor shall remove noncomplying material from Project site, pay for testing, and correct deficiency of surfaces treated with rejected materials, as approved by Engineer.
- B. Coverage Test: In the presence of Engineer, hose down a dry, repellent-treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.
 - 1. Notify Engineer seven days in advance of the dates and times when surfaces will be tested.
 - 2. Reapply water repellent until coverage test indicates complete coverage.

3.05 CLEANING

- A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water-repellent application as work progresses. Correct damage to work of other trades caused by water-repellent application, as approved by Engineer.
- B. Comply with manufacturer's written cleaning instructions.

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SECTION 07552
STYRENE-BUTADIENE-STYRENE (SBS)
MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install styrene-butadiene-styrene (SBS) modified bituminous membrane roofing, as shown on the Drawings and as specified herein.
- B. Section includes, but is not limited to the following:
 - 1. Styrene-butadiene-styrene (SBS) modified bituminous membrane roofing.
 - 2. Vapor retarder.
 - 3. Roof insulation.

1.02 RELATED WORK

- A. Joint sealants, joint fillers, and joint preparation are included in Section 07920.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings, layouts of tile jointing and control joints for rooms and areas requiring tile. Submittals shall include the following:
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Base flashings and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Crickets, saddles, and tapered edge strips, including slopes.
- D. Wind Uplift Resistance Submittal: For roofing system indicating compliance with wind uplift performance requirements.
- E. Samples for Verification: For the following products:
 - 1. Sheet roofing materials, including base sheet membrane cap sheet and flashing sheet, of color specified.
 - 2. Roof insulation.
 - 3. Six insulation fasteners of each type, length, and finish.

- F. Qualification Data: For qualified Installer, manufacturer, and testing agency.
- G. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of complying with performance requirements.
- H. 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.
- I. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.
- J. Maintenance Data: For roofing system to include in maintenance manuals.
- K. Warranties: Sample of special warranties.
- L. Florida Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.04 DEFINITIONS

- A. 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.
- B. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt, within a range of plus or minus 25 deg F, measured at the mop cart or mechanical spreader immediately before application.

1.05 PERFORMANCE REQUIREMENTS

- A. 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.
- B. 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.
- C. 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.
 - 1. Corner Uplift Pressure: As indicated on drawings.
 - 2. Perimeter Uplift Pressure: As indicated on drawings.
 - 3. Field-of-Roof Uplift Pressure: As indicated on drawings.

1.06 QUALITY ASSURANCE

- A. 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.
- B. 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.

1.07 DELIVERY, STORAGE AND HANDLING

- A. 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.
- B. 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.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. 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.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.08 PROJECT CONDITIONS

- A. 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.

1.09 FLORIDA REGULATORY REQUIREMENTS

- A. The products, materials and assemblies, including anchorage, proposed for the work of this Section shall comply with project specific calculated design pressures and the Florida Building Code (Code), including wind-borne debris region requirements, and shall be designed by the Manufacturer and installed by the Contractor to meet these requirements. Refer to project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Code, the more stringent requirement shall apply.
- B. It shall be the responsibility of the contractor to provide evidence of code compliance for the products, materials and assemblies, including anchorage specified in this section. Evidence of code compliance shall be demonstrated by compliance with the Florida Building Code, using one of the methods outlined in Chapter 9N-3 of the Florida Administrative Code, Department of Community Affairs, Florida Building Commission, Product Approval.

1.10 WARRANTY

- A. 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.
 - 1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- B. 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:
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 SBS-MODIFIED ASPHALT-SHEET MATERIALS

- A. SBS-Modified Bituminous Membrane Roofing:
 - 1. Manufacturers: Provide products by one of the following:
 - a. CertainTeed Corp.
 - b. Firestone Building Products.
 - c. GAF Materials Corporation.
 - d. Johns Manville.
 - e. Siplast, Inc.
 - f. Soprema.
 - g. Tremco Incorporated.
 - h. Or equal.
- B. Granule-Surface Roofing Membrane Cap Sheet: ASTM D 6163, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with glass fibers); granular surfaced; suitable for application method specified, and as follows:
 - 1. Granule Color: Gray.

2.02 BASE-SHEET MATERIALS

- A. Base Sheet: ASTM D 4601, Type I, non-perforated, asphalt-impregnated and -coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.

2.03 BASE FLASHING SHEET MATERIALS

- A. Backer Sheet: ASTM D6164, Grade S, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric); smooth surfaced; suitable for application method specified.

- B. Granule-Surfaced Flashing Sheet: ASTM D6164, Grade G, Type I or II, SBS-modified asphalt sheet (reinforced with polyester fabric); granular surfaced; suitable for application method specified, and as follows:

- 1. Granule Color: Gray.

2.04 AUXILIARY ROOFING MEMBRANE MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

- 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
- 2. 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):
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Contact Adhesive: 80 g/L.
 - f. Other Adhesives: 250 g/L.
 - g. Non-membrane Roof Sealants: 300 g/L.
 - h. Sealant Primers for Nonporous Substrates: 250 g/L.
 - i. Sealant Primers for Porous Substrates: 775 g/L.

- B. Asphalt Primer: ASTM D41.

- C. Cold-Applied Adhesive: Roofing system manufacturer's standard asphalt-based, one- or two-part, asbestos-free, cold-applied adhesive specially formulated for compatibility and use with roofing membrane and base flashings.

- D. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required by roofing system manufacturer for application.

- E. Mastic Sealant: Polyisobutylene, plain or modified bitumen; non-hardening, non-migrating, non-skinning, and non-drying.

- F. Miscellaneous Accessories: Provide those recommended by roofing system manufacturer.

2.05 VAPOR RETARDER

- A. Self-Adhering Sheet Vapor Retarder: ASTM D 1970, minimum of 40-mil-thick, polyethylene film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor-retarder manufacturer.

2.06 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation; Saint-Gobain North America.
 - b. Firestone Building Products.
 - c. Johns Manville; a Berkshire Hathaway company.
- B. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
- C. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.07 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
- B. Modified Asphaltic Insulation Adhesive: Insulation manufacturer's recommended modified asphaltic, asbestos-free, cold-applied adhesive formulated to attach roof insulation to substrate or to another insulation layer.
- C. Bead-Applied Insulation Adhesive: Insulation manufacturer's recommended bead-applied, low-rise, one-component or multicomponent urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
- D. Full-Spread Applied Insulation Adhesive: Insulation manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive formulated to attach roof insulation to substrate or to another insulation layer.
- E. Insulation Cant Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.
- F. Wood Nailer Strips: Comply with requirements in Section 06100 .
- G. Tapered Edge Strips: ASTM C 208, Type II, Grade 1, cellulosic-fiber insulation board.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - 1. 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.

2. 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.
 3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - a. Test for moisture by pouring one pint of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
 5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
 6. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. 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. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gal./100 sq. ft. and allow primer to dry.
- D. Install insulation strips in ribs of acoustical roof decks according to acoustical roof deck manufacturer's written instructions.

3.03 VAPOR-RETARDER INSTALLATION

- A. Self-Adhering Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and six inches, respectively. Seal laps by rolling.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

3.04 INSULATION INSTALLATION

- A. Comply with roofing system manufacturer's written instructions for installing roof insulation.
- B. Install one lapped base-sheet course and mechanically fasten to substrate according to roofing system manufacturer's written instructions.

- C. 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.
- D. Install tapered insulation under area of roofing to conform to slopes indicated.
- E. 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 with insulation.
 - 1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- F. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches or more, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of six inches in each direction.
 - 1. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
- G. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- H. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- I. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
 - 1. Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. and allow primer to dry.
 - 2. Set each layer of insulation in a solid mopping of hot roofing asphalt applied within plus or minus 25 deg F of equiviscous temperature.
 - 3. Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 4. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.05 ROOFING MEMBRANE INSTALLATION, GENERAL

- A. 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:
 - 1. Deck Type: C (concrete or non-nailable).
 - 2. Adhering Method: L (cold-applied adhesive).
 - 3. Base Sheet: One.
 - 4. Number of SBS-Modified Asphalt Sheets: One.

5. Surfacing Type: M (mineral-granule-surfaced cap sheet).
- B. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.
- C. Where roof slope exceeds 3/4 inch per 12 inches, install roofing membrane sheets parallel with slope.
- D. Cooperate with testing agencies engaged or required to perform services for installing roofing system.
- E. 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.
 1. 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.
 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
 3. Remove and discard temporary seals before beginning work on adjoining roofing.
- F. Substrate-Joint Penetrations: Prevent roofing asphalt and adhesives from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.06 BASE-SHEET INSTALLATION

- A. Loosely lay one course of sheathing paper, lapping edges and ends a minimum of two inches and six inches, respectively.
- B. Install lapped base-sheet course, extending sheet over and terminating beyond cants. Attach base sheet as follows:
 1. Adhere to substrate in a uniform coating of cold-applied adhesive.

3.07 SBS-MODIFIED BITUMINOUS MEMBRANE INSTALLATION

- A. Install modified bituminous roofing membrane sheet and cap sheet according to roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants, installing as follows:
 1. Adhere to substrate in cold-applied adhesive.
 2. Unroll roofing membrane sheets and allow them to relax for minimum time period required by manufacturer.

- B. Laps: Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
 - 1. Repair tears and voids in laps and lapped seams not completely sealed.
 - 2. Apply roofing granules to cover exuded bead at laps while bead is hot.
- C. Install roofing membrane sheets so side and end laps shed water.

3.08 FLASHING AND STRIPPING INSTALLATION

- A. Install base flashing over cant strips and other sloped and vertical surfaces, at roof edges, and at penetrations through roof; secure to substrates according to roofing system manufacturer's written instructions, and as follows:
 - 1. Prime substrates with asphalt primer if required by roofing system manufacturer.
 - 2. Backer Sheet Application: Adhere backer sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
 - 3. Flashing Sheet Application: Adhere flashing sheet to substrate in cold-applied adhesive at rate required by roofing system manufacturer.
- B. Extend base flashing up walls or parapets a minimum of eight inches above roofing membrane and four inches onto field of roofing membrane.
- C. Install roofing membrane cap-sheet stripping where metal flanges and edgings are set on membrane roofing according to roofing system manufacturer's written instructions.

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to prepare test reports.
- B. Test Cuts: Test specimens will be removed to evaluate problems observed during quality-assurance inspections of roofing membrane as follows:
 - 1. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617.
 - 2. 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."
 - 3. Repair areas where test cuts were made according to roofing system manufacturer's written instructions.
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
 - 1. Notify Architect and District 48 hours in advance of date and time of inspection.

- D. Roofing system will be considered defective if it does not pass tests and inspections.
 - 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.10 PROTECTING AND CLEANING

- A. 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 District.
- B. 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.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.11 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
 - 1. District: .
 - 2. Address: .
 - 3. Building Name/Type: .
 - 4. Address: .
 - 5. Area of Work: .
 - 6. Acceptance Date: .
 - 7. Warranty Period: .
 - 8. Expiration Date: .
- B. AND WHEREAS Roofing Installer has contracted (either directly with District or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding _____ mph (m/s);
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and
 - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by District.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by District or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if District allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If District engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified District in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. District shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off District from other remedies and resources lawfully available to District in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with District or a subcontract with District's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____
2. Name: _____
3. Title: _____

END OF SECTION

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SECTION 07710
ROOF SPECIALTIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and design and deliver roof specialties for the Project as shown on the Drawings and as specified herein.
- B. The work includes:
 - 1. Roof-edge flashings.
 - 2. Roof-edge drainage systems.
 - 3. Reglets and counterflashings.

1.02 RELATED WORK

- A. Manufactured sheet metal expansion-joint covers are included in Division 5.
- B. Wood nailers, curbs, and blocking are included in Section 06100.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, the following:
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. 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:
 - 1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 - 2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 - 3. Details of termination points and assemblies, including fixed points.
 - 4. Details of special conditions.
- D. Samples: For each type of roof specialty indicated with factory-applied color finishes. For roof-edge flashings, roof-edge drainage systems, reglets and counterflashings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for roof-edge flashings.
- F. Maintenance Data: For roofing specialties to include in maintenance manuals.

G. Warranty: Sample of special warranty.

1.04 REFERENCE STANDARDS

A. American Architectural Manufacturers Association

1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum
2. AAMA 620 - Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates
3. AAMA 621 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates
4. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels
5. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

B. ASTM International

1. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
2. ASTM A 240/A 240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
3. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
4. ASTM A 666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
5. ASTM A 755/A 755M - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
6. ASTM B 32 - Specification for Solder Metal
7. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
8. ASTM B 221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
9. ASTM B 370 - Specification for Copper Sheet and Strip for Building Construction
10. ASTM C 920 - Specification for Elastomeric Joint Sealants
11. ASTM C 1311 - Specification for Solvent Release Sealants

12. ASTM D 226 - Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
 13. ASTM D 1187 - Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
 14. ASTM D 1970 - Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
 15. ASTM D 2244 - Test Method for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
 16. ASTM D 4214 - Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films
 17. ASTM D 4586 - Specification for Asphalt Roof Cement, Asbestos-Free
 18. ASTM F 2329 - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
- C. National Association of Architectural Metal Manufacturers
1. Metal Finishes Manual for Architectural and Metal Products.
- D. Sheet Metal and Air Conditioning Contractors' National Association
1. Architectural Sheet Metal Manual.
- E. Where reference is made to one of the above or other referenced standards, the revisions in effect at the time of bid opening shall apply.

1.05 PERFORMANCE REQUIREMENTS

- A. 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.
- B. FM Approvals' Listing: Manufacture and install roof-edge flashings that are listed in FM Approvals' "RoofNav" and approved for applicable windstorm classification. Identify materials with FM Approvals' markings.
- C. SPRI Wind Design Standard: Manufacture and install roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
 1. Design Pressure: As indicated on Drawings.
- D. 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.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.06 QUALITY ASSURANCE

A. Pre-installation Conference: Conduct conference at Project site.

1. Meet with District, Engineer, District's insurer if applicable, Installer, and installers whose work interfaces with or affects roof specialties including installers of roofing materials and accessories.
2. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
3. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.07 DELIVERY, STORAGE AND HANDLING

- A. 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.
- B. 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.

1.08 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than five Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 EXPOSED METALS

- A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
 1. Surface: Smooth, flat finish.
 2. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

- B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:
 - 1. Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.02 CONCEALED METALS

- A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
- B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.03 UNDERLAYMENT MATERIALS

- A. Slip Sheet: Building paper, three-lb/100 sq. ft. minimum, rosin sized.

2.04 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 - 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 - 2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
- C. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

2.05 COPINGS

- A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.
 - 1. Manufacturers: Provide products by one of the following:
 - a. Architectural Products Company.
 - b. ATAS International, Inc.
 - c. Castle Metal Products.
 - d. Cheney Flashing Company.
 - e. Hickman Company, W. P.
 - f. Johns Manville.
 - g. Merchant & Evans, Inc.

- h. Metal-Era, Inc.
 - i. Metal-Fab Manufacturing, LLC.
 - j. MM Systems Corporation.
 - k. National Sheet Metal Systems, Inc.
 - l. Perimeter Systems; a division of Southern Aluminum Finishing Company, Inc.
 - m. Petersen Aluminum Corporation.
 - n. Or equal.
2. Coping-Cap Material: Formed aluminum, 0.080 inch thick .
 - a. Finish: Clear anodic .
 3. Corners: Factory mitered and mechanically clinched and sealed watertight.
 4. Coping-Cap Attachment Method: Face leg hooked to continuous cleat with back leg fastener exposed, fabricated from coping-cap material.
 5. Face Leg Cleats: Concealed, continuous stainless steel.

2.06 ROOF-EDGE DRAINAGE SYSTEMS

A. Manufacturers: Provide products by one of the following:

1. Andreas Renner KG.
2. Architectural Products Company.
3. ATAS International, Inc.
4. Berger Building Products, Inc.
5. Castle Metal Products.
6. Cheney Flashing Company.
7. CopperCraft by FABRAL; a Euramax company.
8. Hickman Company, W. P.
9. Klauer Manufacturing Company.
10. Merchant & Evans, Inc.
11. Metal-Era, Inc.
12. Metal-Fab Manufacturing, LLC.
13. MM Systems Corporation.
14. National Sheet Metal Systems, Inc.
15. Perimeter Systems; a division of Southern Aluminum Finishing Company, Inc.

16. Or equal.

- B. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
 - 1. Extruded Aluminum: 0.125 inch thick.
- C. Parapet Scuppers: Manufactured with closure flange trim to exterior, four-inch-wide wall flanges to interior, and base extending four inches beyond cant or tapered strip into field of roof.
 - 1. Fabricate from the following exposed metal:
 - a. Formed Aluminum: 0.032 inch thick.
- D. Conductor Heads: Manufactured conductor 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.
 - 1. Fabricate from the following exposed metal:
 - a. Formed Aluminum: 0.032 inch thick.
- E. Aluminum Finish: Clear anodic.

2.07 REGLETS AND COUNTERFLASHINGS

- A. Manufacturers: Provide products by one of the following:
 - 1. Castle Metal Products.
 - 2. Cheney Flashing Company.
 - 3. Fry Reglet Corporation.
 - 4. Heckmann Building Products Inc.
 - 5. Hickman Company, W. P.
 - 6. Keystone Flashing Company, Inc.
 - 7. Metal-Era, Inc.
 - 8. Metal-Fab Manufacturing, LLC.
 - 9. MM Systems Corporation.
 - 10. National Sheet Metal Systems, Inc.
 - 11. Or equal.

- B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
 - 1. Stainless Steel: 0.025 inch thick.
 - 2. Corners: Factory mitered and mechanically clinched and sealed watertight.
 - 3. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
- C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by four inches and in lengths not exceeding 12 feet designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
 - 1. Stainless Steel: 0.025 inch thick.
- D. Accessories:
 - 1. 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.
 - 2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
- E. Stainless-Steel Finish: No. 3 (coarse, polished directional satin).

2.08 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. 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

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 UNDERLAYMENT INSTALLATION

- A. 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 two inches.

3.03 INSTALLATION, GENERAL

- A. 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.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 - 4. Torch cutting of roof specialties is not permitted.
 - 5. Do not use graphite pencils to mark metal surfaces.
- B. 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.
 - 1. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet.
 - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
 - 1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.
 - 2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal joints with elastomeric sealant as required by roofing-specialty manufacturer.

- F. 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.
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches except reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.04 ROOF-EDGE FLASHING INSTALLATION

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.05 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

- A. 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.
- B. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and one inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.
 - 1. Provide elbows at base of downspout to direct water away from building.
 - 2. Connect downspouts to underground drainage system indicated.
- C. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
 - 1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
 - 2. Loosely lock front edge of scupper with conductor head.
 - 3. Seal or solder exterior wall scupper flanges into back of conductor head.
- D. Conductor Heads: Anchor securely to wall with elevation of conductor top edge one inch below scupper discharge.

3.06 REGLET AND COUNTERFLASHING INSTALLATION

- A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

- B. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap four inches over top edge of base flashings. Lap counterflashing joints a minimum of four inches and bed with elastomeric sealant. Fit counterflashings tightly to base flashings.

3.07 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. 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.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07720 ROOF ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Roof hatches.
- B. Related Requirements:
 - 1. Section 077100 "Roof Specialties" for manufactured fascia, copings, gutters and downspouts.

1.03 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
 - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

C. Florida Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.07 FLORIDA REGULATORY REQUIREMENTS

A. The products, materials and assemblies, including anchorage, proposed for the work of this Section shall comply with project specific calculated design pressures and the Florida Building Code (Code), including wind-borne debris region requirements, and shall be designed by the Manufacturer and installed by the Contractor to meet these requirements. Refer to project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Code, the more stringent requirement shall apply.

B. It shall be the responsibility of the contractor to provide evidence of code compliance for the products, materials and assemblies, including anchorage specified in this section. Evidence of code compliance shall be demonstrated by compliance with the Florida Building Code, using one of the methods outlined in Chapter 9N-3 of the Florida Administrative Code, Department of Community Affairs, Florida Building Commission, Product Approval.

1.08 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

- a. Color fading more than five Delta E units when tested according to ASTM D2244.
- b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories 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.
- B. Wind-Restraint Performance: As indicated on Drawings.

2.02 ROOF HATCHES

- A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Architectural Specialties, Inc.
 - b. BILCO Company (The).
 - B. Type and Size: Single-leaf lid, 48 by 48 inches.
 - C. Hatch Material: Aluminum sheet.
 - 1. Thickness: Manufacturer's standard thickness for hatch size indicated.
 - 2. Finish: Mill.
 - D. Construction:
 - 1. Insulation: Two-inch- thick, polyisocyanurate board.
 - 2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
 - 3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 - 4. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 - 5. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
 - E. Hardware: Spring operators, hold-open arm, stainless steel spring latch with turn handles, stainless steel butt- or pintle-type hinge system, and padlock hasps inside and outside.

2.03 METAL MATERIALS

- A. Aluminum Sheet: ASTM B209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
 - 1. Mill Finish: As manufactured.
 - 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.
- B. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

2.04 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for above-ground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWWA C2; not less than 1-1/2 inches thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- E. Underlayment:
 - 1. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils 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.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
 - 1. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C920, elastomeric polyurethane polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

- J. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

2.05 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. 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

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install roof accessories according to manufacturer's written instructions.
 - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. 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.
 - 1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.

3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Roof-Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.

- D. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

3.03 REPAIR AND CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions.
- B. Clean off excess sealants.
- C. Replace roof accessories 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

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to complete joint sealants as shown on the Drawings and as specified herein.
- B. Section includes:
 - 1. Urethane joint sealants.

1.02 REFERENCES

- A. ASTM International
 - 1. ASTM C 794 - Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
 - 2. ASTM C 834 - Specification for Latex Sealants
 - 3. ASTM C 920 - Specification for Elastomeric Joint Sealants
 - 4. ASTM C 1021 - Practice for Laboratories Engaged in Testing of Building Sealants
 - 5. ASTM C 1193 - Guide for Use of Joint Sealants
 - 6. ASTM C 1248 - Test Method for Staining of Porous Substrate by Joint Sealants
 - 7. ASTM C 1311 - Specification for Solvent Release Sealants
 - 8. ASTM C 1330 - Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants
 - 9. ASTM C 1521 - for Evaluating Adhesion of Installed Weatherproofing Sealant Joints
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03 SUBMITTALS

- A. Provide in accordance with Section 01300.
- B. Product Data: For each joint-sealant product.
- C. Samples: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.

2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
 1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.06 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 2. When joint substrates are wet.
 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.07 WARRANTY

- A. Special Installer's Warranty: 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.
 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 - 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 - 2. Disintegration of joint substrates from causes exceeding design specifications.
 - 3. Mechanical damage caused by individuals, tools, or other outside agents.
 - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 PRODUCTS

2.01 JOINT SEALANTS, GENERAL

- A. 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.
- B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:
- C. Colors of Exposed Joint Sealants: As selected by Engineer from manufacturer's full range.

2.02 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, non-sag, non-traffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 1. Products: Provide one of the following:
 - a. BASF Construction Chemicals, LLC, Building Systems; Sonalastic TX1.
 - b. Sika Corporation U.S.; Sikaflex Textured Sealant.
 - c. Tremco Incorporated; Dymonic.
 - d. Or equal.
- B. Urethane, M, P, 25, T, NT: Multi-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 25, Uses T and NT.
 - 1. Products: Provide one of the following:
 - a. Bostik, Inc.; Chem-Calk 555-SL.
 - b. Sherwin-Williams Company (The); Stampede-2SL.
 - c. Tremco Incorporated; THC 900/901.
 - d. Or equal.

2.03 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

2.04 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Non-staining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
 - 1. Manufacturers: Provide products by the following:
 - a. BASF Construction Chemicals, LLC, Building Systems.
 - b. Construction Foam Products, a division of Nomaco, Inc.
 - c. Or equal.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. 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.

2.05 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from pre-construction joint-sealant-substrate tests and field tests.
- B. Cleaners for Non-porous 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 non-porous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. **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:
1. 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.
 2. 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:
 - a. Concrete.
 - b. Masonry.
 3. Remove laitance and form-release agents from concrete.
 4. Clean non-porous 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. Non-porous joint substrates include the following:
 - a. Metal.
 - b. Glass.
- B. **Joint Priming:** Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by pre-construction 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.
- C. **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.

3.03 INSTALLATION OF JOINT SEALANTS

- A. **General:** Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. **Sealant Installation Standard:** Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. **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.**
1. Do not leave gaps between ends of sealant backings.

2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Non-sag 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.
1. Remove excess sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.04 CLEANING

- A. 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.

3.05 PROTECTION

- A. 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, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.06 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- B. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Vertical joints on exposed surfaces of masonry walls.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- C. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Other joints as indicated on Drawings.
 2. Joint Sealant: Butyl-rubber based.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

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SECTION 08111
ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and design and deliver aluminum doors and frames for the Project as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Masonry is included in Section 04200.
- B. Door Hardware is included in Section 08710.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01300:
 - 1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.
 - 2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- B. Samples: For each type of exposed finish required, in manufacturer's standard sizes.
 - 1. Frame corner with six-in long legs showing construction with the galvanized material specified, welding, touch-up and priming.
 - 2. Door panel corner, six-in square, showing door and insulating materials, construction and finishing as specified above.
 - 3. Provide certification as approved that all materials, construction requirements and fire ratings herein specified will be met in the project.
 - 4. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.
- C. Florida Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.04 REFERENCE STANDARDS

- A. American Architectural Manufacturers Association (AAMA)
 - 1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum

2. AAMA 620 - Voluntary Specification High Performance Organic Coatings on Coil Coated Architectural Aluminum
 3. AAMA 2603 - Pigmented Organic Coatings on Extruded Aluminum
 4. AAMA 2604 - High Performance Organic Coatings on Architectural Extrusions and Panels
- B. ASTM International (ASTM)
1. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel
 2. ASTM B 209 - Aluminum and Aluminum-Alloy Sheet and Plate
 3. ASTM B 221 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
 4. ASTM E 283 - Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- C. National Association of Architectural Metal Manufacturers
1. Metal Finishes Manual for Architectural and Metal Products.
- D. Where reference is made to one of the above or other referenced standards, the revisions in effect at the time of bid opening shall apply.

1.05 PERFORMANCE REQUIREMENTS

- A. General: Aluminum doors and frames shall withstand structural loads, air infiltration, water infiltration and thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Structural: Shapes and thicknesses of framing members shall be sufficient to withstand the design wind load indicated with a deflection of not more than 1/175 times the length of the member and a safety factor of not less than 1.65. Provide glazing beads, moldings, and trim of not less than 0.050 inch nominal thickness.
- C. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.
- D. Water Penetration under Static Pressure: Provide aluminum-framed systems 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 8.00 lbf/sq. ft.
- E. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.06 QUALITY ASSURANCE

- A. All products specified in this Section shall be furnished by a single manufacturer specializing in the fabrication of aluminum doors and frames with not less than five years of successful experience in the fabrication of aluminum doors and frames of the type required for this project.
- B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- C. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."

1.07 REGULATORY REQUIREMENTS

- A. The products, materials and assemblies, including anchorage, proposed for the work of this Section shall comply with project specific calculated design pressures and the Florida Building Code (Code), including wind-borne debris region requirements, and shall be designed by the Manufacturer and installed by the Contractor to meet these requirements. Refer to project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Code, the more stringent requirement shall apply.
- B. It shall be the responsibility of the contractor to provide evidence of code compliance for the products, materials and assemblies, including anchorage specified in this section. Evidence of code compliance shall be demonstrated by compliance with the Florida Building Code, using one of the methods outlined in Chapter 9N-3 of the Florida Administrative Code, Department of Community Affairs, Florida Building Commission, Product Approval.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Do not store aluminum doors and frames in contact with other materials that might cause staining, denting, or other surface damage. Store aluminum doors and frames away from uncured concrete and masonry.
- B. Protect strippable protective covering on aluminum doors and frames from exposure to sunlight and high humidity, except to the extent necessary for the period of aluminum doors and frames installation.

1.09 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - c. Water leakage through fixed glazing and framing areas.
 - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

- A. All exterior doors and components shall be designed by the Manufacturer and installed by the Contractor to withstand wind pressures, both positive and negative and salient corner conditions as calculated in accordance with the Building Code to withstand the wind load required by the Building Code.
- B. At no additional cost to the District, provide additional, non-standard door bracing, reinforcements or heavier gauge materials required in order to conform to wind load and the requirements of 1.07.A and 2.01.A herein.

2.02 MATERIALS

- A. Anchors: Stainless steel or steel with hot-dipped galvanized finish.
- B. Weatherstripping: Continuous wool pile, silicone treated, or type recommended by door manufacturer
- C. Aluminum Alloy for Doors and Frames: ASTM B 221 / ASTM B 221M, alloy 6063-T5 for extrusions; ASTM B 209 / B 209M, alloy and temper best suited for aluminum sheets and strips.
- D. Fasteners: Hard aluminum or stainless steel.
- E. Structural Steel: ASTM A 36/A 36M.
- F. Aluminum Paint: Aluminum door manufacturer's standard aluminum paint.

2.03 DOORS

- A. Aluminum flush doors shall be 1-3/4-in thick, completely flush in design, constructed with extruded aluminum alloy 6063-T5 tubular jamb rails (0.125-in lock side, 0.190-in hinge side) and minimum 0.090-in thick smooth aluminum alloy 5005-H34 face sheets.
- B. Internal grid system shall consist of a 4-1/2-in, 0.080-in extruded aluminum tubular sections. Top and bottoms of doors shall be reinforced with (5-1/2-in) and tied to jamb rails with 3/8-in plated steel rods, nuts and washers. Jamb rails shall be 4-7/16-in hinge rail and 4-9/16-in lock rails so that no portion of the locksets, exit devices or other hardware project into the core area of the door. The perimeter of all cut outs shall be reinforced with same section. All internal members shall be anodized (Aluminum Association AA-C22A31).
- C. All voids in doors between grid sections shall be filled with a rigid, high density, waterproof, noncombustible mineral insulation conforming to FS HH-1-529b, polyisocyanurate FS HH-I-530, or other self-extinguishing, insulating stiffening material; ASTM E84 flame spread 25.
- D. The face panels shall be bonded to the perimeter, grid sections and core with a thermosetting two component epoxy adhesive. Doors shall be completely reinforced for and shop fabricated to receive all specified hardware. Reinforcement shall be 6061-T6 alloy, 0.250-in thick, minimum. Doors shall be Series 2901 Flush Aluminum Door by AluTech Corporation or approved equal.

2.04 FRAMES, AND MISCELLANEOUS

- A. Frames shall be 0.125-in minimum wall thickness, extruded tubular 6063-T5 aluminum alloy with pile weather-stripped doorstops.
- B. Frame joints and components shall be factory milled and fitted to hairline cracks. Corners shall be mechanically joined with interlocking 3/16-in wall, aluminum channel clips and flat head stainless steel screws. Frames shall be completely fabricated and reinforced for all hardware as specified in Section 08710.

2.05 PACKING

- A. Doors shall be individually wrapped in corrugated cardboard with wood strips on vertical edges and banded with metal straps.

2.06 FABRICATION

- A. Aluminum Frames: Extruded aluminum shapes with contours approximately as indicated. Provide removable glass stops and glazing beads for frames accommodating fixed glass. Use countersunk stainless steel Phillips screws for exposed fastenings, and space not more than 12 inches on center. Mill joints in frame members to a hairline fit, reinforce, and secure mechanically.
 - 1. Construction: Non-thermal at interior locations; thermally broken at exterior locations.
- B. Aluminum Doors: Of type, size, and design indicated and not less than 1-3/4 inch thick. Minimum wall thickness, 0.125 inch, except beads and trim, 0.050 inch. Door sizes shown are nominal and shall include standard clearances as follows: 0.093 inch at hinge and lock stiles,

0.125 inch between meeting stiles, 0.125 inch at top rails, 0.187 inch between bottom and threshold, and 0.687 inch between bottom and floor.

- C. Flush Doors: Use facing sheets with an embossed or a plain smooth surface. Use one of the following constructions:
1. A phenolic resin-impregnated kraft paper honeycomb core, surrounded at edges and around glass and louvered areas with extruded aluminum shapes. The impregnation of core shall have a minimum of 18 percent resin content. Provide sheet aluminum door facings, not less than 0.032-inch-thick laminated to a 0.10-inch-thick tempered hardboard backing and bond the backing to the honeycomb core. Bond facing sheets to core under heat and pressure with a thermosetting adhesive, and mechanically lock to the extruded edge members.
 2. A phenolic resin-impregnated kraft paper honeycomb core. Use aluminum facing sheets not less than 0.050-inch-thick and form into two pans which will eliminate seams on the faces. Bond honeycomb core to the face sheets using an epoxy resin or contact cement-type adhesive.
 3. A solid fibrous core, surrounded at edges and around glass and louvered areas and cross-braced at intermediate points with extruded aluminum shapes. Use aluminum facing sheets of not less than 0.050-inch thickness. Bond facing sheets to core under heat and pressure with a thermosetting adhesive, and mechanically lock to the extruded edge members.
 4. Form from extruded tubular stiles and rails mitered at corners, reinforce, and continuously weld at miters. Facing sheets shall consist of 0.032-inch-thick sheet aluminum internally reinforced with aluminum channels or Z-bars placed horizontally not more than 16 inch apart and extending full width of panel. Fit spaces between reinforcing with sound-deadening insulation. Facing sheets shall finish flush with faces of stiles and rails and be welded to reinforcing bars or channels and to stiles and rails.
 5. Form from an internal grid system composed of extruded aluminum tubular sections. Provide extruded aluminum tubular sections at both sides, and at perimeters of louver and glass cutouts. Provide three extruded aluminum tubular sections at top and bottom of door. Wall thickness of tubular sections shall be not less than 0.09 inch except that lock rail shall be not less than 0.125-inch-thick, hinge lock rail shall be not less than 0.125-inch-thick, and hinge rail edge shall be not less than 0.19 inch thick. Fill spaces in door with mineral insulation. Facing sheets shall be of aluminum not less than 0.09 inch thick.
 6. Form from extruded aluminum members at top and bottom, both sides, and at perimeters of louver and glass cutouts. Wall sections of extruded aluminum members shall be not less than 0.09-inch-thick and be properly reinforced for application of hardware. Framing members shall be covered on both sides with aluminum facing sheets not less than 0.064 inch thick. Fill door with foamed-in urethane with a three-pound density.
- D. Welding and Fastening: Where possible, locate welds on unexposed surfaces. Dress welds on exposed surfaces smoothly. Select welding rods, filler wire, and flux to produce a uniform texture and color in finished work. Remove flux and spatter from surfaces immediately after welding. Exposed screws or bolts will be permitted only in inconspicuous locations and shall have countersunk heads. Weld concealed reinforcements for hardware in place.

2.07 ACCESSORIES

- A. Weatherstripping: Provide on stiles and rails of exterior doors. Fit into slots which are integral with doors or frames. Weatherstripping shall be replaceable without special tools, and adjustable at meeting rails of pairs of doors. Installation shall allow doors to swing freely and close positively. Air leakage of a single leaf weatherstripped door shall not exceed 0.5 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283.
- B. Anchors: On the backs of subframes, provide anchors of the sizes and shapes indicated for securing subframes to adjacent construction. Anchor transom bars at ends and mullions at head and sill. Reinforce and anchor freestanding door frames to floor construction as indicated on approved shop drawings and in accordance with manufacturer's recommendation. Place anchors near top and bottom of each jamb and at intermediate points not more than 25 inches apart.
- C. Hardware: Coordinate with Section 08710. Deliver hardware templates and hardware (except field-applied hardware) to the door manufacturer for use in fabrication of aluminum doors and frames. Cut, reinforce, drill, and tap doors and frames at the factory to receive template hardware. Provide doors to receive surface-applied hardware, except push plates, kick plates, and mop plates, with reinforcing only; drill and tap in the field. Provide hardware reinforcements of stainless steel or steel with hot-dipped galvanized finish, and secure with stainless steel screws. Provide reinforcement in core of flush doors as required to receive locks, door closers, and other hardware.

2.08 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish aluminum doors and frames after assembly.

2.09 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: Match color of existing doors and frames on site (Surrey Beige by Valspar)..

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure non-movement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.

G. Perimeter joint sealants are installed under Section 07920.

3.03 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet; 1/4 inch over total length.

3.04 CLEANING

- A. Upon completion of installation, clean door and frame surfaces in accordance with door manufacturer's written recommended procedure. Do not use abrasive, caustic, or acid cleaning agents.

3.05 PROTECTION

- A. Protect doors and frames from damage and from contamination by other materials such as cement mortar. Prior to completion and acceptance of the work, restore damaged doors and frames to original condition, or replace with new ones.

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SECTION 08710
DOOR HARDWARE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and design and deliver door hardware for the Project as shown on the Drawings and as specified herein.
- B. Hardware for exterior doors is a component of a door system required to conform to the Florida Building Code (Code). Coordinate the hardware schedule for those doors with the appropriate supplier to ensure compliance with the Code.
- C. Furnish all templates and schedules required by the manufacturers of the metal doors and frames to enable the Manufacturer's to make proper provision in their work to receive the finish hardware. All locks, lock strikes and flush bolts shall be made to ANSI standard dimensions.
- D. Coordinate key cylinders with the District's master key system.

1.02 RELATED WORK

- A. Aluminum doors and frames are included in Section 08111.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300.
- B. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Qualification Data: For Architectural Hardware Consultant.
- D. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.
- E. Warranty: Special warranty specified in this Section.
- F. Other Action Submittals:
 - 1. Door Hardware Sets: Prepared by or under the supervision of an Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - a. 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 and use same door numbers as indicated.
 - b. Content: Include the following information:

- 1) Identification number, location, hand, fire rating, and material of each door and frame.
 - 2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
 - 3) Complete designations of every item required for each door or opening including name and manufacturer.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - 6) Explanation of abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for door hardware.
 - 8) Door and frame sizes and materials.
 - 9) List of related door devices specified in other Sections for each door and frame.
- c. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.
2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing District's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.04 REFERENCE STANDARDS

A. American National Standards Institute

1. ANSI A250.6 - Hardware for Standard Steel Doors (Reinforcement - Application)

B. ASTM International

1. ASTM E 283 - Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen

C. Builders Hardware Manufacturers Association

1. BHMA A156.1 - Butts and Hinges (ANSI)
2. BHMA A156.4 - Door Controls - Closers (ANSI)
3. BHMA A156.5 - Auxiliary Locks and Associated Products (ANSI)
4. BHMA A156.6 - Architectural Door Trim (ANSI)
5. BHMA A156.7 - Template Hinge Dimensions (ANSI)
6. BHMA A156.13 - Mortise Locks & Latches Series 1000 (ANSI)
7. BHMA A156.16 - Auxiliary Hardware (ANSI)

8. BHMA A156.18 - Materials and Finishes (ANSI)
9. BHMA A156.21 - Thresholds (ANSI)
10. BHMA A156.22 - Door Gasketing and Edge Seal Systems (ANSI)
11. BHMA A156.30 - High Security Cylinders (ANSI)
12. Certified Product Directory.

D. Door and Hardware Institute

1. DHI A115 Series - Specifications for Steel Door and Frame Preparation for Hardware (ANSI)
2. Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames.
3. Sequence and Format for the Hardware Schedule.

- E. Where reference is made to one of the above or other referenced standards, the revisions in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by lock manufacturer.

1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Engineer, and District about door hardware and keying.
2. Installer shall have warehousing facilities in Project's vicinity.
3. Scheduling Responsibility: Preparation of door hardware and keying schedules.

B. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project.

C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

D. Keying Conference: Conduct conference at Project site. In addition to District, Contractor, and Engineer, conference participants shall also include Installer's Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.

3. Requirements for key control system.
4. Address for delivery of keys.

1.06 REGULATORY REQUIREMENT

- A. Hardware for exterior doors may be a component of a door system required to conform to the Code. Coordinate the hardware schedule for those doors with the appropriate supplier to ensure compliance with the project specific calculated design pressures, including wind-borne debris region requirements, Refer to project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Code, the more stringent requirement shall apply.
- B. The “Approved Products Listing Table” on the drawings contains a list of the approved products, materials or systems. For substitutions, it shall be the sole responsibility of the Contractor to provide evidence of code compliance for any product, material or system not listed on the Approved Products List, and the responsibility of the Contractor to obtain the required Product Approval for the product, material or system by demonstrating the products compliance with the Florida Building Code, using one of the methods outlined in Chapter 9B-72 of the Department of Community Affairs, Florida Building Commission.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to District.
- D. Deliver keys and permanent cores to District by registered mail or overnight package service.

1.08 COORDINATION

- A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.

- c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

- 2. Warranty Period: Three years, except 10 years for manual closers.

1.10 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for District's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Provide six months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in the manufacture and installation of original products.

PART 2 PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products and the BHMA standard referenced.
- B. 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 Sets" Article. Products are identified by using door hardware designations, as follows:
 - 1. 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 Sets" Article.
 - 2. References to BHMA Standards: Provide products complying with these standards and requirements for description, quality, and function.

2.02 MATERIALS

- A. All hardware shall be best grade, entirely free from imperfections in manufacture and finish. Qualities, weights and sizes specified herein are the minimum that will be accepted. All UL labeled doors shall have UL approved hardware, except that hinges which are not UL approved shall have a melting point of greater than 2000 degrees F.
- B. Hardware Items
 - 1. Hinges - Aluminum Doors – three 4-1/2-in by 4-1/2-in by 1/4-in aluminum plate. Alutech or Equal.

- a. Quantity: Provide the following, unless otherwise indicated:
 - 1) Two Hinges: For doors with heights up to 60 inches.
 - 2) Three Hinges: For doors with heights 61 to 90 inches.
 - 3) Four Hinges: For doors with heights 91 to 120 inches.
2. Door Closers - Sargent 250 Series (cast iron bodies). Covers shall be primed compatible with finished paint specified except with plastic covers, no priming required. Provide with cushion stop arm where no separate stop is provided and with other arm functions as scheduled. Equals - LCN4000 Series.
3. Locksets - Sargent 9200 Series, heavy duty Mortise type, with LNP lever and rosette with wrought box strike, stainless steel, six pin cylinders. Furnish in operation scheduled. Equal – Corbin/Russwin, Schlage or Yale.
4. Kick Plates - Stainless Steel, six-in high by 0.050-in thick by two-in less width of door (LWOD), 1-in LWOD, at double doors.
5. Stops - Ives 436 or 438 as required by floor condition. Other stops as scheduled. Equals - Baldwin, Quality.
6. Flush Bolts – Glynn-Johnson FB6W forged brass, 1/2 inch diameter flattened bolt tip and standard 12 inch rod.
7. Sound/Weather Seals - Zero 360 Mortised automatic door bottom x Zero 188 Surface type neoprene head and jambs. Meeting stile - Zero 328 each leaf on inside. All clear aluminum except provide in bronze anodized finish at bronze anodized/bronze colored doors. Equals - Pemko, Reese.
8. Silencers - Glynn-Johnson GJ 64. Equals - Baldwin, Quality.
9. Thresholds - Zero 655 5-in thresholds in aluminum (unless otherwise noted). Zero 65A 5-in threshold in aluminum for latch track hardware applications. Equals - Pemko, Reese.
10. Exit Devices – Where concealed vertical rod devices are scheduled, provide Sargent model 8400 for metal or aluminum doors, function as indicated in Hardware Schedule, Dor-O-Matic model 1690 or equal. Elsewhere provide Sargent mortise lock type pushbar 8900 Series, function as indicated in Hardware Schedule. Trim design shall be ETP. Stainless steel assemblies, covers, internal parts, pins, springs and pivots. Provide full coverage, stainless steel back plates at full vision light doors. Equal - Von Duprin.
11. Secure Firefighter's Key Box
 - a. Knox Co., UL approved, Series 3200-R Knox-Box key box (entrance access box) with cylinder protection flap (hinged) for recessed mounting in masonry. Locate recessed as directed. Finish - factory finished, baked polyester powder coat on prime coat in color as selected. Provide with five 1/4-in minimum stainless steel bolts and expansion anchors as specified in Division 5 with anchors drilled and set in masonry into CMU backup and bolts securing key box as approved.

- b. The manufacturer's authorization form shall be obtained by the Contractor and he/she shall coordinate obtaining the required authorization by fire agency and pay required processing fees. Keys for box will be issued only to the fire agency.
- C. Closers shall be sized as recommended by Manufacturer and as approved for size and location of door served.
- D. On exterior doors, provide hinges with pins not removable when door is closed. Provide 1/2 pair hinges for each two-ft-six-in or part thereof of door height.
- E. Provide type of threshold required by the Door Schedule for particular doors and provide weather seals at exterior doors.
- F. Provide three silencers in lock side jamb of single doors and four silencers in head of double doors. No silencers are required at doors with sound/weather seals.

2.03 FINISHES

- A. Stainless steel finish shall be US32D.
- B. Chrome plated, bronze or brass finish shall be US26D.

2.04 KEYING

- A. All cylinder locks including padlocks shall be grand masterkeyed in one new set that is coordinated with the District's system. All cylinders shall be construction keyed for Contractor's use during construction period. Install permanent cylinders when directed.
- B. Furnish:
 - 1. Three masterkeys.
 - 2. Two change keys with each lock.
 - 3. Three construction day keys.
- C. Key Schedule: After a keying meeting between representatives of the District, Engineer, hardware supplier, and, if requested, the representative for the lock manufacturer, the supplier shall provide a keying schedule, listing the levels of keying, as well as an explanation of the key system's function, the key symbols used, and the door numbers controlled.

2.05 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location and as otherwise approved by Engineer.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal, 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. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

- C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to 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.
 - 1. 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.
 - 2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

2.06 FINISHES

- A. Standard: BHMA A156.18, as indicated in door hardware sets.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. 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

3.01 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, wall and floor construction, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.

3.03 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.

1. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
- B. 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 work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant.

3.04 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: District will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.
 1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.05 ADJUSTING

- A. 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.
 1. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least three seconds to move to a point three inches from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.06 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.07 DOOR HARDWARE SETS

HW 1

Hinges
1 Exit Device - 8713ET
1 Closer
1 Kickplate
Silencers
Bottom Seal

HW 2 – pair of doors

Hinges
1 Exit Device - 8713ET
1 Flush Bolts (inactive leaf)
2 Closers - Stop/Holder Arms
2 Kickplates
Silencers
Bottom Seal

END OF SECTION

SECTION 09901
SURFACE PREPARATION AND SHOP PRIME PAINTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required for the surface preparation and application of shop primers on ferrous metals, excluding stainless steels, as specified herein.

1.02 RELATED WORK

- A. Finish painting is included in Section 09902.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings, manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses.
- B. Submit representative physical samples of the proposed primers, if required by the Engineer.

1.04 REFERENCE STANDARDS

- A. The Society for Protective Coatings (SSPC)
 - 1. SSPC-SP 6/NACE No. 3 - Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3: Commercial Blast Cleaning
 - 2. SSPC-SP 10/NACE No. 2 - Joint Surface Preparation Standard SSPC-SP 10/NACE No. 2: Near-White Blast Cleaning.
- B. 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 MATERIALS

- A. Submerged Surfaces - Shop primer for ferrous metals which will be in contact with water being treated, either submerged or which are subject to splash action or which are specified to be considered submerged service shall be shop primed with the following:
 - 1. Shop Prime Coat for Ferrous Metal Surfaces: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)
 - a. TNEMEC: Series 1 Omnithane
 - b. Carboline: Carboguard 561
 - c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
 - d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amerlock 400.
 - e. Or equal.

2. Shop Prime Coat for Ductile Iron Pipe: (Epoxy, Polyamidoamine Shop Primer)
 - a. TNEMEC: Series N140 Pota-Pox-Plus
 - b. Carboline: Carboguard 561
 - c. Sherwin-Williams Company (The): Macropoxy 846 NSF Winter Grade Epoxy Mill White
 - d. PPG PMC Aquapon HB Potable Water Epoxy Coating 95-132 Series or PPG PMC Amerlock 2 Epoxy.
 - e. Or equal.
- B. Non-Submerged Surfaces: Shop primer for ferrous metals which will not be in contact with water being treated, not submerged and not subject to splash action shall be shop primed with the following:
 1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)
 - a. TNEMEC: Series 1 Omnithane
 - b. Carboline: Carboguard 561
 - c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
 - d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amercoat 68HS
 - e. Or equal.
- C. Non-Primed Surfaces - Gears, bearings surfaces and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during all periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.
- D. Compatibility of Coating Systems - Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Section 09902 for use in the field and which are recommended for use together.

PART 3 EXECUTION

3.01 APPLICATION

- A. Surface Preparation and Priming
 1. Non-submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 6/NACE No. 3, immediately prior to priming. Submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 10/NACE No. 2, immediately prior to priming. Consult manufacturer regarding required surface profiles.
 2. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
 3. Shop prime in accordance with approved manufacturer's recommendations.
- B. Non-Primed Surfaces
 1. Apply approved coating per manufacturer's recommendations.

3.02 FABRICATED ITEMS

- A. All items to be shop primed shall be blast cleaned as specified for applicable service prior to priming. If, in the opinion of the Engineer, any prime coating that has been improperly applied or if material contrary to this Section has been used, that coating shall be removed by abrasive blasting to white metal and reprimed in accordance with this Section.
- B. All shop prime coats shall be of the correct materials and applied in accordance with this Section. Remove prime coats not in accordance with this Section by blast cleaning and apply the specified prime coat at no additional cost to the District.
- C. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots prepared as approved and retouched with the specified primer before the application of successive paint coats in the field.
- D. Shop finish coats, if proposed and allowed, shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the Engineer, a shop finish coat system does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat or coats of paint as directed by the Engineer to accomplish the desired appearance and protection quality. Submit to the Engineer substantial evidence that the standard finish is compatible with the specified finish coat.
- E. Properly protect the shop prime and finish coats against damage from weather or any other cause.
- F. Wherever fabricated equipment is required to be blast cleaned, protect all motors, drives, bearings, gears, etc., from the entry of grit. Equipment found to contain grit shall be promptly and thoroughly cleaned.

END OF SECTION

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SECTION 09902
PAINTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all painting complete as shown on the Drawings and as specified herein.
- B. It is the intent of this Section to paint all exposed structural and miscellaneous steel; chemical tanks and systems; mechanical and electrical equipment; sluice gates, operators and posts; conveying systems, pipe, fittings and valves; electrical conduit and appurtenances; new CMU walls; exposed interior ducts; all as specified in the attached painting schedules and all other work obviously required to be painted unless otherwise specified. Minor items not mentioned in the schedule of work shall be included in the work of this Section where they come within the general intent of this Section as stated herein.
- C. Aluminized steel, above roof level, for stacks - Paint with silicone aluminum as specified. Other aluminum-paint only where noted (as is specified). Paint items so noted in Paragraph 1.01B and in accordance with the Painting Schedule. Provide vinyl film letters and numbers for markings as specified. Items noted in other Specification Sections as having factory finish and other factory finished items are obviously not field painted. The Contractor is responsible for having damaged factory finish painted items repaired or, if so ordered, for replacing items. The various Sections are responsible, as stated in each, for preparation and field touch-up of abrasions, welds and damaged primed areas of primed or galvanized components after erection.
- D. The following items will not be painted:
 - 1. Concrete except where specified above and scheduled to be painted and seamless flooring.
 - 2. Finish hardware.
 - 3. Non-ferrous metals and stainless steel, unless specifically noted otherwise.
 - 4. Factory pre-finished architectural components.
 - 5. Packing glands and other adjustable parts and name plates of mechanical equipment.
 - 6. Parts of buildings not exposed to sight, unless specifically noted otherwise.
 - 7. Maintenance equipment
 - 8. Plumbing fixtures.
 - 9. Mechanical, HVAC, Plumbing and Electrical equipment which has been finished painted in the factory as specified in Divisions 11, 13, and 15.

1.02 RELATED WORK

- A. Valve identification is included in Division 15.

- B. Shop priming and surface preparation of equipment and piping (except copper piping) are specified in Section 09901 and included in the respective Section with the item to be primed.
- C. Shop primers associated with hollow metal doors and frames are included in Section 08111.
- D. Shop primers associated with louvers are included in Section 10200.
- E. Shop priming of metal substrates with primers is included in Division 5.
- F. Concrete coating on interior wall surfaces, slabs, and overhead slabs exposed to wastewater are specified in 03180.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01300.
- B. Product Data: For each type of product indicated.
- C. Samples: Submit the following for each type of coating system and in each color and gloss of finish coat indicated.
 - 1. Color cards for initial color selections.
 - 2. Three sets of eight-in by eight-in samples, on 1/4-in hardboard, of all colors required for all types of paint. Resubmit until approved.
- D. Product List: For each product indicated. Cross-reference products to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules.

1.04 REFERENCE STANDARDS

- A. Steel Structures Painting Council (SSPC)
 - 1. SSPC SP-1 - Surface Preparation Specification No. 1 Solvent Cleaning.
 - 2. SSPC SP-2 - Surface Preparation Specification No. 2 Hand Tool Cleaning.
- 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 DELIVERY, STORAGE AND HANDLING

- A. 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.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.06 PROJECT CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F.
- B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than five deg F above the dew point; or to damp or wet surfaces.

1.07 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
 - 1. Quantity: Furnish an additional five percent, but not less than one gal. of each material and color applied.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Provide products by one of the following:
 - 1. Tnemec, Inc.(TN);
 - 2. The Sherwin Williams Company (SW)
 - 3. PPG Architectural Finishes, Inc. (PPG)
 - 4. PPG Architectural Finishes, Inc. Ameron (AME)
 - 5. Or equal.

2.02 MATERIALS

- A. Material Compatibility:
 - 1. Provide materials for use within each coating 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.
 - 2. Provide products of same manufacturer for each coat in a coating system.
- B. All painting materials shall be delivered to the work site in unbroken packages, bearing the manufacturer's brand and name. They shall be used without adulteration and mixed, thinned and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.
- C. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used. Refer to Section 09901 for special primers.

- D. Work areas will be designated by the Engineer for storage and mixing of all painting materials. Materials shall be in full compliance with the requirements of pertinent codes and fire regulations. Proper containers outside of the buildings shall be provided and used for painting wastes and no plumbing fixture shall be used for this purpose.
- E. Colors: As selected by Engineer from manufacturer's full range.

2.03 COLOR CODING FOR PIPES AND EQUIPMENT

- A. The color code establishes, defines and assigns a definite color for each process system. All elements which are an integral part of the system, that is originating from the equipment and/or supplying the equipment, shall be painted between and up to but not including the fixed flanges nor the flexible conduit connections on the equipment. Valves and fittings shall be painted in the color of the main body of the pipe.
- B. All pipes and equipment shall be painted with final coat color selected by the Engineer and shall be treated as an integral part of the Contract.
- C. All hanger saddles and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. Hanger rods and hanger rod connections to building structure shall be painted to match the color of the wall or ceiling to which it is attached.

2.04 LETTERING OF TITLES

- A. The name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of fluids, shall be indicated on each pipe system. Titles shall not be located more than 26 linear feet apart and shall also appear directly adjacent to each side of any wall the pipeline breaches, adjacent to each side of the valve regulator, flowcheck, strainer cleanout and all pieces of equipment.
- B. Titles shall identify the contents by complete name at least once in each space through which it passes and thereafter by generally recognized abbreviations, letters or numerals as approved. Identification title locations shall be determined by the Engineer but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title should be clearly visible from operating positions especially those adjacent to control valves.
- C. Numbers and letters shall be die-cut from 3.5 mil vinyl film and pre-spaced on carrier tape. Adhesive and finish surface shall be protected with one piece removable liners. Color shall be white or black as approved depending on substrate color.
- D. Letter size shall be as indicated in the following table:

OUTSIDE DIAMETER OF PIPE OR COVERING	SIZE OF LEGEND LETTERS
3/4-in to 1-1/4-in	1/2-in
1-1/2-in to 2-in	3/4-in
2-1/2-in to 6-in	1-1/2-in
8-in to 10-in	2-1/2-in
Over 10-in	3-in

- E. The system for preparation and application of letters shall be Type B a.s.i/2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Letter type shall be Optima Bold, upper case. Grid 2 spacing shall be employed. Arrow shall match as approved, letter type and size. The instructions of the manufacturer shall be followed in respect to storage, surface preparation and applications of letters.

2.05 TITLES FOR EQUIPMENT

- A. Titles shall be provided in vinyl film as specified above on all equipment using one-in. high Optima Bold upper case, Grid 2 spacing, white or black in color as approved depending on substrate. Use titles shown on mechanical drawings for bidding purposes. Titles shall be mounted at eye level on machines where possible or at the upper most broad vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, the items shall be numbered consecutively as indicated on the mechanical drawings or as directed by the Engineer; for example, Pump No. 1, Pump No. 2, etc. Titles shall be composed in more than one line if required and justified on the left-hand side as approved.

2.06 TESTING EQUIPMENT

- A. Furnish to the Engineer for use on the Project for paint inspection, wet and dry film thickness gauges and all other equipment required by the Engineer for inspection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
 - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
 - b. Masonry (CMU): 12 percent.
 - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 3. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
 - 4. Coating application indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. All surfaces to be painted shall be prepared as specified herein and shall be dry and clean before painting. Special care shall be given to thoroughly clean interior concrete and CMU surfaces to receive polyamide cured epoxy paint of all marks before application of finish.

- B. All metal welds, blisters, etc., shall be ground and sanded smooth. All pits and dents shall be filled, and all imperfections shall be corrected so as to provide a smooth surface for painting. All rust, loose scale, oil, tar and asphalt bearing coatings, grease and dirt shall be removed by use of approved solvents, wire brushing, grinding or sanding.
- C. Concrete surfaces shall have been finished as specified in Section 03350. Report unsatisfactory surfaces to the Engineer. Concrete shall be left for one month minimum before painting and shall be free of dust, oil, curing compounds and other foreign matter.
- D. Concrete masonry unit surfaces shall be smooth and cleaned of all dust, loose mortar and other foreign matter.
- E. All PVC pipe and other plastic matrix surfaces to be painted shall be sanded to an approved profile and cleaned of residue before painting.
- F. All PVC pipe and other plastic matrix surfaces to be painted shall be lightly sanded and cleaned of residue before painting.
- G. Galvanized, aluminum, and copper surfaces shall have all oxidation and foreign material removed before painting by SSPC SP-1, using an approved V.O.C. compliant method. Galvanized and, when ordered, the other metal surfaces specified above shall be hand tool cleaned to SSPC SP-2 standards to provide a uniform 1 mil surface profile.
- H. Existing Surfaces to be Repainted
 - 1. Existing masonry, steel and other previously field painted surfaces so noted or as provided in Paragraph 1.01B shall be repainted.
 - 2. Preparation shall be in general as specified above for new surfaces except that all loose paint shall be removed, and all edges of existing paint shall be feathered to ensure a smooth surface.
 - 3. Paint removal, capture of its residue, and its disposal shall be handled in accordance with all laws and regulations concerning disposal of hazardous materials.
 - 4. Primer (spot) and paint used for a particular surface shall, in general, be as scheduled for that type of new surface. Provide a CDM Smith approved organic zinc-rich (min. 83% zinc in dried film) primer as specified. Confirm with the paint manufacturer that the paint proposed for a particular repaint condition will be compatible with the existing painted surface. Perform adhesion and compatibility tests on existing substrates as ordered and required. Repainted areas shall be covered by the same guaranty specified for remainder of Project.

3.03 WORKMANSHIP

A. General

- 1. At the request of the Engineer, sample areas of the finished work prepared in strict accordance with this Section shall be furnished and all painting shall be equal in quality to the approved sample areas. Finished areas shall be adequate for the purpose of determining the quality of workmanship. Experimentation with factory or paint manufacturer's

warehouse mixed colors shall be furnished to the satisfaction of the Engineer where standard chart colors are not satisfactory.

2. Protection of furniture and other movable objects, equipment, fittings and accessories shall be provided throughout the painting operation. Canopies of lighting fixtures shall be loosened and removed from contact with surface, covered and protected and reset upon completion. Remove all electric plates, surface hardware, etc., before painting, protect and replace when completed. Mask all machinery name plates and all machined parts not receiving a paint finish. Dripped or spattered paint shall be promptly removed. Lay drop cloths in all areas where painting is being done to adequately protect flooring and other work from all damage during the operation and until the finished job is accepted.
3. On metal surfaces apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. One gallon of paint as originally furnished by the manufacturer shall not cover a greater area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s). On masonry, application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.

B. Field Priming

1. Steel members, metal castings, mechanical and electrical equipment and other metals which are shop primed before delivery at the site will not require a prime coat on the job. All piping and other bare metals to be painted shall receive one coat of primer before exposure to the weather, and this prime coat shall be the first coat as specified in the painting schedule. Surface preparation of bare metal shall be the responsibility of the Contractor.
2. Equipment which is specified to receive a baked-on enamel finish or other factory finish shall not be field painted unless the finish has been damaged in transit or during installation. Surfaces that have been shop painted and have been damaged, or where the shop coat or coats of paint have deteriorated, shall be properly cleaned and retouched before any successive painting is done on them in the field. All such field painting shall match as nearly as possible the original finish. Preparation and painting shall be provided by the Contractor.
3. Equipment shipped with a protective shop painting coat or coats shall be touched up to the satisfaction of the Engineer with primers as recommended by the manufacturer of the finish paint. Preparation and painting shall be provided by the Contractor.

C. Field Painting

1. All painting at the site shall be under the strict inspection of the Engineer. Only skilled painters and, where dictated by special conditions or systems and so ordered, specialist painters shall be used on the work.

2. All paint shall be at room temperature before applying, and no painting shall be done when the temperature is below 60 degrees F, in dust-laden air, when rain or snow is falling, or until all traces of moisture have completely disappeared from the surface to be painted.
3. Successive coats of paint shall be different shades (from paint manufacturer's stock or shop mixed paint) of the required colors so as to make each coat easily distinguishable from each other with the final undercoat the approximate shade of the finished coat to ensure no show-through as approved.
4. Finish surfaces shall not show brush marks or other irregularities. Undercoats shall be thoroughly and uniformly sanded with the type paper appropriate for the undercoats to remove defects and provide a smooth even surface. Top and bottom edges of doors shall be painted.
5. Painting shall be continuous and shall be accomplished in an orderly manner so as to facilitate inspection. Materials subject to weather shall be primed coated as quickly as possible. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.
6. All painting shall be performed by approved methods with number of coats modified as required to obtain the total dry film thickness specified. Spray painting shall be performed specifically by methods submitted and as approved by the Engineer.
7. All surfaces to be painted as well as the atmosphere in which painting is to be done shall be kept warm and dry by heating and ventilation, if necessary, until each coat of paint has hardened. Any defective paint shall be scraped off and repainted in accordance with the Engineer's directions.
8. Before final acceptance of the work, all damaged surfaces of paint shall be cleaned and repainted as directed by the Engineer.
9. Only the aluminum work noted on the Drawings or in the Painting Schedule shall be field painted.

3.04 FIELD QUALITY CONTROL

- A. District reserves the right to invoke the following procedure at any time and as often as District deems necessary during the period when coatings are being applied:
 1. District will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
 2. Testing agency will perform tests for compliance with specified requirements.
 3. District may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

3.05 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Engineer, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.06 PAINTING SCHEDULE

- A. All colors will be selected by the Engineer.
- B. The following types of paints by Tnemec Co. (TN), The Sherwin Williams Company (SW), PPG Protective & Marine Coatings, (PPG), and Ameron International (AME) have been used as a basis for the paint schedule; use one of these paints or equal:
 - 1. Epoxy:
 - a. TN: Hi-build Epoxoline II, Series N69.
 - b. SW: Macropoxy 646, B58 Series.
 - c. PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - d. AME: Amerlock 2/400 Series Epoxy.
 - 2. Waterborne Cementitious Acrylic: Result in pinhole free surface.
 - a. TN: Envirofil, Series 130-6602.
 - b. SW: Cement-Plex 875, B42 Series.
 - c. PPG: Cementitious Waterproofing Block Filler 95-217 Series.
 - d. AME: Amerlock 400 BF Epoxy Block Filler.
 - 3. High-Build Acrylic Polyurethane Enamel:
 - a. TN: Endura-Shield - semi-gloss, Series V73.
 - b. SW: Acrolon 218 HS, B65 Series.
 - c. PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
 - d. AME: Amercoat 450HSG Polyurethane.
 - 4. High Heat Silicone Aluminum (to 600 degrees F):
 - a. TN: No product.
 - b. SW: Heat-Flex Hi-Temp 1000 Aluminum, B59-820 Series.
 - c. PPG: Speedhide 6-220 Series Silicone Aluminum Coating.
 - d. AME: Amercoat 878 Silicone Aluminum Coating.

5. Tie Coat, Low VOC, Epoxy:
 - a. TN: FC Typoxy, Series V27.
 - b. SW: Macropoxy 646, B58 Series.
 - c. PPG: Pitt-Guard Epoxy Mastic 95-245 Series.
 - d. AME: Amercoat 385 Multi-Purpose Epoxy.

6. Acrylic Latex Emulsion, Eggshell Finish:
 - a. TN: Tneme-Cryl, Series 6.
 - b. SW: DTM Primer/Finish, B66 Series.
 - c. PPG: Pitt-Tech Plus 90-1110 Series Satin DTM Acrylic.
 - d. AME: Amercoat 220 Waterborne Acrylic.

7. Vinyl Acrylic Surface Sealer:
 - a. TN: PVA Sealer, Series 51.
 - b. SW: Prep-Rite 200 Primer, B28 Series.
 - c. PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
 - d. AME: Amercoat 148 Acrylic Primer.

- C. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat as recommended by manufacturer:
 1. Exterior non-submerged ferrous metals (except first coat-hollow metal-pressed metal work):
 - a. First Coat: On properly prepared unprimed metal or for touch-up:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
 - b. Second Coat:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
 - c. Third Coat:
 - 1) TN: Endura-Shield - semi-gloss, Series V73.
 - 2) SW: Acrolon 218 HS, B65 Series.
 - 3) PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
 - 4) AME: Amercoat 450HSG Polyurethane.
 2. Interior non-submerged concrete scheduled for painting:
 - a. First and Second Coats:

- 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
3. Interior concrete masonry units:
- a. First Coat: Result in pinhole free surface.
 - 1) TN: No. 130-6602.
 - 2) SW: Cement-Plex 875, B42 Series.
 - 3) PPG: Cementitious Waterproofing Block Filler 95-217 Series.
 - 4) AME: Amerlock 400 BF Epoxy Block Filler.
 - b. Second and Third Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
4. Interior non-submerged ferrous metals (except first coat of previously painted metal work), on properly prepared unprimed metal or for touch-up:
- a. First Coat:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
 - b. Second and Third Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
5. Submerged ferrous metals and ferrous metals subject to submersion or splashing. Surface shall be lightly sanded or abraded before application of first field coat.
- a. First and Second Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
6. Plastic piping and, where scheduled to be painted, plastic components:
- a. First and Second Coats:

- 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
7. Pipe insulation: (Plastic or metal sheathed insulation-paint as scheduled for appropriate substrate):
- a. First Coat:
 - 1) TN: Vinyl-Acrylic Sealer, No. 51-792.
 - 2) SW: Prep-Rite 200, B28 Series.
 - 3) PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
 - 4) AME: Amercoat 148 Acrylic Primer.
 - b. Second and Third Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
8. Aluminum Designated to be Painted:
- a. Mechanically abrade surfaces to a uniform profile of 1 to 2 mils and clean completely.
 - b. First and Second Coats - (Interior):
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
 - c. First Coat - (Exterior):
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
9. Copper Piping:
- a. First and Second Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
10. Hot Ferrous Metal Surfaces:
- a. First and Second Coats:

- 1) TN: No product.
- 2) SW: Heat-Flex Hi-Temp 1000 Aluminum, B59-820 Series, Aluminum.
- 3) PPG: Speedhide 6-220 Series Silicone Aluminum Coating.
- 4) AME: Amercoat 878 Silicone Aluminum Coating.

11. Previously Painted Metal Surfaces:

- a. First coat on substrates prepared as approved and replacing first coat of above-specified systems. Complete painting with remainder of specified system for each type of substrate.
- b. First Coat:
 - 1) TN: FC Typoxy, Series V27.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.

12. Exterior galvanized steel surfaces:

- a. Mechanically abrade surfaces to a uniform profile of 1 to 2 mils and clean completely.
- b. First Coat:
 - 1) TN: FC Typoxy, Series V27.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard Epoxy Mastic 95-245 Series.
 - 4) AME: Amercoat 385 Multi-Purpose Epoxy.
- c. Second Coat:
 - 1) TN: Endura-Shield - semi-gloss, Series V73.
 - 2) SW: Acrolon 218 HS.
 - 3) PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
 - 4) AME: Amercoat 450HSG Polyurethane.

13. Interior concrete surfaces of secondary containment areas

- a. Surface Preparation: SSPC-SP13
- b. Surfacer:
 - 1) TN: Series 218 applied at 1/16"±
 - 2) Or Equal
- c. Primer:
 - 1) TN: Series 201
 - 2) Or Equal

- d. Base Coat:
 - 1) TN: Series 275
 - 2) Or Equal

- e. Top Coat:
 - 1) TN: Series 282
 - 2) Or Equal

END OF SECTION

SECTION 10140
SIGNAGE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and design and deliver signage for the Project as shown on the Drawings and as specified herein.
- B. The work includes:
 - 1. Panel signs.
 - 2. Restrictive Signage.

1.02 RELATED WORK

- A. Temporary Project identification signs and for temporary information and directional signs are included in Division 1.
- B. Labels, tags, and nameplates for plumbing systems and equipment are included in Division 15.
- C. Labels, tags, and nameplates for HVAC systems and equipment are included in Division 15.
- D. Illuminated Exit signs are included in Division 16.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show fabrication and installation details for signs.
 - 1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
 - 2. Provide message list, typestyles, graphic elements and layout for each sign.
- D. Samples for Initial Selection: Manufacturer's color charts consisting of actual units or sections of units showing the full range of colors available for the following:
 - 1. Acrylic sheet.
 - 2. Die-cut vinyl characters and graphic symbols. Include representative samples of available typestyles and graphic symbols.
- E. Samples for Verification: For each of the following products and for the full range of color, texture, and sign material indicated, of sizes indicated:

1. Aluminum: For each form, finish, and color, on 6-inch- long sections of extrusions and squares of sheet at least four by four inches.
 2. Acrylic Sheet: 8 by 10 inches for each color required.
 3. Panel Signs: Not less than 12 inches square including border.
 4. Accessories: Manufacturer's full-size unit.
- F. Qualification Data: For Installer and fabricator.
- G. Maintenance Data: For signs to include in maintenance manuals.
- H. Warranty: Special warranty specified in this Section.

1.04 REFERENCE STANDARDS

A. American Architectural Manufacturers Association

1. AAMA 611 - Voluntary Specifications for Anodized Architectural Aluminum
2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

B. ASTM International

1. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
2. ASTM A 666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
3. ASTM A 1008/A 1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low-Alloy with Improved Formability
4. ASTM B 26/B 26M - Specification for Aluminum Alloy Sand Casting
5. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
6. ASTM B 221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
7. ASTM D 256 - Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
8. ASTM D 638 - Test Method for Tensile Properties of Plastics
9. ASTM D 648 - Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position
10. ASTM D 790 - Test Method for Flexural Properties for Unreinforced and Reinforced Plastics and Electrical Insulating Material

- 11. ASTM D 4802 - Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
- C. International Code Council/American National Standards Institute
 - 1. ICC/ANSI A117.1 - Accessible and Usable Buildings and Facilities
- D. National Association of Architectural Metal Manufacturers
 - 1. Metal Finishes Manual for Architectural and Metal Products.
- E. SSPC: The Society for Protective Coatings
 - 1. SSPC-SP 5/NACE No. 1 - Joint Surface Preparation Standard SSPC-SP 5/NACE No. 1: White Metal Blast Cleaning
 - 2. SSPC-SP 8 - Surface Preparation Specification No. 8: Pickling
- F. Where reference is made to one of the above or other referenced standards, the revisions in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- C. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

1.06 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when weather conditions permit installation of signs in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify recess openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.07 COORDINATION

- A. Coordinate placement of anchorage devices with templates for installing signs.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Deterioration of metal finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image colors and sign lamination.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aluminum Castings: ASTM B 26/B 26M, of alloy and temper recommended by sign manufacturer for casting process used and for use and finish indicated.
- B. Aluminum Sheet and Plate: ASTM B 209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 5005-H32.
- C. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.
- D. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
- E. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils with pressure-sensitive adhesive backing, suitable for exterior applications.

2.02 PANEL SIGNS

- A. Manufacturers: Provide products by one of the following:
 1. ACE Sign Systems, Inc.
 2. APCO Graphics, Inc.
 3. Gemini Incorporated.
 4. Mohawk Sign Systems.
 5. Signature Signs, Incorporated.
 6. Or equal.
- B. Exterior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner, complying with the following requirements:
 1. Aluminum Sheet: 0.080 inch thick.
 2. Edge Condition: Square cut.
 3. Corner Condition: Square.

4. Mounting:
 - a. Wall mounted.
 - b. Manufacturer's standard non-corroding anchors for substrates encountered.
5. Color: As selected by Engineer from manufacturer's full range.

C. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminum to suit panel sign construction and mounting conditions indicated. Factory paint brackets in color matching background color of panel sign.

2.03 RESTRICTIVE SIGNAGE:

- A. 60 mil, polished vinyl, overcoated with Tedlar sheet with four mounting holes and rounded corners for other locations.
- B. Print (permanent type as approved) all with required graphics and letters. Print under overcoat where such occurs.
- C. Provide stainless steel fasteners and plastic drill-in anchors as required or stainless steel wire for fastening where each is ordered.
- D. Signs shall be by Seton Name Plate Corp. or equal.
- E. Restrictive signs shall conform with OSHA regulations for accident prevention. Size of signs: 10-in high by 14-in. Provide signs in Restrictive Signage Schedule.

2.04 ACCESSORIES

- A. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.05 FABRICATION

- A. General: Provide manufacturer's standard signs of configurations indicated.
 1. Welded Connections: Comply with AWS standards for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded surfaces of welding flux and dress exposed and contact surfaces.
 2. Mill joints to tight, hairline fit. Form joints exposed to weather to exclude water penetration.
 3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
 4. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.06 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. 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.

2.07 ALUMINUM FINISHES

- A. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - 1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils, medium gloss.

2.08 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Verify that items including anchor inserts are sized and located to accommodate signs.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
 - 1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.

- B. Wall-Mounted Signs: Comply with sign manufacturer's written instructions except where more stringent requirements apply.
 - 1. Two-Face Tape: Mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.
 - 2. Mechanical Fasteners: Use non-removable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.
- C. Bracket-Mounted Signs: Provide manufacturer's standard brackets, fittings, and hardware for mounting signs that project at right angles from walls and ceilings. Attach brackets and fittings securely to walls and ceilings with concealed fasteners and anchoring devices to comply with manufacturer's written instructions.

3.03 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by District.

3.04 SIGNAGE SCHEDULE

ROOM IDENTIFICATION SIGNAGE SCHEDULE		
Room Name/Sign Text	Location Door Number	Panel Type (Int. or Ext.)
PUMP ROOM	DA-101A	EXT
PUMP ROOM	DA-101B	EXT
ELECTRICAL ROOM	DB-101A	EXT
ELECTRICAL ROOM	DB-101B	EXT
RESTRICTIVE SIGNAGE SCHEDULE		
Quantity	Sign Copy	Location
4	NOTICE No Smoking	Located at each door.
2	DANGER High Voltage Electric	Located at each electrical building door.

END OF SECTION

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SECTION 10200
LOUVERS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install louvers complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Louvers that are a part of mechanical equipment are included in Division 15.
- B. Caulking is included in Division 7.
- C. Dampers and ductwork are included in Division 15.
- D. Grilles and registers are included in Division 15.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, detailed information on materials proposed and installation methods.
- B. Product Data: For each type of product indicated.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- C. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
- D. Samples for Verification: For each type of metal finish required.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- F. Florida Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.04 REFERENCES

- A. Air Movement and Control Association International, Inc.
 - 1. AMCA 500-L - Test Methods for Louvers, Dampers
 - 2. AMCA 501 - Application Manual for Air Louvers
- B. American Welding Society
 - 1. AWS D1.2/D1.2M - Structural Welding Code - Aluminum
- C. ASTM International
 - 1. ASTM B 221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
 - 2. ASTM D 1187 - Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal
 - 3. ASTM E 488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.
- C. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.06 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.07 QUALITY ASSURANCE

- A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

1.08 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.09 FLORIDA REGULATORY REQUIREMENTS

- A. The products, materials and assemblies, including anchorage, proposed for the work of this Section shall comply with project specific calculated design pressures and the Florida Building Code (Code), including wind-borne debris region requirements, and shall be designed by the Manufacturer and installed by the Contractor to meet these requirements. Refer to project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Code, the more stringent requirement shall apply.
- B. It shall be the responsibility of the contractor to provide evidence of code compliance for the products, materials and assemblies, including anchorage specified in this section. Evidence of code compliance shall be demonstrated by compliance with the Florida Building Code, using one of the methods outlined in Chapter 9N-3 of the Florida Administrative Code, Department of Community Affairs, Florida Building Commission, Product Approval.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.
- B. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 - 2. For color-finished louvers, use fasteners with heads that match color of louvers.

- C. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.02 FABRICATION, GENERAL

- A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Channel unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.
 - 1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
 - 2. Semi-recessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
 - 3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
 - 4. Exterior Corners: Prefabricated corner units with mitered and welded blades and with semi-recessed mullions at corners.
- G. Provide extended sills for recessed louvers.

- H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.03 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Acoustical Louver:

1. Manufacturers: Provide products by one of the following:
 - a. Greenheck Fan Corporation.
 - b. Ruskin Company.
 - c. Or equal.
2. Louver Depth: 12 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. Louvers shall meet the criteria as specified in the table below Performance Ratings:

	ACL1245D
Blade Angle	45°
Free Area (4-ft x 4-ft unit)	4.57 sq ft
Percent free area	29 percent

5. Sound Transmission Performance:

Octave Band/Frequency (Hz)	Transmission Loss	Free Field Noise Reduction (db) Ruskatherm Blanket
2/125	7	13
3/250	6	12
4/500	14	20
5/1000	16	22
6/2000	13	19
7/4000	11	17
STC	13	
OITC	11	

6. Wind-Driven Water Penetration Performance:
 - a. Beginning point of water penetration, 1025 fpm.
7. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
8. Louver shall be Miami-Dade approved.

2.04 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 - 1. Screen Location for Fixed Louvers: Interior face.
 - 2. Screening Type: Bird screening.
- B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of six inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 - 1. Metal: Same kind and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
 - 2. Finish: Mill finish unless otherwise indicated.
 - 3. Type: Non-rewirable, U-shaped frames.
- D. Louver Screening for Aluminum Louvers:
 - 1. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire.

2.05 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.06 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. Color and Finish to match existing louvers in building.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required.

3.04 ADJUSTING AND CLEANING

- A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.
- B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Engineer, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

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SECTION 10520
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install fire protection specialties complete as shown on the Drawings and as specified herein.
- B. This Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.02 SUBMITTALS

- A. Submit, in accordance with Section 01300, detailed information on materials proposed and installation methods.
- B. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.
- D. Warranty: Sample of special warranty.

1.03 REFERENCES

- A. ASTM International (ASTM)
 - 1. ASTM D 4802 - Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet
- B. National Association of Architectural Metal Manufacturers
 - 1. Metal Finishes Manual for Architectural and Metal Products.
- C. NFPA (NFPA)
 - 1. NFPA 10 - Portable Fire Extinguishers
- D. SSPC: The Society for Protective Coatings (SSPC)
 - 1. SSPC-SP 8 - Surface Preparation Specification No. 8: Pickling
 - 2. SSPC-SP 5/NACE No. 1 - Joint Surface Preparation Standard SSPC-SP 5/NACE No. 1: White Metal Blast Cleaning
- E. Where reference 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. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

- 1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

- 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Completion.

PART 2 PRODUCTS

2.01 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

- 1. Manufacturers: Provide products by one of the following:
 - a. Amerex Corporation.
 - b. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - c. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc.
 - d. Or equal.
 - 2. Valves: Manufacturer's standard.
 - 3. Handles and Levers: Manufacturer's standard.
 - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

- B. Multipurpose Dry-Chemical Type in Aluminum Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with mono-ammonium phosphate-based dry chemical in enameled-steel container.

2.02 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

- 1. Manufacturers: Provide products by one of the following:
 - a. Amerex Corporation.
 - b. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - c. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc.

- d. Or equal.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Engineer.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.03 ADJUSTING AND CLEANING

- A. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- B. Touch up marred finishes. Use only materials and procedures recommended or furnished by fire protection mounting bracket manufacturers.

END OF SECTION

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SECTION 11214
VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required, install, complete and ready for operation and field test, four vertical turbine can pumps, including their respective motors and variable frequency drives as shown on the Drawings and as specified herein.
- B. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, factory testing, delivery and complete installation and field testing of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.
- C. The work under this Section shall include supervisory services during installation and field testing of each unit and instructing the regular operating personnel in the proper care, operation and maintenance of the equipment.

1.02 RELATED WORK

- A. Concrete work and the installation of anchor bolts are included in Division 3; however, anchor bolts for these units as recommended by the pump manufacturer (Manufacturer) shall be furnished by the Contractor under this Section.
- B. Instrumentation and control work, except as specified herein, is included in Division 13. Instrumentation and controls provided in this section shall adhere to Instrumentation and Control Specifications Sections in Division 13.
- C. Valves, mechanical piping and appurtenances and pipe hangers and supports are included in Division 15.
- D. Electrical work except as hereinafter specified is included in Division 16.

1.03 REFERENCE STANDARDS

- A. Design, manufacturing and assembly of elements of the equipment specified herein shall be in accordance with the following, where applicable:
 - 1. American Concrete Institute (ACI).
 - 2. American Gear Manufacturers Association (AGMA).
 - 3. American Institute of Steel Construction (AISC).
 - 4. American Iron and Steel Institute (AISI).
 - 5. American Society of Mechanical Engineers (ASME).
 - 6. American National Standards Institute (ANSI).

7. American Petroleum Institute (API).
8. American Society for Testing Materials (ASTM).
9. American Water Works Association (AWWA).
10. American Welding Society (AWS).
11. American Bearing Manufacturers Association (ABMA).
12. Hydraulic Institute (HI) Standards.
13. Institute of Electrical and Electronics Engineers (IEEE).
14. International Organization for Standardization (ISO).
15. National Electrical Code (NEC).
16. National Electrical Manufacturers Association (NEMA).
17. National Sanitation Foundation (NSF).
18. Occupational Safety and Health Administration (OSHA).
19. The Society for Protective Coatings (SSPC).
20. Underwriters Laboratories (UL).

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

1.04 SYSTEM DESCRIPTION

- A. The vertical turbine can pumps will pump water from the South Fork of Black Creek, at the crossing of Black Creek and SR 16 to Keystone Heights area between Lake Magnolia and Lake Brooklyn. The on/off pump operation of the four pump system will be controlled by the corresponding on/off water surface levels within Black Creek and the flow will be limited using the VFD to a maximum of 1,750 gpm per pump in operation. The equipment to be furnished under this section shall include four vertical turbine raw water can pumps, motors, variable frequency drives, and accessories all as specified herein and as shown on the Drawings. Refer to Section 13305 for system description and control narratives. Contractor shall coordinate and be fully responsible for proper operation and compatibility between items in this scope of work and items in Division 13 scope.

1.05 QUALIFICATIONS

- A. To assure unity of responsibility, the pumps, the motors, pump cans, and variable frequency drives shall be furnished and coordinated by the Pump Manufacturer. The Contractor and Pump Manufacturer shall assume responsibility for the satisfactory installation and operation of the entire pumping system including pumps, motors, variable frequency drives, and pump cans as specified.

- B. The equipment covered by this Section is intended to be standard pumping equipment of proven ability as manufactured by companies having extensive experience in the production of such equipment similar to the applications stated in Articles 1.04 and 2.02. Units specified herein shall be furnished by a single manufacturer. The equipment provided shall be designed, constructed and installed to operate satisfactorily when installed as shown on the Drawings or as approved by the Engineer.
- C. Pumps and pump cans shall be manufactured in accordance with the Hydraulic Institute Standards, except where otherwise specified.
- D. The Pump Manufacturer shall be fully responsible for the design, arrangement, and operation of all connected rotating components of the assembled pumping unit mounted on a fabricated steel baseplate and pump can to ensure that neither harmful nor damaging vibrations occur at any speed within the specified operating range.
- E. The Pump Manufacturer or its representative shall have an authorized warranty center within a 300-mile radius of the job site, fully staffed with factory trained mechanics.
- F. All equipment furnished under this Specification shall be new and unused, shall be the standard product of manufacturers having a successful record of manufacturing and servicing similar equipment and systems to that specified herein for a minimum of five years.
- G. The pumping equipment shall be furnished complete with accessories required and shall meet the detailed requirements of the Specifications.
- H. The Pump Manufacturer shall be certified to the ISO 9001 standard for design and manufacture of vertical turbine pumps.
- I. Welding of pressure-containing fabrications shall be by welders qualified to ASME Code Section 9 or AWS D1.1 Structural Welding Code – Steel.
- J. Prior to manufacture, a submittal must be forwarded to the Engineer indicating that the required vibration analyses outlined herein have been performed and that the specified limitations will be met. For the dynamic vibration analysis described, minimum and maximum operating speeds will be in accordance with the operating speeds required to satisfy the conditions of operation specified in Article 2.02. The dynamic vibration analysis required by the following paragraphs shall be performed by Mechanical Solutions Inc. (MSI) of Whippany, NJ, or Engineering Dynamics Inc. (EDI) of San Antonio, TX or alternatively by the Pump Manufacturer if Pump Manufacturer's demonstrated, successful, vibration analysis experience, in at least 20 projects similar in scope, with proposed personnel involved, may be acceptable to the Engineer with analyses in accordance with the specified requirements.
 - 1. Structural dynamic analysis of the combined pump/motor system including the nearby foundation and the piping out to the first pipe restraint or expansion joint. Analysis shall not simply assume the foundation is rigid rather it shall incorporate foundation design shown on the Drawings. The structural dynamic analysis shall predict that no first or second bending mode frequencies will exist within a pump speed range from 20 percent below minimum operating speed of 70 percent to 20 percent above maximum operating speed of 100 percent.

2. A lateral rotordynamic analysis of the pump rotating system (i.e., motor rotor, line shafting, couplings, bowl shafting and impellers, etc.) shall identify and predict that the first lateral critical speed shall have a separation margin of at least 20 percent above the maximum pump speed or 20 percent below the minimum pump speed. If a design modification (i.e., such as changing the bearing span or shaft diameter) cannot resolve a separation margin deficiency or is not practical, a forced damped response analysis shall be performed to demonstrate that the pump will function properly over the speed range.
3. A torsional rotordynamic analysis of the complete rotating system (pump, motor, intermediate shafting, and coupling) shall identify and predict that no torsional natural frequencies occur within a separation margin extending from 20 percent below to 20 percent above the specified pump operating speed range. Additionally, no natural frequencies shall be +/- 10% of 2x times running speed, line frequency, 2x line frequency, vane pass frequency, and VFD control frequencies (if applicable). If a design modification (i.e., such as a shaft diameter change or different coupling arrangement) cannot resolve a separation margin deficiency or is not practical, a forced damped response analysis shall be performed to show that infinite life will be achieved with a safety factor of at least two.
4. Campbell diagrams shall be submitted, documenting the structural lateral, rotating component lateral, and torsional analysis results, graphically demonstrating the separation margins specified above.
5. Maximum vibration velocity in inches per second RMS, measured in the field, shall conform to the requirements of ANSI/HI 9.6.4. In addition, for operating motor speeds less than or equal to 600 rpm, field vibration displacement in mils peak-to-peak shall conform to the requirements of ANSI/HI 9.6.4.

1.06 SUBMITTALS

- A. Submit, in accordance with Section 01300, copies of all materials required to establish compliance with the specifications. In the event that it is not practical to conform to certain details of the specifications because of different manufacturing techniques, describe completely all nonconforming aspects. Submittals shall include the following:
 1. Certified dimensional drawings showing all important details of pump construction and auxiliary apparatus.
 2. Baseplate and pump support design details showing anchor bolt locations and sizing information.
 3. Literature and drawings describing the equipment in sufficient detail, including materials of construction, to indicate full conformance with the detail specifications.
 4. Schematic electrical wiring diagram and other data as required for complete pump installation.
 5. The total weight of the equipment including the weight of the single largest item.
 6. A complete materials table for all equipment establishing compliance with these specifications.

7. A list of the Pump Manufacturer's recommended spare parts with the Pump Manufacturer's current price for each item. Include gaskets, packing, etc. on the list. List all bearings by the bearing manufacturer's numbers only.
8. All information required by Division 1.
9. A statement and supporting data indicating motor bearing life meets or exceeds specified value.
10. Complete data on motors in accordance with Section 16150.
11. Compliance with noise levels as specified in this Section.
12. Complete description of surface preparation and shop painting for pumps and motors.
13. Critical speed analyses report submittal including backup documentation and a statement of guarantee that the critical speed analyses as required in Paragraph 1.05 J of this Section have been completed and that the specified limitations will be met.

B. Design Data:

1. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves to ANSI/HI 14.6 acceptance grade 1U for all specified points, based on actual factory tests of similar units, which show that they meet the specified requirements for head, flow rate, efficiency, guaranteed maximum net positive suction head required (NPSH3), submergence and horsepower. 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 zero flow at shut off head to pump flow rate at minimum specified total head (TH). The POR and AOR (refer to ANSI/HI 9.6.3) shall be clearly shown on the curves. This information shall be prepared specifically for the pump proposed. Catalog sheets showing a family of curves will not be acceptable.

C. Test Reports:

1. Certified motor test data as described in Section 16150.
2. Tabulated data for the drive motors including rated horsepower, full load rpm, power factor and efficiency curves at 1/2, 3/4 and full load, service factor and kW input, including when the pump is at its design point. Submit a certified statement from the motor manufacturer that the motors are capable of continuous operation on the power supply from the variable frequency drives to be furnished without affecting their design life for bearings or windings.
3. Description of proposed pump factory test procedures and equipment.
4. Factory and field performance test data as specified in PART 2 and PART 3.
5. A schedule of the date of factory testing and delivery of the equipment to the job site.

D. Instructions, Certifications, and Reports:

1. Manufacturer's Installation Instructions.

2. Manufacturer's certification of installation meeting Manufacturer's installation, operation and maintenance manuals and as specified in PART 3.
3. Manufacturer's field report as specified in PART 3.
4. Submit warranty information to demonstrate conformance to Article 1.10.
5. Identify the entity and experienced individual who will inspect the installation in accordance with Article 1.07.
6. Welder certifications.

E. Pump Can Plumbness Monitoring Program:

1. At least three weeks prior to beginning installation of any pump can unit, Contractor shall submit to the Engineer a plan for monitoring the plumbness of each installed pump can during and throughout its installation and the installation of surrounding facilities, including concrete placement and earth backfilling, that could affect the unit. The plan should be developed in accordance with the Pump Manufacturer's guidelines for pump can and pump unit to be provided. At a minimum, the plan shall address the following:
 - a. The type and construction of monitoring points to be used including their design and procedures for installation.
 - b. The number and location of monitoring points on each pump can installation.
 - c. Equipment and procedures to be used to perform the monitoring.
 - d. Personnel responsible for conducting the monitoring program and their qualifications. Should the proposed program incorporate surveying techniques, they shall be performed by a professional surveyor with at least three years of experience in surveying with similar instruments.
 - e. The location of control points to which the monitoring measurements will be referenced. The control points shall be at stable locations beyond the influence of planned construction operations and public interference.
 - f. The accuracy of measurements to be acquired and reported.
 - g. Procedures for establishing baseline values to which all subsequent measurements will be compared. Baseline values shall be developed from at least three independent measurements.
 - h. The frequency at which measurements will be made. At a minimum the frequency shall be daily during installation of the pump cans and when excavation, construction or backfilling operations are occurring within 50 feet of the monitored location. If previous readings indicate a trend of possible movement, daily readings shall continue for a period of one week after any apparent movement has ceased. Readings shall be made at least once every two weeks until the pump installation is complete.
 - i. Replacement and/or repair of damaged monitoring instruments including reestablishment of baseline values.
 - j. Provide threshold values that indicate corrective action may be needed to prevent the installation from exceeding the tolerances established by the Pump Manufacturer. The threshold values should be developed so as to provide sufficient warning such that corrective actions can be implemented before limit values are exceeded. Limit values shall be: top plate level within 0.002 in/ft or tolerance provided by the Pump Manufacturer in all directions and plumb to allow centering of suction bell within three percent of bell diameter.

- k. Provisions for developing a plan for corrective action if the threshold value is reached such that the limit value will not be exceeded.
 - l. Provide limit values based on the Pump Manufacturer's tolerances that if exceeded will require corrective action.
 - m. Provisions for developing a plan for corrective action to achieve Pump Manufacturer's requirements.
2. Within one week following establishment of the monitoring network on each installation, Contractor shall submit to the Engineer drawings and reports showing the actual locations of the monitoring points and baseline monitoring records. The monitoring report shall include but not be limited to:
- a. Project name and number.
 - b. Identification of the monitored installation.
 - c. Monitoring point identification number.
 - d. Date and time of measurement.
 - e. Person making the measurement.
 - f. Measurement results.
 - g. Notes concerning, equipment malfunctions, damage to monitoring components, interferences to measurement or any other unusual occurrence that could have an effect on the measurement.
3. Contractor shall submit measurement data to the Engineer and Pump Manufacturer within 24 hours of each measurement. Include all previous measurements and utilize graphs or other means to illustrate trends and relationships to threshold and limit values.

F. Project Record Documents.

1.07 MANUFACTURER SERVICES INCLUDING OPERATING INSTRUCTIONS

A. Operating and Maintenance Manual:

1. Operating and maintenance manual shall be furnished by the Manufacturer to the Engineer as provided for in Section 01730. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, description, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data, full preventative maintenance schedules, and complete spare parts lists with ordering information.

B. Installation Inspection and Startup:

1. The Contractor shall include in his bid price the services of a Manufacturer's factory representative who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the District and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and start-up. If there are difficulties in operation of the equipment because of the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the District. The listed service requirements are exclusive of travel time, and shall not limit or relieve the Contractor of the obligation to provide sufficient service

necessary to place the equipment in satisfactory and functioning condition. VFD training shall be as specified in Division 16. Also refer to requirements in PART 3 of this Section.

2. Installation inspection: Complete review of installation in accordance with Section 01465. Provide written certification that the installation is complete and operable in all respects, and that no conditions exist which may affect the warranty. Qualified supervisory services, including Manufacturers' Factory representatives, shall be provided to ensure that the installation is done in a manner fully approved by the Manufacturer. The Manufacturer's factory representative shall specifically approve the installation and alignment of the pump with the motor, the grouting, and the alignment of the connecting piping and the installation of the field installed packing or mechanical seal. If there are difficulties in the start-up or operation of the equipment due to the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the District. Services of the Manufacturer's factory representative and training shall be provided when the first pump is started, with follow-up visits upon start-up of each subsequent pump.
 - a. Minimum time on-site shall be three eight-hour days per pump station.
3. Start-Up: Provide written report, summarizing test procedures, tested and measured variables (flow rates, total heads, shaft-speed, vibration measurements, alignment check, etc.):
 - a. Minimum time on-site shall be one eight-hour day per pump station.

C. Training:

1. Field and classroom instruction on operation and maintenance of the equipment, including start-up, shut-down troubleshooting, lubrication, maintenance and safety.
2. The Manufacturer shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
3. The Manufacturer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to District.
 - a. Minimum time on-site shall be one eight-hour day per pump station.

- D. The Contractor alone shall be responsible for requesting these services, and shall coordinate these requests with all other relevant trades, to ensure the effectiveness of the Manufacturers' service. In the event that the lack of coordination by the Contractor results in the need to recall the Manufacturer's factory representative, the lost time shall not be counted against the above days.

1.08 TOOLS AND SPARE PARTS

- A. Furnish all special tools and test equipment required for the proper servicing of all equipment as specified in Section 01030. All such tools and test equipment shall be furnished in a suitable steel tool chest complete with lock and duplicate keys.
- B. All spare parts shall be properly protected for long periods of storage and packed in containers that are clearly identified with indelible markings as to contents.

- C. Furnish the following spare parts for each size pump.
 - 1. One mechanical seal.
- D. Provide to the District a list of all spare and replacement parts with individual prices and location where they are available. Prices shall remain in effect for a period of not less than one year after start-up and final acceptance.
- E. Special tools and spare parts shall be furnished in accordance with Section 01030.

1.09 PRODUCT HANDLING

- A. Delivery, storage and handling of equipment shall be in accordance with Section 01600 and as specified herein.
- B. All equipment and parts must be properly protected against any damage during shipment. Store the equipment in accordance with Manufacturer's recommendations.
- C. All completely assembled units shall be off loaded by the use of a primary and "tail" crane system. Additionally, when lifting the units from a horizontal position to a vertical position, the use of a primary and "tail" crane system shall be used.
- D. Long Term Storage:
 - 1. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of fabrication, including storage in accordance with Manufacturer's requirements, until the unit and equipment are ready for operation.
 - 2. If long-term storage is required on-site, Contractor shall follow Manufacturer's detailed recommendations for long term storage.
 - 3. If the pumps are delivered and stored on-site in a horizontal position and left for an extended period of time, the rubber line-shaft bearings may become deformed and the shafts may take on a permanent "sag". The Contractor shall be responsible for rotating the shafting so that damage does not occur.
- E. Factory assembled parts and components less than 25 feet in length shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- F. For units greater than 25 feet in length that are shipped unassembled, all connecting parts shall be "match-marked" by the Manufacturer to ensure correct assembly on-site by the Contractor.
- G. The finished surfaces of all exposed flanges shall be protected by wooden or equivalent blank flanges, strongly built and securely bolted thereto.
- H. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- I. No shipment shall be made until approved by the Engineer in writing.

- J. For protection of bearings during shipment and installation, the bearing shall be properly processed. Anti-friction bearings, if pre-lubricated, shall be protected in accordance with the bearing manufacturer's recommendations against formation of rust during a long period of storage while awaiting completion of installation and start-up of the machine in which they are used. Anti-friction bearings which are not pre-lubricated shall be properly treated in accordance with the bearing manufacturer's recommendation against formation of rust during a long period of storage while waiting completion of installation and start-up by the application of an appropriate rust preventative treatment.

1.10 WARRANTY

- A. All equipment supplied under this Section of the Specifications shall be warranted for a period of one year from Substantial Completion by the Contractor and the Pump Manufacturer. Warranty period shall commence on the date of District acceptance, as outlined in Division 1 and in Division 0.
- B. 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 in the machine(s) and the unit(s) restored to service at no expense to the District.
- C. The Pump Manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.
- D. Refer to Section 01740 for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. The pumping units shall all be supplied by one manufacturer and shall be complete including pumps, cans, motors, variable frequency drives, and appurtenances such as, but not limited to, couplings, guards and gauges. The pump shall conform to AWWA E-103, Horizontal and Vertical Line-Shaft Pumps Standard where not in conflict with the requirements specified herein. Ample room shall be provided for inspection, repairs and adjustments.
- B. Discharge head lifting lugs or eye bolts shall be provided by the Pump Manufacturer.
- C. The pumps, motors, variable frequency drives, shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, excessive vibration or strain.
- D. Pump can top flange and baseplate shall be rigidly and accurately anchored into position, precisely leveled and aligned, so that the completed installation is free from stress or distortion. The baseplate shall be proportioned to support each entire pump/motor assembly and the loads (including the results of the dynamic vibration analysis) to which it may be subjected during operation. All necessary anchor bolts, plates, nuts and washers shall be furnished as specified herein and installed by the Contractor and conform to the recommendations and instructions of the Pump Manufacturer.

- E. The pump can top flange shall be bolted to the concrete foundation with Type 316 stainless steel sleeve type cast-in anchor bolts and washers. Nuts on stainless steel anchor bolts shall be monel. Anchor bolt configuration and installation shall be in accordance with API RP 686 and ACI 318-08 where not in conflict with the specific requirements contained herein. An anti-seize compound of molybdenum disulfide base such as Moly coat G or approved equal, shall be used on the anchor bolt threads.
- F. The pump support/anchors and associated accessories shall conform to the following:
1. Pump shall be properly supported on can top flange and anchored with Type 316 stainless steel bolts and monel nuts, where nuts used and located as shown on the Drawings. Special slings, strongbacks, or other devices necessary to handle the pump during loading, unloading, erection, installation, and subsequent disassembly and assembly shall be furnished by the Contractor.
 2. Can top flange shall be provided under pump discharge head. The can top flange shall be installed, leveled and grouted in accordance with API RP 686, Chapter 5 – Mounting Plate Grouting. Jacking bolts and Five Star non-shrink epoxy grout as specified below shall be provided for leveling pump baseplate assembly.
 3. An anchor bolt layout shall be provided to aid in placement of anchor bolts. All leveling jacking bolts shall be backed off after grouting so that they do not support any of the load. The use of shims or leveling nuts on anchor bolts is specifically prohibited.
 4. The grout for use in grouting under the can top flange supported by jack bolts shall be Five Star DP Epoxy Grout which is an expansive, non-shrink, low exothermic epoxy system, or approved equal, mixed and applied according to the manufacturer's directions to a thickness as noted in Article 2.03.
 5. The presence of the Pump Manufacturer's representative during the pouring of the epoxy grout as well as the use of rigid non-absorbing formwork and a head box are mandatory. The surface of the formwork in contact with the epoxy grout shall be covered with a layer of paste wax to facilitate removal. Clearance between the concrete surface and the bottom surfaces of the can top flange shall be per Pump Manufacturer's recommendation.
 6. The concrete surface to be in contact with the epoxy grout shall be chipped to present a slightly rough surface and remove the laitance. The surface shall then be cleaned of all dust, moisture and oil. A one-inch minimum diameter by 1/4 inch thick stainless steel disk, with full radiused edges shall be placed under each jack bolt. A thin layer of leveling grout shall be placed under metal discs on which the jack bolts shall bear. All metal edges in contact with the epoxy grout shall be radiused to a minimum 1/2 inch radius in order to prevent stress risers in the epoxy grout. Plastic vent tubes, sized and spaced per Pump Manufacturer's recommendation, shall be placed under the can top flange to vent air during grouting and prevent voids in the epoxy grout.
 7. The annular space between the anchor bolts and the anchor bolt sleeve shall be filled with expanding urethane foam. The threads of both the anchor bolts and jack bolts in contact with the grout shall be covered with paste wax and a layer of duct tape. After all alignment tolerances are met, the anchor bolts shall be tightened snug to prevent movement during the pour. The epoxy grout shall not be allowed to extend above the top edge of the can top flange. After the epoxy grout has fully cured, within 24 to 48 hours after pouring, the jack

bolts shall be removed and the anchor bolts tightened to the torque levels as recommended by the Pump Manufacturer.

8. The threaded jack bolt holes shall be coated with grease and the jack bolts cleaned of the paste wax and duct tape then reinserted and secured in position with a lock nut to within 1/4 inch of the bottom of the hole. After grouting, edges shall be chipped and patched to present a smooth finish.
- G. Each major piece of equipment shall be furnished with a stainless steel nameplate (with embossed data) securely mounted to the body of the equipment. At a minimum, the nameplate for the pumps shall include the manufacturer's name and model number, serial number, rated flow rate, head, and speed. At a minimum, nameplates for motors shall include the manufacturer's name and model number, serial number, horsepower, speed, input voltage, amps, number of cycles and power and service factors. Nameplate information for the variable frequency drives shall include the manufacturer's name and serial number, input speed, voltage, current and frequency and horsepower at full load.
- H. The pump and its driving equipment shall be designed and constructed to prevent reverse rotation using a non-reverse ratchet installed in the electric motor. As an alternate, the pump and motor shall be designed and constructed to successfully withstand a maximum turbinning speed of the unit resulting from backflow through the pump. Manufacturer shall determine maximum potential reverse rotational speed for design.
- I. The maximum sound pressure level from one pump/motor when operating on utility power measured three feet from the equipment and five feet above the floor shall be 90 dBA.
- J. The nameplate ratings of the motor shall not be exceeded, nor shall the design service factor be reduced when the pump is operating at any point on its performance curve within the specified operating range at maximum speed.
- K. Mechanical equipment, including electric motors shall be supplied and installed in accordance with applicable OSHA regulations. The Contractor's attention is drawn to the requirement for guards on all rotation assemblies.

2.02 CONDITIONS OF OPERATION

- A. The pumps shall be Model 14EMM by Flowserve; or equal; Model M14HC by National; Model 14KDM by Trillium Flow Technologies (Floway). Any "or equal" substitution must be submitted to the design engineer at least two weeks before the bid date for pre-approval. The pumps shall be identical in every respect with all parts interchangeable.
- B. Each pump shall be designed for the conditions of service tabulated as follows and shall operate within the system head curve envelope as appended. All pumps shall have a continuously rising (from runout toward shutoff) head-flow rate performance curve for stable pump operation within the AOR.
- C. The pumps shall operate throughout the specified operating range, within the vibration limitations specified in Paragraph 1.05 J.5 above.

TABLE 11214-1
PUMPING UNIT DESIGN REQUIREMENTS

Item Description	Design Conditions
Service	Raw Water
Number of Pumps (operating/standby)	4 (3/1)
Maximum Motor Full Load Speed (FLS) (rpm)	1775
Minimum Motor Speed (rpm as % of FLS)	65
Maximum Allowable Motor Horsepower (non-overloading throughout operating range) (HP)	250
Motor Design Voltage/Phase/Frequency	460/3/60
Maximum Anticipated Pumped Fluid Temperature (degrees F.)	85
Minimum Pump Discharge Nozzle Size (inches)	10
Minimum Pump Column Diameter (inches)	10
Minimum Can Diameter (inches)	24
Minimum Can Suction Diameter (inches)	18
Pump Shut-Off Head at Motor FLS Acceptable Range (minimum/maximum) (feet)	470/610
Flow Rate at Secondary Operation Point (gpm)	750
Minimum TH at Secondary Operation Point (feet)	430
Minimum Bowl Efficiency at Secondary Operation Point (%)	58
Maximum NPSH3 at Secondary Operation Point (feet)	11
Intermediate (Design) Point Flow Rate (gpm)	1,750
Minimum TH at Intermediate (Design) Point (feet)	360
Minimum Bowl Efficiency at Intermediate (Design) Point (%)	80
Maximum NPSH3 at Intermediate (Design) Point (feet)	14
Best Efficiency Point (BEP) Flow Rate Acceptable Range (minimum/maximum) (gpm)	1,580/1,760
Minimum Bowl Efficiency at BEP (%)	80
BEP Location Relative to Intermediate Design Point	Left
Primary Operating Point TH (feet)	260
Minimum Flow Rate at Primary Operating Point (gpm)	2,100
Minimum Bowl Efficiency at Primary Operating Point (%)	70
Maximum NPSH3 at Primary Operating Point (feet)	32
Minimum Submergence Above Pump Suction Bell (feet)	6.86
Minimum Can Water Level (feet)	7.69
Can Suction Configuration	below ground suction

See attached pump and system curve envelope in Figure 11214-1.

2.03 PUMP CONSTRUCTION

- A. Vertical turbine line-shaft pumps shall be product lubricated with open line-shaft bearings as specified below, completely equipped with motor support and discharge head and shall conform to AWWA E-103, Horizontal and Vertical Line-Shaft Pumps, and ANSI/NSF 61 and ANSI/NSF 61 Annex G and ANSI/NSF 372 where not in conflict with the specific requirements contained herein. All pump assemblies shall be evaluated by the manufacturer for galvanic corrosion potential and zinc anode protection systems provided where required.

- B. Pump bowls, including suction bell, shall be ASTM A48 Class 30 cast iron, flanged and bolted construction with bearings as specified below. All bowl hardware shall be Type 316 stainless steel with monel nuts, where nuts used.
- C. Impeller shall be enclosed type of 316L stainless steel ASTM A582 Grade CF-3M two-plane dynamic balance in accordance with ISO 1940-1 quality grade G6.3. Enclosed type impeller design shall include adequate material so as to provide for the future addition of wear ring to restore impeller efficiency.
- D. Impeller shafts and couplings shall be 416 stainless steel. Collets and locknuts shall be steel ASTM A519 grade 1020 or approved equal.
- E. Line-shafts and couplings shall be provided in accordance with AWWA E-103 and shall be 416 stainless steel and shall be field replaceable. Maximum shaft lengths shall be 10-ft and shall be verified with vibration analysis as specified in Paragraph 1.05J above and clearance limitations. Design of the column couplings, for flange system shall provide for bearing retainers and shall be constructed of Type 316 stainless steel if of bolted or threaded construction.
- F. Open line-shaft and bowl bearings above impeller shall be removable self-flushing product lubricated combination bismuth tin bronze (ASTM B505 Alloy C89835) and cutlass rubber, or synthetic materials as manufactured by Greene Tweed and Co. (model AR[®] HT) or Thordon (model SXL) mounted in bronze, fabricated steel, or stainless steel bearing supports as specified above.
- G. Discharge columns shall be carbon steel, flanged and bolted construction in lengths not exceeding 10-ft. All flange hardware shall be Type 316 stainless steel with monel nuts. The minimum wall thickness on all columns with nominal diameters 12-in and above shall be 0.375-in. The minimum wall thickness on columns below 12-in nominal size shall be in accordance with Table E-1 of AWWA E-103.
- H. Discharge Head for Can Mounted Pumps:
 - 1. The discharge head shall be fabricated carbon steel with 150 lb ASME B16.5 or B16.47 flanged connections. The discharge head shall be an L-type design. The base of the discharge head shall be machined to match the drilling of the can top flange or adaptor flange if can is oversized as selected by the Pump Manufacturer or as shown on the Drawings complete with all Type 316 stainless steel bolts and washers and monel nuts. The pump shall be equipped with a one-inch tapped vent in the pump baseplate with a one-inch 316 stainless steel nipple, and Type 316 stainless steel J-tube for the removal of air from the can. A can top flange shall be welded to the suction can at the location shown on the Drawings and as specified below.
 - 2. Motor mounting flange for the vertical driving motor shall be of standard NEMA dimensions for commercially available motors.
 - 3. The top of the discharge head shall have a registered fit for mounting the driving motor.
 - 4. The discharge head shall include a stuffing box and have large openings for pump adjustment and seal maintenance. Provide suitably sized drain connection, a design that ensures continuous positive stuffing box bushing lubrication and a 1/4-in tap for the suction and discharge pressure gauges, each complete with 1/4-in brass pipe nipples and

stainless steel ball valves. Stuffing box must be located and accessible above pump baseplate.

- I. Stuffing box/seal box sealed with single-piece mechanical seal: The discharge head shall be fitted with a mechanically sealed type stuffing box arranged for fresh water flush of stuffing box. Stuffing box shall be equipped complete with a cartridge mechanical seal manufactured by A.W. Chesterton, John Crane, Flowserve or equal. The mechanical seal shall have self-aligning faces and be of a stationary cartridge design specific for high pressure, high torque applications and capable of sealing 25" Hg vacuum to 300 psig. The seal shall have a flushing/venting port. The seal faces shall be sleeve mounted to insure the faces remain both concentric and perpendicular to the shaft and minimize oscillation and wiping limiting the opportunity for face contamination. The springs shall be isolated from the pumpage. All dynamic O-rings shall be on the O.D. and seal to a micro polished surface to eliminate hang up and hysteresis. The seal materials of construction shall be 316 stainless steel for all wetted parts and Hastelloy C springs. The Pump Manufacturer shall be responsible for ensuring that shaft movement and seal chamber pressures at all specified operating conditions are fully compatible with the mechanical seal system provided. Any small diameter drain piping shall be secured to the pump column and be armored to prevent damage during installation and removal.
1. O-rings shall be Viton® or compatible with the fluid being pumped. The gland shall be of a universal design to fit varied bolt sizes and circles. The gland shall have a minimum of one tapped flush/by-pass port that can be rotated 360 degrees to accommodate flush piping.
 2. Seal faces shall be of carbon rotating face and 99.5% minimum alumina ceramic stationary face.
 3. The Pump Manufacturer shall install a SpiralTrac version D installation type I, as manufactured by EnviroSeal Engineering Products Ltd., active throat bushing in the bottom of each stuffing box to convert the radial flow created inside the seal area into axial flow to remove any solids away from the seal. The SpiralTrac devices shall be made of Type 316 stainless steel. The Pump Manufacturer shall install a throat bushing in the bottom of stuffing box to throttle flow into seal area. The throat bushing shall be bismuth tin bronze.
 4. System shall be configured in accordance with flushing system, API Plan 13.
 5. Shaft sleeve: The section of line-shaft that extends through or into the stuffing box shall be fitted with a replaceable 316 stainless steel sleeve that extends beyond the face of the stuffing box far enough to accommodate the total length of the mechanical seal. The sleeve shall be held to the shaft with set screws to prevent rotation and shall be sealed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 1/4 inch.
- J. Vortex suppressor: A pump suction bell mounted "basket" style vaned type vortex suppressor, or other approved device shall be furnished and installed to reduce the possibility of vortices entering the pump. The dimensions of the device shall be as recommended by the Pump Manufacturer. Configuration of the device shall be equivalent to the configuration provided at the end of this Specification.

K. Pump Suction Can:

1. The pump suction can shall be designed and supplied by the Pump Manufacturer and shall be constructed of carbon steel with a minimum wall thickness of 0.375-in and shall be suitable for 50 psig working pressure. The diameter and length of the can shall be selected by the Pump Manufacturer to ensure proper delivery of flow into the first stage impeller and shall meet the requirements of the Hydraulic Institute Standard for Pump Intake Design – ANSI/HI 9.8.
 2. Can lengths that require the can to be transported in sections shall be connected in the field as directed by the Pump Manufacturer to the tolerances required by the Pump Manufacturer. See Paragraph 1.06.E for Pump Can Plumbness Monitoring Program.
 3. The suction can and both flange connections (suction and can top flanges) shall be designed to ASME standards. Suction flange and nozzle shall be sized and furnished for non-“T” head design and located in accordance with ANSI/HI 9.8 requirements.
 4. The can top flange, constructed of materials specified for the can, shall be welded to the suction can, drilled and tapped ASME B16.5 or B16.47 standard flanged dimensions to mate to the pump discharge head. An O-ring gasket shall be used to seal the pump discharge head to the can top flange. The suction can top flange shall extend beyond the can diameter to serve as a rectangular supporting plate to support the weight of the entire assembled pumping unit and shall have a minimum thickness of 1.5-in. The flange shall be secured to the structural concrete support with anchor bolts and a one to two-in. grout layer between the suction can top flange and the concrete as specified in Paragraph 2.01F.
 5. Internally mounted vertical flow vanes, shall be furnished and installed within the pump suction can to prevent the possibility of fluid circulation around the pump bowl assembly for pump flow rates above 1,000 gpm. The dimensions of the vanes shall be as recommended by the Pump Manufacturer. Special design considerations shall be taken for vertical flow vanes in order to avoid flow induced excitation of vane sheets, which can result in vibration and loosening of the flow straightener. Below 3,000 gpm the pump manufacturer may propose an alternate vane design. Dimensional allowances shall be made for the vortex suppressor specified in Paragraph 2.03 J above.
- L. The construction of the pumps, position and number of column pipe flanges shall be such that the pumps can be readily installed and removed for repairs within the head room limitations of the building and crane vertical lift limitations using normal methods of operation and handling without undue difficulties.
- M. Furnish one pump can blind flange at each site that is normally uninstalled but, when a pump has been removed for maintenance, the pump can blind flange can be bolted to the open pump can to protect against accidents and for general safety. The pump can blind flange designed for maximum internal can pressure, with holes drilled to match the top can flange bolts and be fitted with a large lifting eye(s) in the middle to allow lifting by a crane. All surfaces shall be painted per Paragraph 2.08.

2.04 MOTOR TO PUMP COUPLING

- A. Pump shafting shall be directly connected to the motor by means of a flanged adjustable spacer coupling, suitably sized to transmit the required driving torque, axial thrust and be easily accessible for impeller adjustment, packing or mechanical seal replacement.

2.05 MOTORS

- A. Each pump shall be driven by a vertical solid shaft, inverter duty rated squirrel cage induction electric motor with a maximum horsepower and speed as specified under Article 2.02 above and with Weather Protected (WP) Type I enclosure and shall meet all the requirements of Section 16150 and include a thrust bearing capable of handling both the mechanical and hydraulic thrust of the pump.
- B. A non-reverse ratchet shall be installed in the motor to prevent reverse rotation.
- C. Non-reverse ratchet:
 - 1. The non-reverse ratchet shall provide immediate protection against reversing due to phase reversals or from backspin at shutdown.
 - 2. The non-reverse ratchet shall be a shaft mounted mechanical device configured with an outer rotating component equipped with a series of holes bored at angles. The holes shall house hardened steel balls. The inner stationary component shall consist of a series of flutes to receive the balls, with one of which shall engage in the locked position the instant the motor stops running. The number of flutes shall differ from the number of balls to increase the number of possible locking positions.
 - 3. In cases of conflict with the motor specification this Section shall control.
 - 4. The non-reverse ratchet shall be robust enough to withstand the motor torque developed during accidental reverse rotation.
 - 5. The non-reverse ratchet shall disengage due to normal rotation speed of no more than 20% of full speed.
- D. All lubrication fittings shall be brought to the outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards, or without creating falling hazards. Fittings shall be buttonhead type. Lubrication fittings shall be mounted together wherever possible. Pressure grease-lubricated fittings shall be the "Zerk Hydraulic" type or the "Alemite" type. Housings of grease-lubricated bearings shall be automatically exhausted to the atmosphere to prevent excessive greasing.
- E. Motors shall be mounted to the top of the pump discharge head motor stand with Heavy Hex Grade 8 bolts, nuts and washers torqued to the Pump Manufacturer's recommended value.

2.06 VARIABLE FREQUENCY DRIVES

- A. The speed control for variable speed pumps shall be Variable Frequency Drives, as specified in Section 16370, suitable for installation as shown on the Drawings.

- B. The Variable Frequency Drives shall be supplied by the Pump Manufacturer and shall be completely coordinated with the pumps and pump driving motors and shall include all internal auxiliaries required to meet the functional specifications.
- C. The Variable Frequency Drives shall conform to all requirements stipulated in this section and Division 16, Electrical, and shall be designed for a speed range of 70% to 100% of full load motor speed. The VFD design shall incorporate the necessary components to accommodate receiving vibration and temperature data from the pump motor.
- D. The Variable Frequency Drives shall be compatible with the motors provided by the Pump Manufacturer.

2.07 PRESSURE GAUGES

- A. Each pump shall be equipped with a discharge pressure gauge. Pressure gauges shall be bronze bourdon tube Ametek U.S. Gauge, SOLFRUNT Duragauge Series 1980 Black Phenol Turret type with 316 stainless steel rack and pinion movement or equal. The gauges shall be glycerin filled. Gauges shall be calibrated from 0 to 300 psig for discharge service. Gauges shall be 4-1/2-in diameter furnished with 1/4-in inlet. All fittings and cocks shall be Type 316 stainless steel. Pressure gauges shall be furnished with isolating pulsation dampers. Diaphragm seals shall be Teflon coated, oil filled, Type 316 stainless steel suitable for use with pressure gauges. All gauges and diaphragms shall be furnished by the Contractor.

2.08 SHOP PAINTING

- A. Each piece of equipment in the pumping system including pump, support system, motor and associated equipment shall be prepared, shop-primed and finished-coated in accordance with the Pump Manufacturer's standard practice prior to shipment. Colors shall be Pump Manufacturer's standard. Coating for Variable Frequency Drives shall be as specified in Section 16370. Adequate supply of touch-up paints shall be supplied by the Pump Manufacturer.
- B. All interior and exterior surfaces of pump columns ,cans and discharge heads and the exterior of the bowl assemblies shall be cleaned of all rust and mill scale, grease, dirt, other foreign matter and supplied with Pump Manufacturer's standard epoxy coatings.
- C. All coatings on wetted surfaces shall be epoxy type and shall comply with AWWA E-103 and ANSI/NSF 61 and ANSI/NSF 61 Annex G and ANSI/NSF 372 for use with drinking water systems. Surface preparation shall conform to the coating manufacturer's recommendations.
- D. All nameplates shall be properly protected during painting.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Take all necessary measurements in the field to determine the exact dimensions for all work and the required sizes of all equipment under this Contract. All pertinent data and dimensions shall be verified.

- B. Installation shall be in strict accordance with the Pump Manufacturer's instructions and recommendations in the locations shown on the Contract Documents and pump shop drawings. Refer to Article 1.07 for additional requirements. The Contractor shall furnish all required oil and grease for initial operation, if required, in accordance with the Pump Manufacturer's recommendations. Anchor bolts shall be set in accordance with the Pump Manufacturer's recommendations and setting plans.
- C. If the Contractor does not provide qualified installation staff on the job during the pump installation, the Engineer may direct the Contractor to provide the services of a Pump Manufacturer's factory representative to give the necessary instructions to ensure a proper installation.
- D. Refer to Article 2.01 for additional installation (sole plate temporary support, grouting, etc.) requirements. Connection of piping to pumps and cans shall be done in the presence of the Engineer. All piping connections to the pump and can shall be done without bending and/or twisting the piping to mate with the pump and can flange connections.
- E. A certificate from the Pump Manufacturer shall be submitted stating that the installation of their equipment is satisfactory, that the equipment is ready for operation, and that the District's operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.02 INSPECTION AND TESTING

- A. General:
 - 1. The Engineer shall have the right to inspect any equipment to be furnished under this Section prior to their shipment from place of manufacture and shall witness the factory pump performance test.
 - 2. The Engineer shall be notified in writing no fewer than 10 working days prior to the factory performance test, so that arrangements can be made for inspection by the Engineer.
 - 3. Field tests shall not be conducted until such time that the pumping system, including controls, is complete and ready for testing.
- B. Factory Pump Testing:
 - 1. Each pump shall be factory tested as described in ANSI/HI 14.6, American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests, as specified herein.
 - 2. The Pump Manufacturer shall perform hydrostatic test on the pressure-containing parts in accordance with ANSI/HI 14.6. Test shall be conducted on each pump prior to shipment.
 - 3. Cast surfaces of all components shall be examined by visual inspection per MSS SP-55.
 - 4. Each pump shall be factory tested as described in ANSI/HI 14.6, American National Standard for Rotodynamic Pumps for Hydraulic Performance Acceptance Tests, as specified herein.

5. The Pump Manufacturer shall perform hydrostatic test on the pressure-containing parts in accordance with ANSI/HI 14.6. Test shall be conducted on each pump prior to shipment.
 6. Cast surfaces of all components shall be examined by visual inspection per MSS SP-55.
 7. Factory pump tests shall be the basis of acceptance of the hydraulic performance of the pumps. The Pump Manufacturer shall factory test all pumps prior to shipment in accordance with the Hydraulic Institute standards. Flow rate, total head, efficiency and input KW shall be tested and recorded for at least five points on the pump performance curve. Test shall be performed to demonstrate that the pumps meet ANSI/HI 14.6, acceptance grade 1U for all specified points. The five points shall include the points specified in Article 2.02. If any pump tested fails to meet any specification requirement it will be modified until it meets all specification requirements. If any pump tested fails to meet the flow rate, head or efficiency requirements for any of the conditions listed in Article 2.02 of this specification and all reasonable attempts to correct the inefficiency are unsuccessful, the pump(s) shall be replaced with a unit(s) that meets the specified requirements.
 8. Certified pump performance curves shall be submitted, including total head, flow rate, bowl efficiency and total brake horsepower for each pump supplied. Test data shall be submitted for approval by the Engineer prior to shipment.
 9. If the Pump Manufacturer does not have historical test records for NPSH3 at the specified design pump speed, one pump shall be tested to demonstrate NPSH3 versus flow rate.
 10. All meters, gauges, and other test instruments shall be calibrated within the manufacturer's established time period prior to the scheduled test and certified calibration data shall be provided. If the Pump Manufacturer has no ISO standard calibration period, Hydraulic Institute Standards shall govern.
 11. In lieu of testing with all job equipment, job pump bowls may be tested with a laboratory motor, laboratory column pipe and discharge head similar in size to that furnished for final installation. If possible, the length of column pipe will be the same as will be required to set the bowl in the field.
 12. The pumps shall be tested at 100 percent of the design speed. Reduced speed curves will be determined using affinity laws.
 13. Each pump shall be tested through the specified range of flow, and head/flow rate/efficiency curves plotted at maximum output speed. During each test, the pump shall be run at each head condition for sufficient time to accurately determine flow rate, head, power input, and efficiency. In addition, during the tests, the overall efficiency shall be determined at each test point. The pump under test shall be modified until the specified conditions are met or replaced with a pump that will meet the specified conditions.
 14. All pumps shall receive a non-witness factory test.
- C. Pump motor tests, including physical testing after manufacture and before shipment to determine actual motor reed critical frequency of each motor, in two perpendicular planes denoted relative to the conduit box, at the motor manufacturer's facility, as specified in Section

16150 and variable frequency drive tests as specified in Section 16370 shall be submitted for approval by the Engineer prior to shipment.

D. Field Testing:

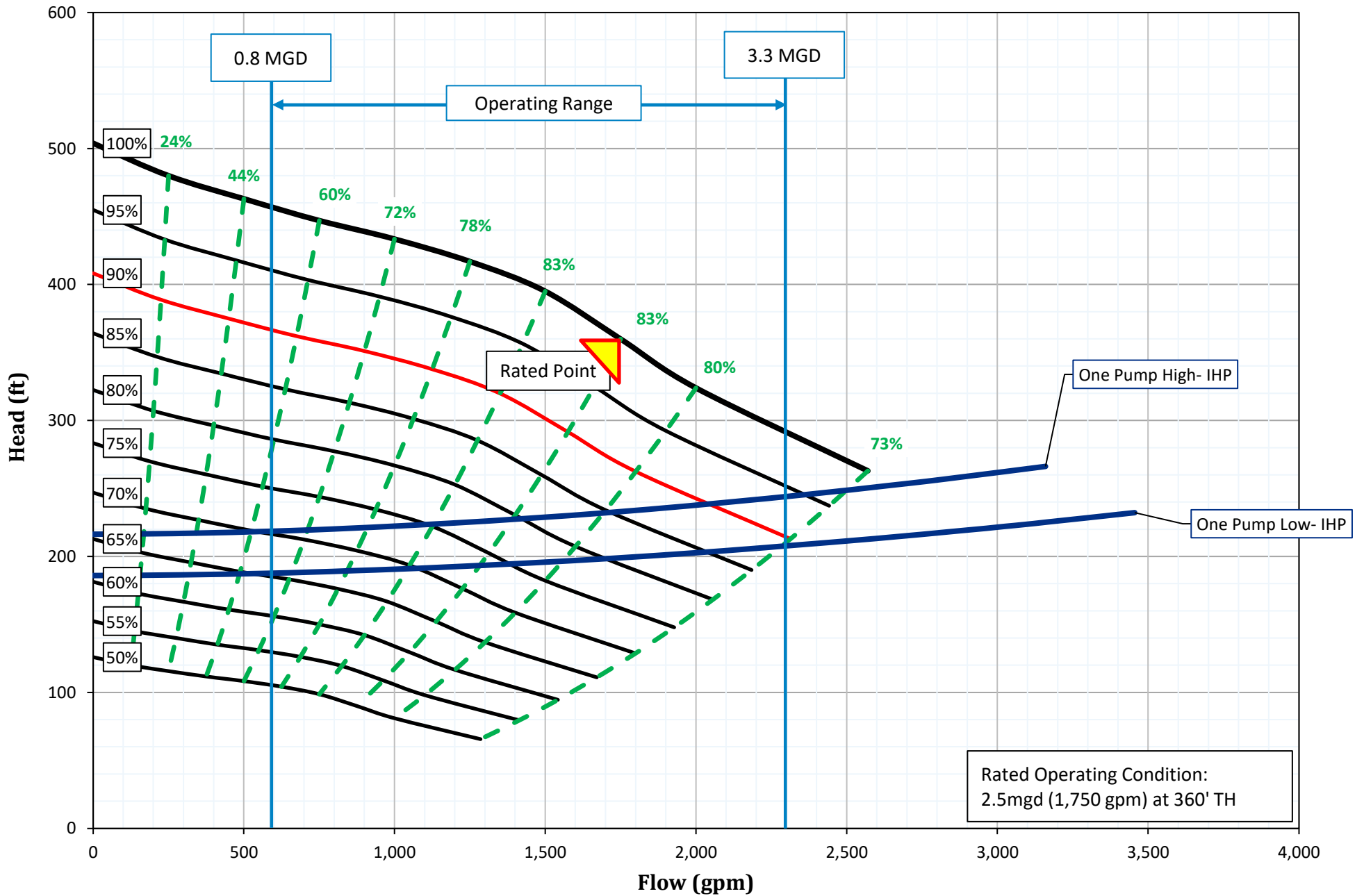
1. In the presence of the Engineer, necessary tests shall be performed to indicate that the pumps, variable frequency drives and motors generally conform to the operating conditions specified. The factory testing specified above will be the basis of performance acceptance. A seven-day operating period of the pumps will be required before acceptance. If a pump performance does not generally agree with the factory test results, corrective measures shall be taken or the pump shall be removed and replaced with a pump that satisfies the conditions specified. Provide, calibrate and install all temporary gauges and meters, make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the Engineer for approval no fewer than 30 days prior to testing.
2. After installation and as soon as conditions permit full speed operation, and in the presence of the Engineer, have the vibration tests performed in accordance with ANSI/HI 9.6.4 on each unit by a minimum level III qualified vibration technician as defined by Vibration Institute or equivalent to (a) prove compliance with specified limitations, and (b) prove that there are no field installed resonant conditions due to misalignment, the foundation, or the connecting piping and its supports, when operating at any speed within the specified operating range.
 - a. At a minimum, if pump system is furnished with vibration and temperature monitoring system, the motor lower vibration sensors may be used for acceptance testing. Alternatively, temporary surface mounted sensors mounted in the vicinity of the installed sensors are preferred to additionally establish the accuracy of the permanently installed system.
 - b. If required, take corrective action and the units shall be retested to ensure full compliance with this Section. All costs associated with the field tests or any required corrective action shall be borne by the Contractor.
3. Motor tests:
 - a. Prior to any pump mechanical test, the Contractor shall megger 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.
 - b. Prior to any pump mechanical test, the Contractor shall check all motors for correct clearances and alignment and for correct lubrication in accordance with the motor manufacturer's instructions. The Contractor shall check direction of rotation of all motors prior to any pump mechanical test and reverse connections, if necessary.
4. The Contractor shall meet all the testing requirements of Section 16150.

- E. If required, take corrective action and have the units retested to ensure full compliance with the specified requirements. All costs associated with the field tests or any required corrective action shall be borne by the Contractor.

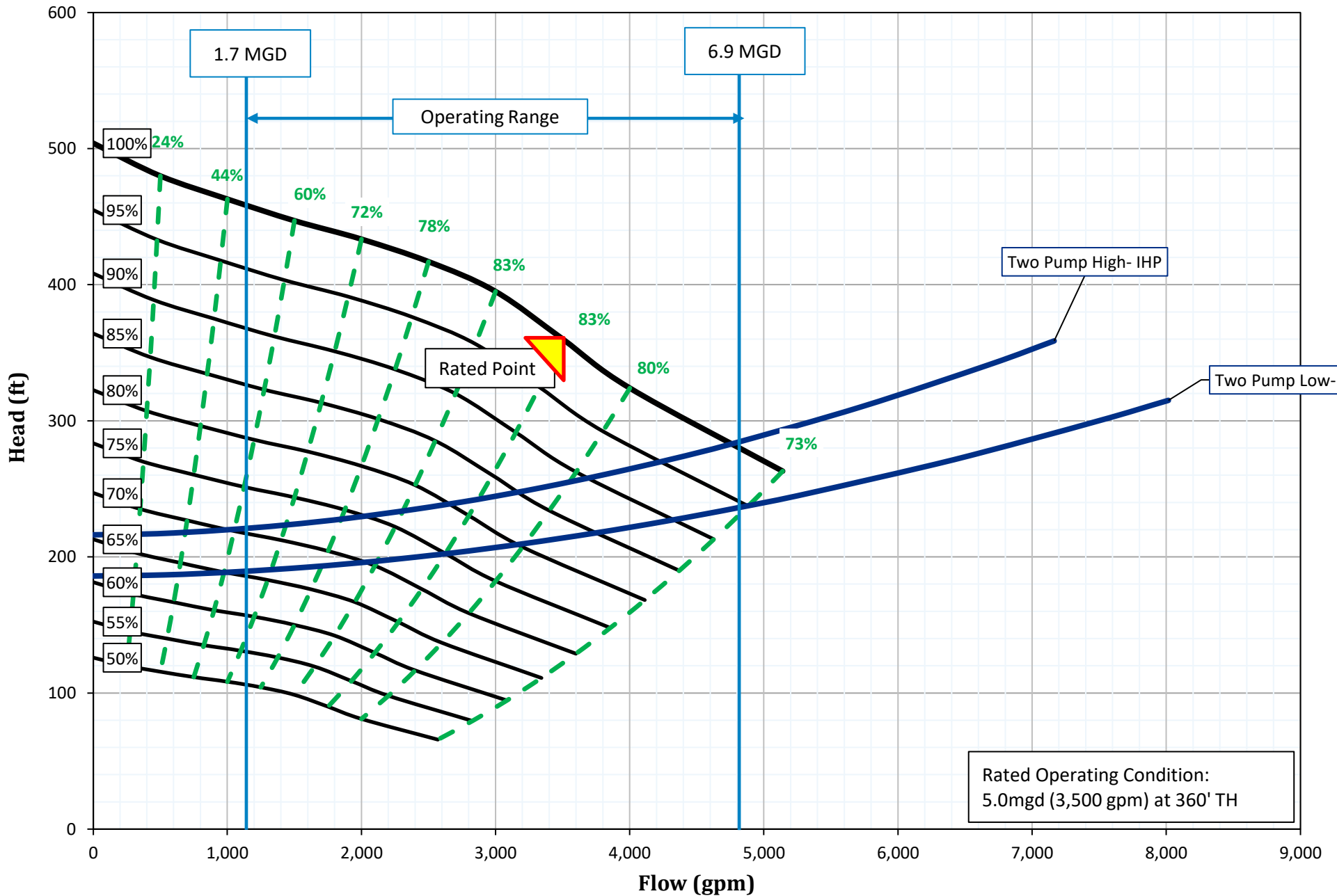
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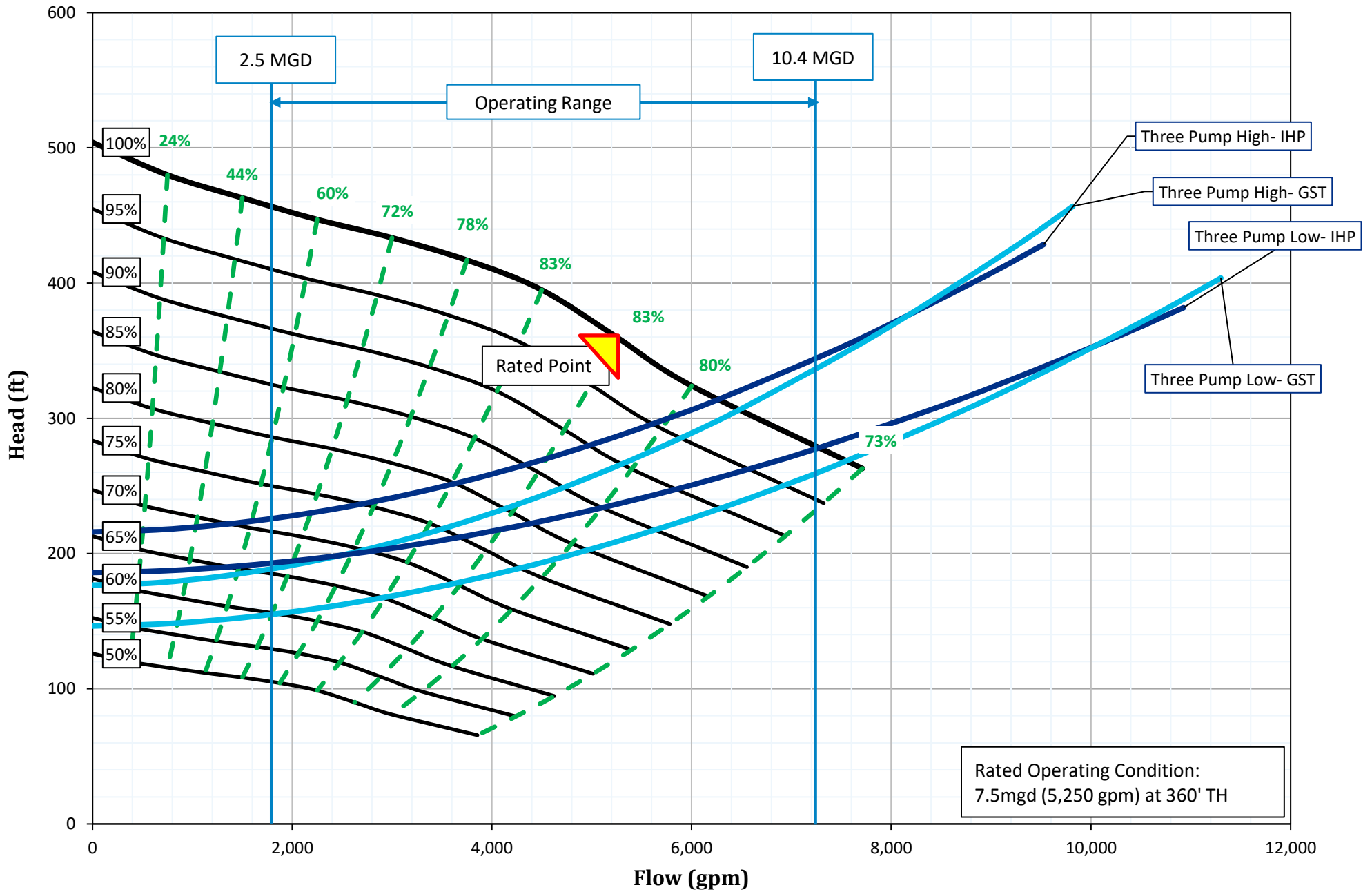
One Pump Operation



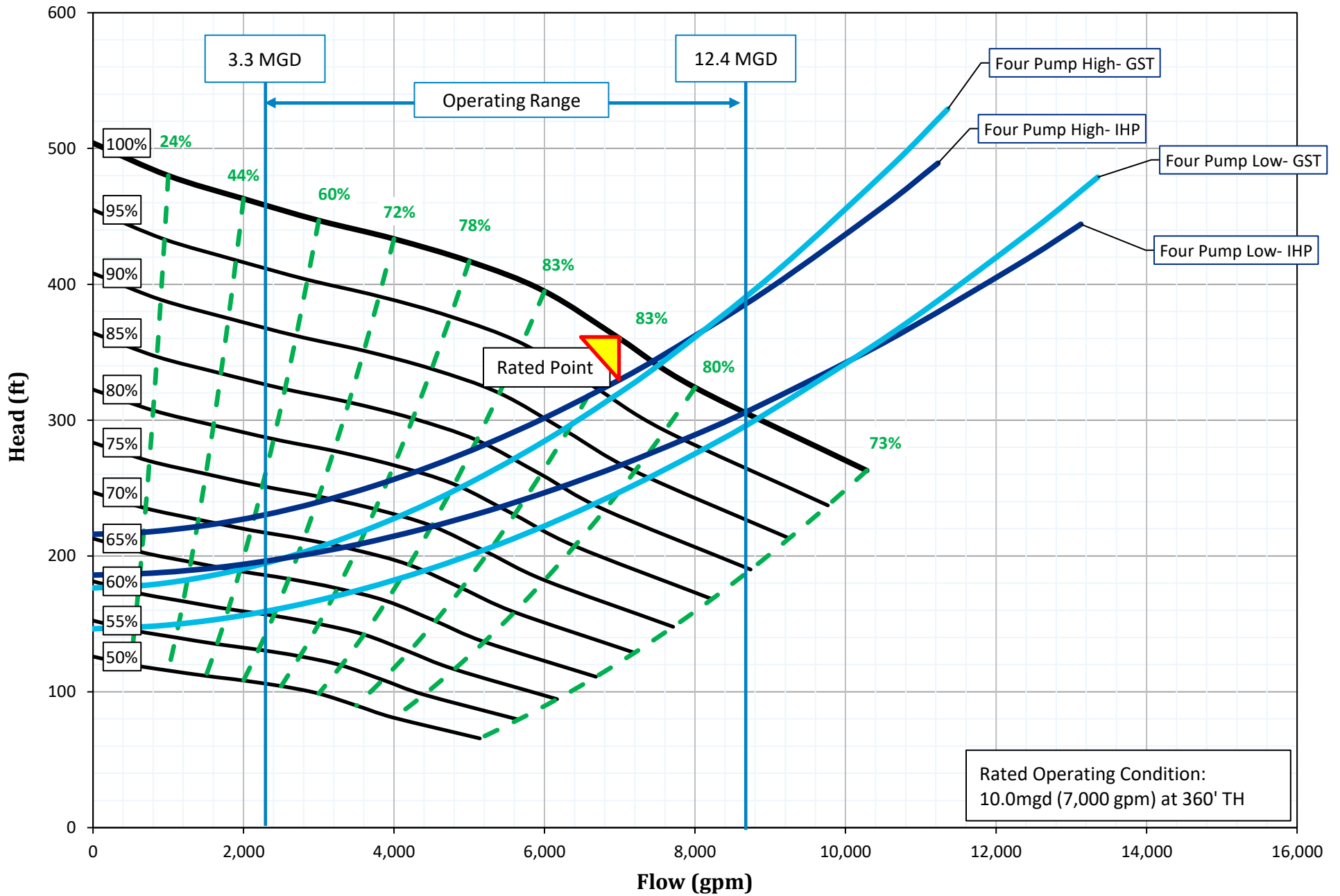
Two Pump Operation



Three Pump Operation



Four Pump Operation



SECTION 11290
RAW WATER INTAKE SCREENS AND AIR BACKWASH SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide all labor, materials, equipment and incidentals required to furnish and install a complete raw water intake screens and air backwash system, as shown on the Drawings and specified herein.
- B. The raw water intake screen system consists of six half-cylindrical (24-inch diameter) wedge-wire passive screens and an air-backwash system. The intake screens will be mounted on an intake structure consisting of multiple precast concrete modules (one screen per module).
- C. The air backwash system will include a rotary screw air-compressor, an air-receiver tank, two solenoid-controlled pneumatically-operated butterfly valves, a backwash control panel, piping, fittings and accessories. The compressor and air-backwash control panel will be located indoors approximately 850 feet from the intake screens. Two four-inch diameter HDPE air lines will extend from the air-receiver tank to the intake structure. At the intake structure, each air line will have branch connections to three intake screens.
- D. The raw water intake screens, air-compressor, air-receiver tank, solenoid-controlled pneumatically-operated air-backwash valves, air-backwash control panel, and instruments and gauges shall be furnished by the intake screen manufacturer who shall provide all the services, equipment and appurtenances required to achieve a complete, fully integrated and operational system meeting all the design and operational conditions specified herein.
- E. The equipment furnished under this shall comply with requirements of the American Iron and Steel (AIS) Act, as applicable. See Division 0.

1.02 RELATED WORK

- A. Valves and exposed piping, except as provided as part of this Section, are included in Division 15.
- B. Piping is included in Division 2.
- C. Concrete is included in Division 3.
- D. Instrumentation and Controls, except as provided as part of this Section, is included in Division 13.
- E. Electrical, except as provided as part of this Section, is included in Division 16.

1.03 SUBMITTALS

- A. Submit complete shop drawings, in accordance with Section 01300, showing details of materials, fabrication and installation of all equipment furnished under this Section.
- B. Submit complete description of all controls and control panels, including master wiring diagrams, elementary or control schematics and panel outline drawings.

- C. Prior to fabrication, the Contractor shall submit to the Engineer for approval, written documentation verifying that the equipment to be supplied meets the installation and performance criteria specified herein. The submittal shall include drawings showing overall and interface dimensions, general configuration, materials, slot size, percentage of open area, capacity, weight and strength. Provide a velocity distribution profile across the screen face based on actual test and computational data and showing maximum, average and minimum values and demonstrating that, at the rated capacity specified in subsection 2.01.B, the maximum through slot velocity specified 2.01.B will not be exceeded.
- D. Submit a list of the manufacturer's recommended spare parts.
- E. Submit calculations for design of airwash diffuser piping headers located inside each tee screen to provide for uniform dispersion of the air burst under the design conditions specified herein.

1.04 DESCRIPTION OF SYSTEM

- A. Six 24-inch diameter, removable, submerged, half-cylindrical, 316 stainless steel wedge-wire screens, with 12-inch diameter water outlets shall be installed on concrete intake structure modules as shown on the Drawings.
- B. The raw water intake screens shall be cleaned by an air backwash system designed to generate and transmit a high pressure, short duration air burst to the intake screens (three at a time) to remove materials deposited on the outside surfaces of the screens. The air backwash system generally consists of a rotary screw air compressor and a dedicated air receiver, solenoid-controlled pneumatically-actuated valves, and piping for conveying compressed air to each intake screen, and a backwash control panel. The air-receiver tank and solenoid-controlled pneumatically-operated air valves shall be located adjacent to the pump building and approximately 850 feet from the intake screens.
- C. The air backwash control panel shall have separate contacts to receive a remote signal to backwash intake screens one through three, or screens four through six. The air backwash system will be fully automated. Each valve shall automatically close when the discharge line pressure drops to a predetermined set point or based on a timer. The local air compressor control system shall automatically start the compressor when the pressure in the air receiver drops to a predetermined low-pressure set point. The air receiver must be fully charged before the control system can initiate the next valve opening in the air backwash sequence.
- D. The design of the piping system also will allow screen cleaning via short-duration reverse flow of screened water through the intake screens.

1.05 QUALIFICATIONS

- A. All the intake screens, compressor, air-receiver tank, solenoid-controlled pneumatically operated butterfly valves, and the air-backwash control panel shall be furnished by the manufacturer of the raw water intake screens. The manufacturer shall have the sole responsibility for the proper functioning of all equipment furnished.
- B. The raw water intake screens and related components shall be as manufactured by Hendricks Screen Company, Johnson Filtration Systems, Inc., or equal.

- C. The specified equipment shall be of standard design, modified as required herein, in regular production and designed and suitable in every respect for the intended service.
- D. The following equipment specifications are intended to give a general description of what is required, but do not cover all details which may vary in accordance with the exact requirements of the equipment as offered. They are, however, intended to cover the furnishing, delivery, installation, field testing, and field calibration of all materials and apparatus, as required. Any additional equipment necessary for the proper operation of the proposed installation, not specifically mentioned in these Specifications or shown on the Drawings, shall be furnished and installed at no additional cost.

1.06 OPERATING INSTRUCTIONS

- A. Operating and maintenance instructions shall be furnished, as provided in Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. required to instruct operating personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data, preventive maintenance schedules, and complete spare parts lists with ordering information.
- B. A factory representative who has complete knowledge of the proper operation and maintenance of the intake screen system and air backwash system shall be provided for two days to instruct representatives of the District and Engineer on proper operation and maintenance of the equipment. This work may be conducted in conjunction with the inspection of installation and test runs, as provided under Part 3. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication or the Contractor's installation, additional instruction service shall be provided at no additional cost.

1.07 TOOLS AND SPARE PARTS

- A. Furnish one set of all special tools required to properly service the equipment herein specified. All such tools shall be provided in a suitable steel tool chest with lock and duplicate keys.
- B. Furnish all spare parts recommended by the manufacturer for normal operation and maintenance. These shall include as a minimum the following:
 - 1. Two sets of all gaskets and O-rings required for each compressor.
 - 2. A complete set of spare air filters for each compressor.
 - 3. One complete seal kit for each pneumatic cylinder.
 - 4. Three solenoid valves.
- C. All spare parts shall be carefully packaged or boxed for long-term storage. Each part shall be clearly identified by part description, part number and any other pertinent data.

PART 2 PRODUCTS

2.01 INTAKE SCREENS

- A. Service Conditions

1. Intended service: Surface water intake.
 2. Arrangement: As shown on the Drawings.
- B. Performance Requirements
1. Rated capacity of each screen: 1,500 gpm, minimum
 2. Maximum through slot velocity (clean screen) at rated capacity: 0.5 fps
 3. Maximum clean screen pressure drop at rated capacity: 0.1 psig (screen only)
 4. Maximum pressure drop through assembly: 0.5 psig
- C. Each raw water intake screen and tee assembly shall be a passive type design, complete with internal backwash air distribution system, and conform, with the following requirements.
1. Each 24-inch diameter half-cylindrical screen shall include a solid back plate with opening for 12-inch pipe (13.2-inch O.D.) penetration, and circumferential screening surface. Each screen shall have integral mounting tabs or continuous mounting flange for anchoring to a concrete intake structure, as shown on the Drawings.
 2. Screen elements shall be fabricated from triangular profile, wedge-wire No. 69 or equivalent. Maximum slot width shall be 0.08 inches at the outside face of the screen. Slots shall run circumferentially.
 3. The screen assembly shall be fabricated entirely of Type 316 stainless steel. The screen assembly shall be capable of withstanding an external hydrostatic pressure of 35 feet of water and the internal pressures created by the air backwash system.
 4. The air backwash diffuser piping shall be designed and installed inside the screen assembly by the screen manufacturer. The diffuser piping shall be Type 316 stainless steel. The diffuser piping shall be designed to operate at an initial operating pressure of 150 psig and final operating pressure of approximately 30 psi during the air burst cleaning cycle. The connection of the internal air backwash system to the air supply pipe shall be through a two-inch ANSI flange.
 5. The entire screen assembly including flange and bolts shall be capable of withstanding intake structure flow-through velocities of up to 10 feet per second. The flange and bolts shall be capable of withstanding an internal working pressure of 150 psig. All nuts, bolts, washers etc. shall be Type 316SS. A permanent lifting hook(s) shall be provided on the top of each screen assembly so that the assembly may be lowered into place or removed from service.

2.02 AIR BACKWASH SYSTEM

- A. The air backwash system including control panel, compressor, and air-receiver tank (minimum 1,000 gallon) shall be furnished by the intake screen manufacturer who shall be responsible for the proper performance of the assembled system.
- B. Brass or stainless steel nameplates giving the name of the manufacturer and all pertinent data such as rated capacity, discharge flow and pressure, horsepower, speed, etc. shall be attached to each compressor and receiver.

- C. The compressor for the air backwash system shall be a base-mounted rotary screw air compressor. The compressor shall be 15-hp (maximum) and be capable of charging the air-receiver tank from 0 to 150 psig in less than 25 minutes. The compressor motor shall be 480 volt, three phase, 60 Hertz, ball bearing, grease lubricated and meet the requirements as specified in Section 16150. The compressor flywheel, motor pulley, and V-belts shall be totally enclosed within a metal belt guard which shall provide protection on all sides in accordance with OSHA specifications. The compressor intake shall be furnished with a dry type intake filter- silencer. The compressor shall be furnished with a loadless starting device that will automatically unload if the compressor stops or loses oil pressure. A combination motor circuit protector across-the-line magnetic type starter shall be furnished for each compressor. The starter shall have thermal type motor protective elements reset button, and shall be mounted in the control panel. A NEMA 4X pressure switch with a cut-out pressure of 150 psig shall be mounted and wired on the compressor deckplate. A five-micron air filter shall be installed on the compressor discharge piping with a drain line extending to a nearby sump. The filter shall be fitted with a differential pressure gauge.
- D. The air receiver shall be a horizontally mounted ASME code tank. The welded steel tank shall be epoxy-coated inside and out, constructed in accordance with ASME Section VIII Pressure Vessel Code and meet all applicable federal, state, and local codes. The tank shall be rated for a minimum interior working pressure of 200 psig. The tank shall be equipped with the following accessories, as shown on the Drawings:
1. Tank inlet nozzle
 2. Tank outlet nozzle
 3. Tank drain: one-in. valved outlet at bottom of tank
 4. One ASME-rated pressure relief valve.
 5. One tank-mounted pressure gauge with 3-1/2-inch face, minimum, 0-200 psi pressure range, isolation diaphragm and tee handle cock, one high-pressure switch, and one pressure transmitter.
- E. Pneumatic Operated Butterfly Valves
1. One solenoid-controlled pneumatically-operated butterfly valve shall be installed on each of two air backwash pipes (one air-backwash pipe per three intake screens). Air operated butterfly valves shall be equipped with single acting, spring return to close on loss of air pressure, pneumatic cylinder operators for on-off control. Pneumatic operators shall conform to all applicable portions of AWWA C504. Butterfly valves shall be designed for 250 psi air pressure.
 2. Cylinder operators shall be rack and gear type. Gearing shall be sealed in a semi-steel housing, and run in a lubricant. The operator shall clearly indicate valve position. An adjustable stop shall be provided to set closing torque.
 3. Provision shall be made for manual operation of the valve through a lever operator.
 4. Furnish one three-way solenoid valve for each air operated valve. Solenoid valves shall operate the actuator to open the valve when energized. The solenoid shall operate on 120 volt, 60 Hz, single phase power, supplied from the control panel and shall be provided with manual override.

- F. All electrical components shall meet the requirements of Divisions 13 and 16 of these Specifications. Refer to Section 16191, Paragraph 2.02.B for additional control panel construction requirements.
- G. One control panel shall control the entire system and shall be in a NEMA 4X Type 316SS enclosure with lockable main circuit breaker disconnect and shall include the following minimum features:
 - 1. One combination motor starter with all motor protection for each compressor. All motor starters shall be provided with motor circuit protectors (MCPs).
 - 2. One 120V AC, 1 pole circuit breaker for each solenoid valve.
 - 3. System On/Off switch.
 - 4. Local/remote selector switch.
 - 5. Hand/Off/Auto (Test/Off/Auto) selector switch for compressor.
 - 6. System enabled light.
 - 7. 480V-120V, one-phase transformer of KVA to suit.
 - 8. Automatic interlock to prevent valve operation with inadequate air pressure in receiver.
 - 9. Open/auto/close selector switch for each valve (three).
 - 10. Indicating lights to indicate valve status.
 - 11. Automatic shut down and alarm with fault(s).
 - 12. Other necessary control functions.
- H. The control panel shall be able to receive a remote “start air wash” contact for each set of three intake screens to initiate the air wash manually.
- I. The control panel shall provide remote contact outputs for “Common Trouble Alarm,” “Screen Nos. 1-3 Wash in Progress,” and “Screen Nos. 4-6 Wash in Progress”.

2.03 SURFACE PREPARATION AND SHOP PAINTING

- A. All exposed ferrous metal surfaces shall be prepared, shop primed, and field painted as part of the work of this Section (for those items not furnished with factory enamel paint). Surface preparation and shop painting shall be as specified in Section 09901.
- B. All surfaces obviously not to be painted shall be given a shop coat of grease or other appropriate rust resisting coating. This coating shall be maintained as necessary to prevent corrosion during storage and prior to start-up.

PART 3 EXECUTION

3.01 INSPECTION

- A. The Engineer shall have the right to inspect all materials or equipment to be furnished under these Specifications, prior to their shipment from the point of manufacturer/supplier.

3.02 PRODUCT HANDLING

- A. All equipment shall be properly crated to protect any and all components from damage during shipment.
- B. 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. All equipment and parts shall be properly protected against any damage during a prolonged period at the site.
- C. Finished surface of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.
- D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- E. No shipment shall be made until equipment has been approved by the Engineer in writing.

3.03 EQUIPMENT INSTALLATION

- A. The intake screens and air backwash systems shall be installed in accordance with the instructions of the manufacturers and as shown on the Drawings.
- B. The Contractor shall furnish a certificate from each equipment manufacturer stating that the installation of his equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been adequately instructed in the operation, lubrication and care of each unit.
- C. 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.
- D. Field tests shall not be conducted until such time that the entire installation is complete and ready for testing.

3.04 EQUIPMENT FIELD INSPECTION

- A. The Contractor shall furnish the services of a factory representative of the intake screen manufacturer who has complete knowledge and experience in the proper installation, startup, and operation of the intake screens and air backwash systems, to inspect the final installation and supervise the field acceptance tests of the equipment. The services shall be provided for a minimum of three person-days. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or Contractor's installation, additional service shall be provided at no additional cost.

3.05 FIELD ACCEPTANCE TESTS

- A. After the installation of the raw water intake screens and air backwash system, the air backwash system shall be subject to field acceptance tests.
- B. The field acceptance tests shall be made by the Contractor under the direct supervision of a qualified representative of the intake screen manufacturer. All tests shall be performed in the presence of the Engineer. The Contractor shall provide, calibrate and install all temporary gauges and meters, shall make necessary tapped holes in the pipes, and install all temporary piping and wiring required for the field acceptance tests. Written test procedures shall be submitted to the Engineer for approval 30 days prior to testing.
- C. The field acceptance tests shall determine the characteristics of each air compressor and in addition shall demonstrate that under all conditions of operation each unit:
 - 1. Has not been damaged by transportation or installation.
 - 2. Has been properly installed.
 - 3. Has no mechanical defects.
 - 4. Is in proper alignment.
 - 5. Has been properly connected.
 - 6. Is free of overheating of any parts.
 - 7. Is free of objectionable vibration and noise.
 - 8. Is free of overloading of any parts.
- D. Field acceptance testing shall be conducted after the installation of all equipment has been completed, and the equipment operated for a sufficient period to make all desirable corrections and adjustments. Each compressor unit and all associated equipment shall be given a field acceptance test to determine that operation is satisfactory and in compliance with the Specifications.
- E. During the field acceptance tests, each compressor unit and associated backwash control valves shall be operated through two complete air backwash events.
- F. During the field acceptance tests, readings shall be taken for each air burst event and recorded on suitable log sheets. These readings shall include data from pressure gauges, flow meters, power kW, and all other information necessary to calculate the actual performance characteristics of the compressor, and ancillary equipment. The pressure drop and duration of the air burst event and the cycle time for recharging the air receiver shall be recorded. A written report shall be submitted to the Engineer tabulating equipment tested, test results, problems encountered and corrective action to be taken within two weeks after test completion.
- G. If any unit fails to fulfill the performance required by the Specifications, corrective measures shall be taken, and the units retested to assure full compliance with the Specifications. A revised written report shall be submitted to the Engineer. All costs associated with the field acceptance tests including those associated with any required corrective action, shall be borne by the Contractor.

- H. A seven-day operating period of stable and vibration-free operation shall be required for each compressor unit prior to final acceptance.

END OF SECTION

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SECTION 12484
FLOOR MATS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install floor mats as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Concrete work is included in Division 03.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings showing materials and construction with substrate surface preparation installation procedures. Submittals shall include the following:
 - 1. Two samples of each type of mat proposed and proposed adhesive. Sample size shall be approximately six-in by six-in.

1.04 REFERENCE STANDARDS

- A. ASTM International
 - 1. ASTM D178 - Standard Specification for Rubber Insulating Matting
 - 2. ASTM D 5603 - Standard Classification for Rubber Compounding Materials-Recycled Vulcanizate Particulate Rubber
- B. Green Seal (GS)
 - 1. GS 36 - Commercial Adhesives
- C. South Coast Air Quality Management District (SCAQMD)
 - 1. SCAQMD Rule 1168 - Adhesive and Sealant Applications
- D. Where reference is made to the above standard, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 FLOOR MATS

- A. Electrically Energized Equipment Mats: Rubber electric insulating type mats conforming to ASTM D178, Type II, Class 2; branded continuously on back. Bevel edges of mats or attach electric insulating rubber reducing strips as approved to provide a non-trip perimeter.

1. Locations: Provide as indicated.
2. Size: 1/4-in thick, three-ft wide, in lengths equal to bench length or equipment piece length.
3. Materials and Construction: Construct electrically energized equipment mats of prime quality rubber compound, free of calendaring and curing defects, with narrow continuous longitudinal corrugations.
4. Color: Black.
5. Product: Provide one of the following:
 - a. "ASTM Switchboard" by American Floor Products Company, Inc.
 - b. "Switchboard Runner Matting," by Musson, R. C. Rubber Co.
 - c. "Corrugated Switchboard," by Tennessee Mat Co.
 - d. Or approved equal.

2.02 ACCESSORIES

- A. Provide waterproof adhesive, approved by the manufacturer, for securing floor mat to substrate.

2.03 FABRICATION

- A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Prepare substrate and install entrance mats according to approved procedures and when directed by the Engineer. Set length of units perpendicular to traffic direction through vestibule. Set units tightly together.
- B. Lay floor mats in place when and where directed.

END OF SECTION

SECTION 13300
INSTRUMENTATION AND CONTROLS (I&C) –
GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall procure the services of a Process Control System Supplier (PCSS) to furnish and install all materials, equipment, labor and services, required to achieve a fully integrated and operational system as specified herein, in the Specification Sections listed below, and in related drawings, except for those services and materials specifically noted.

1.	Section No	Title
	13302	Testing
	13305	Control Descriptions
	13306	Application Engineering services
	13310	Computer System Hardware
	13311	PLC Hardware and Software
	13323	Cellular Telemetry System
	13330	Control Panel Enclosure and Panel Equipment
	13340	Instruments

2.

2. The PCSS shall program and configure the PLC programming, datalogger, and datalogger remote workstation, and provide graphics development for Operator Interface Terminal (OIT).
3. The PCSS shall program and configure the cellular modem and firewall to achieve secure and reliable communication between the Black Creek Pump Station and the District's secure network.
4. The PCSS shall coordinate with the District the methods, interconnection, and protocol to be used to connect the Alligator Creek level measurement site and the Lake Brooklyn level measurement site to the Black Creek Pump Station.
5. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, shall be included whether they are shown on the Drawings or not.

- B. All equipment and installations shall satisfy applicable Federal, State and local codes.

- C. Use the equipment, instrument, and loop numbering scheme shown on the Drawings and specifications in the development of the submittals. Do not deviate from or modify the numbering scheme without the Engineer's approval.

1.02 RELATED WORK

- A. Instrumentation and Controls conduit systems are specified in Section 16110.

- B. Instrumentation signal cable and alarm and status wiring are specified in Section 16120.

1.03 BID ALLOWANCE

- A. The Contractor shall include a \$ 15,000 allowance in the contract for technical support and/or programming services for the Campbell Scientific data logger. The allowance shall be used to cover the costs of a Campbell Scientific integrator/distributor to assist the PCSS with the integration of the data logger and PLC-1100 in order to facilitate monitoring of the signals shown on the P&IDs and to facilitate basic remote controls such as set point modification, manual start/stop control and manual valve open/close control. The monitoring and controls shall interface with the LoggerNet software loaded on the District's workstation.
- B. The PCSS shall solicit a quotation for the Campbell Scientific integrator/distributor and submit it for approval with other documentation necessary to substantiate the cost of services contracted under the allowance. The PCSS shall include all scope of work required to provide, program, configure, document, and train on the application provided within the allowance as if it were specified herein and not part of the allowance unless specifically stated otherwise.
- C. The District reserves the right to approve the scope of services to be provided under this allowance.

1.04 SUBMITTALS

A. General Requirements:

1. Refer to Section 01300 for general submittal requirements.
2. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these specifications and shall provide a complete record of the equipment as manufactured and delivered.
3. Submittals shall be complete; giving equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.
4. Substitutions on functions or type of equipment specified shall not be acceptable unless specifically noted.
5. Separate submittals shall be made for each submittal listed below.

B. Qualifications Submittal:

1. Submit, within 30 calendar days after Effective Date of the Agreement, detailed information on staff and organization to show compliance with the Quality Assurance requirements of this Section. The Qualifications submittal shall be submitted and approved before any further submittals will be accepted. Failure to meet the minimum requirements shall be grounds for rejection as a PCSS. The Qualifications Submittal shall, as a minimum, contain the following:
 - a. Notarized statement from the firm's financial institution demonstrating the ability of the firm to meet the obligations necessary for the performance of the work.

- b. Copy of UL-508 certificate for panel fabrication facilities.
- c. Project references for water or wastewater projects as defined in the Quality Assurance paragraphs.
- d. Documentation to demonstrate the ability to complete this project including resumes of key staff, financial capacities, details on engineering, design, fabrication, and field service capacity, and location of staff responsible for responding to the site within four hours to resolve startup issues.

C. Project Plan, Deviation List, and Schedule Submittal:

1. Submit, within 45 calendar days after Effective Date of the Agreement, a Project plan. The Project Plan shall be submitted and approved before further submittals shall be accepted. The Project Plan shall, at a minimum, contain the following:
 - a. Overview of the proposed control system describing the understanding of the project work, a preliminary system architecture drawing, interfaces to other systems, schedule, startup, and coordination. A discussion of startup, replacement of existing equipment with new, switchover (Maintaining Plant Operations during system transition), approach to testing and training, and other tasks as required by these specifications shall be included as applicable.
 - b. Preliminary list of OIT and Datalogger software, PLC software, and PLC hardware, including version numbers, solely to determine compliance with the requirements of the Contract Documents prior to beginning development of system programming. Review and approval of software and hardware systems as part of this Project Plan stage shall not relieve the PCSS of meeting all the functional and performance requirements of the system as specified herein. Substitution of manufacturer or model of these systems after the submittal is approved is not allowed without Engineer approval.
 - c. Project personnel and organization including the PCSS project manager, project engineer, and lead project technicians. Include resumes of each these individuals and specify in writing their commitment to this project. These do not need to be submitted again if already submitted in the Qualification submittal.
 - d. Sample formats of the shop drawings to be submitted and in conformance with the requirements of the Specifications. At a minimum include samples of panel fabrication drawings, loop, and I/O wiring diagrams.
2. Exceptions to the Specifications or Drawings shall be clearly defined in a Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. If no exceptions are taken to the specifications or drawings the PCSS shall make a statement as such. If there is no statement by the PCSS, then it is acknowledged that no exceptions are taken.
3. Project schedule shall be prepared in Gantt chart format clearly showing task linkages for all tasks and identifying critical path elements. PCSS schedule must be based on the General Contractor schedule and must meet all field installation, testing, and start-up milestones in that schedule. The project schedule shall illustrate I&C related major project milestones including the following:

- a. Schedule for all subsequent project submittals. Include the time required for Contractor submittal preparation, Engineer's review time, and a minimum of two complete review cycles.
- b. Proposed dates for all project coordination meetings.
- c. Hardware purchasing, fabrication, and assembly (following approval of related submittals).
- d. Software purchasing and configuration (following approval of related submittals).
- e. Shipment of instrument and control system equipment.
- f. Installation of instrument and control system equipment.
- g. Testing: Schedule for all testing.
- h. Schedule for system cutover, startup, and/or going on-line for each major system. At a minimum include the schedule for each process controller and OIT server/workstation provided under this Contract.
- i. Schedule for all training including submittal and approval of O&M manuals, factory training, and site training.
- j. Incorporate time constraints for AESS activities as defined in Section [13301].

D. Input/Output (I/O) List Submittal:

1. Submit, within 60 days after Effective Date of the Agreement, a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
2. I/O list shall be based on the P&ID's, the Drawings, the design I/O list (if included), and requirements in the Specifications.
3. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format and an 8-1/2 inch by 11-inch hard copy.
4. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O as required in the specifications.
5. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet shall include the following information:
 - a. TAG NUMBER(S): As indicated on the Drawings, the identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
 - b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
 - c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
 - d. Physical POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
 - e. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO - Pulse Output.
 - f. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
 - g. ENGINEERING UNITS: The engineering units associated with the Analog I/O.

2. The operations and maintenance manuals shall, at a minimum, contain the following information:
 - a. Table of Contents:
 - 1) A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.
 - b. Instrument and Equipment Lists:
 - 1) The following lists shall be developed in Microsoft Excel format and provided not only as a hardcopy in O&M but also electronically on a CD.
 - 2) An instrument list for all devices supplied including tag number, description, specification section and paragraph number, manufacturer, model number, serial number, range, span, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
 - 3) An equipment list for all non-instrument devices supplied listing description, specification section and paragraph number, manufacturer, model number, serial number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
 - c. Equipment Operations and Maintenance Information:
 - 1) ISA-TR20.00.01-2007 data sheets shall be provided for all field instruments. For non-field instrumentation devices, provide a cover page for each device, piece of equipment, and OEM software that lists date, specification number, product name, manufacturer, model number, Location(s), and power required. Preferred format for the cover page is ISA-TR20.00.01-2007, general data sheet; however, other formats will be acceptable provided they contain all required information.
 - 2) Vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project, or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages that do not apply at all to the specific model supplied shall be removed.
 - d. As-Built Drawings:
 - 1) Complete as-built drawings, including all drawings and diagrams specified in this section under the "Submittals" section. These drawings shall include all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the PCSS.
 - 2) As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.
 - e. Original Licensed Software:
 - 1) Submit original software diskettes or CD-ROMs of all software provided under this Contract. Submit original paper based and electronic documentation for all software provided. Submit license agreement information including serial

numbers, license agreements, User Registration Numbers and related information. All software provided under this Contract shall be licensed to the District at the time of purchase. Provide media in software sleeves within O&M manual.

- f. Electronic O&M Information:
 - 1) In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals and data sheets, along with any software back-up of configuration files, on CDROM or DVD. Electronic documents shall be supplied in Adobe Acrobat format.
 - 2) Provide electronic files for all custom-developed manuals including training manuals. Text shall be supplied in both Microsoft Office format and Adobe Acrobat format.
 - 3) 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, fonts, and the drawing file into individual zip files.
 - 4) Each computer system hardware device shall be backed up onto CDROM or DVD after Substantial Completion and shall be turned over to the District.
 - 5) If specified in the training section, provide digital copies of all training videos. Videos shall be in a format that is readable by standard DVD players and by standard PC DVD drives. Format shall be a minimum of 800 by 600 pixels and shall include sound.
- 3. The cover and edge of each volume shall contain the information as specified in Section 01730.

1.05 COORDINATION MEETINGS

- A. Schedule the mandatory coordination meetings as described herein. The meetings shall be held at the District's designated location and shall include attendance by the District, the Engineer, the Contractor, and the PCSS's Project Engineer. Other Division 13 specifications may require additional meetings. Prepare and distribute an agenda for this meeting a minimum of one week before the scheduled meeting date. The meeting shall be scheduled a minimum of one week before the requested meeting date.
 - 1. A project kickoff coordination meeting shall be held within two weeks after submitting the Project Plan. The purpose of the meeting shall be to discuss the PCSS's Project Plan, to summarize the PCSS's understanding of the project; discuss any proposed substitutions or alternatives; schedule testing and delivery deadline dates; provide a forum to coordinate hardware and software related issues, and request any additional information required from the District. The meeting will last up to one business day.
 - 2. Regular on-site meetings when the PCSS staff is at the plant site.

1.06 REFERENCE STANDARDS

- A. Publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition in effect at the time of bid opening shall apply.

- B. International Society of Automation (ISA):
 - 1. ISA S5.2, Binary Logic Diagrams for Process Operations.
 - 2. ISA S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
 - 3. ISA S5.4, Instrument Loop Diagrams.
 - 4. ISA S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - 5. ISA RP60.3, Human Engineering for Control Centers.
 - 6. ISA RP60.6, Nameplates, Labels, and Tags for Control Centers.
 - 7. ISA-99, Industrial Automation and Control Systems Security.
- C. National Electrical Manufacturers Association (NEMA).
- D. National Fire Protection Agency (NFPA):
 - 1. NFPA 70, National Electrical Code (NEC).
 - 2. NFPA 79, Industrial Control Equipment.
- E. Underwriters Laboratories, Inc. (UL):
 - 1. UL 508 - Industrial Control Equipment - for custom fabricated equipment.
 - 2. A nationally recognized testing laboratory, as approved by the Authority having jurisdiction, may substitute for UL listing on commercial off the shelf products.

1.07 QUALITY ASSURANCE

- A. The Process Control System Supplier (PCSS) shall be a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. For the purposes of this Specification Section, a "systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:
 - 1. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. Key personnel shall hold ISA CCST Level 1 certification or have a minimum of 10 years of verifiable plant startup experience. Key personnel shall include, as a minimum, the lead field technician.
 - 2. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Successful completion shall be defined as a finished project completed on time, without any outstanding claims or litigation involving the

PCSS. Potential references shall be for projects where the PCSS's contract was of similar size to this project.

3. Has been actively engaged in the type of work specified in this Section for a minimum of five years.
- B. The PCSS shall maintain a permanent, fully staffed and equipped service facility within 200 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the PCSS shall be capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within four hours of notification starting at two months before scheduled startup to two months after startup completion.
- C. PCSS shall hold a valid UL-508 certification for their panel fabrication facility.
- D. Actual installation of the instrumentation system need not be performed by the PCSS's employees; however, the PCSS as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.
- E. The selected PCSS shall be one of the following:
 1. Rocha Controls, 5025 W. Rio Vista Ave Tampa, FL 33634, Phone: 813-267-3235
 2. Revere Control Systems, 4245 Pipkin Rd S, Lakeland, FL 33811, Phone: (863) 860-0574
 3. Locher Environmental, 752 Commerce Dr., Suite 3 Venice, FL 34292, Phone: (941) 483-3000
- F. Being listed in this specification does not relieve any potential PCSS from meeting the qualifications specified in this Section.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage, and handling shall be in accordance with Section [01 66 10] [01600].
- B. Shipping Precautions:
 1. After completion of shop assembly, factory test and approval of all equipment, cabinets, panels and consoles shall be packed in protective crates and enclosed in heavy duty (five mil) polyethylene envelopes or secured sheeting to provide protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at the job site.
 2. Manufacturer's special instructions for field handling, storage and installation required for protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other means of protection.

3. None of the control and monitoring equipment shall be shipped to the site until the control room areas comply with specified ambient temperature and humidity. Have qualified personnel accept the equipment on delivery and supervise unloading within the control room areas.
4. If any apparatus has been damaged, such damage shall be repaired at no additional cost to the District.

1.09 NOMENCLATURE AND IDENTIFICATION

A. Field Instrument Tags:

1. See Section 13340.

B. Panel Nameplates:

1. See Section 13330.

1.10 WARRANTY

- A. Provide warranty per Section 01740, Warranties and Bonds, and as specified herein.

1.11 MAINTENANCE CONTRACT

- A. A written proposal for a maintenance contract executed by the PCSS shall be provided to the District for on-site preventive maintenance services related to the Instrumentation and Control system. The cost of this maintenance contract shall not be included in the Contract Price.
- B. This proposal shall be provided within 30 days after final acceptance for the purpose of entering a contract for annual maintenance subsequent to the first year of maintenance. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from date of issue.
- C. This maintenance contract shall include all labor, parts, and emergency calls providing on-site response within 24 hours, to provide complete system maintenance for a period of one year after the date of Substantial Completion of the system for all equipment and software provided as part of the PCSS scope of work.
- D. Provide software updates throughout the maintenance contract period. Provide the latest official released version for all software provided under this Contract. The District shall have the latest software releases at the end of the maintenance contract period.
- E. The maintenance contract shall also include a minimum of one preventive maintenance visit by qualified service personnel of the Supplier who is familiar with the type of equipment provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of system equipment and verification of correct operation.
- F. Visits to the sites to correct deficiencies under warranty shall not be included in this preventive maintenance service contract.

- G. Emergency maintenance procedures or plant visits may coincide with a preventive maintenance visit; however, they shall not replace the work intended to be performed during a preventive maintenance visit. The Supplier shall have full responsibility for the system hardware preventive and corrective maintenance.
- H. During the one-year maintenance period, observation of maintenance operations by plant personnel and the instruction of said personnel in the details of the maintenance work being performed, shall be provided.
- I. Temperature:
 - 1. Outdoor areas' equipment shall operate between -30 to 50 C degrees ambient.
 - 2. Equipment located in indoor locations shall operate between 10 to 35 C degrees ambient minimum.
 - 3. Storage temperatures shall range from 0 to 50 C degrees ambient minimum.
 - 4. Additional cooling or heating shall be furnished if required by the equipment as specified herein.
- J. Relative Humidity. Air-conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between five to 100 percent relative, condensing humidity.

PART 2 PRODUCTS

2.01 GENERAL

- A. All instrumentation and electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture and fungus. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
- B. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks unless otherwise noted. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel. Provide stainless steel fasteners only in corrosive areas rated NEMA 4X on the Drawings or as defined under Section 16000. Provide minimum size anchor of 3/8-inch.
- C. All indicators shall be linear in process units, unless otherwise noted. All transmitters shall be provided with indicators in process units, accurate to two percent or better.
- D. All equipment, cabinets and devices furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain similar products of a single manufacturer, 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.
- E. All electronic/digital equipment shall be provided with radio frequency interference protection.

F. Electrical:

1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).
3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.
4. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.
5. Switches and/or signals indicating an alarm, failure or upset condition shall be wired in a fail-safe manner. A fail-safe condition is an open circuit when in an alarm state.
6. Materials and equipment shall be UL approved whenever such approved equipment and materials are available.
7. All equipment furnished shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.

2.02 ELECTRICAL SURGE PROTECTION

- A. General - Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along with the signal and power supply lines from lightning, utility, or the plant electrical system. The protection systems shall be such that the protective level shall not interfere with the normal operation but shall be lower than the instrument surge withstand level. Protection shall be maintenance-free and self-restoring. Devices shall have a response time of fewer than 50 nanoseconds and be capable of handling a discharge surge current (at an 8x20 μ s impulse waveform) of at least eight kA. Ground wires for all instrumentation device surge protectors shall be connected to a low resistance ground in accordance with Section 16660.
- B. Provide protection of all analog signal (4-20 mA) circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Protection devices located near the transmitter shall be mounted in a separate NEMA 4X stainless steel enclosure (plastic is not acceptable) or conduit mounted and shall be SURGETRAB S-PT, or equal. Substitution of a single device to protect both 120 VAC and 4-20 mA wires to an instrument is acceptable. Protection devices in control panels shall be

PLUGTRAB PT-IQ, or equal. Provide remote signaling on PLC/OIT for each surge protection status at PLC/OIT and Datalogger level.

- C. Inductive Loads - Provide coil surges suppression devices, such as varistors or interposing relays, on all process controller outputs or switches rated 120 VA or less that drive solenoid, coil, or motor loads.

2.03 SPARE PARTS

- A. All spare parts shall be wrapped in bubble wrap, sealed in a polyethylene bag complete with dehumidifier, then packed in cartons and labeled with indelible markings. Complete ordering information including manufacturer's contact information (address and phone number), part name, part number, part ordering information, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by the District or Engineer. Provide remote signaling gor
- B. Furnish one of each type of installed Surge protection device.
- C. Other spare parts are specified in each section. An overview follows:
 - 1. Devices within Control Panels - See the control panels section.
 - 2. Computer Hardware and Software spare parts - See the Computer System Hardware section.
 - 3. PLC spare parts - See the PLC section.
 - 4. Network and Communications System - See the Control and Data Network Equipment section.
 - 5. Instrument related Spare Parts - see the Instrument section(s).

2.04 TEST EQUIPMENT

- A. Provide all test equipment, instruction manuals, carrying/storage cases, unit battery charger, special tools, calibration fixtures, cord extenders, patch cords, test leads, and miscellaneous items for checking field operation of all supplied equipment.
- B. All test equipment shall be wrapped in bubble wrap, sealed in a polyethylene bag with a dehumidifier, then packed in cartons and labeled with indelible markings. Complete ordering information including manufacturer's part number, and equipment name shall be supplied. The test equipment shall be delivered and stored in a location directed by the Engineer.
- C. As a minimum, furnish the following test equipment:
 - 1. One complete electronic process calibrator sets with rechargeable batteries, cases, spare fuses, test leads, and PC-based software. Provide model 830 as manufactured by Altek, or equal.

2. One portable digital multimeter (DMM) with rechargeable battery and test leads, and carrying case, Fluke 289 Industrial Digital Multimeter, or equal. Combining the features of the electronic process calibrator and the DMM such as the Fluke 787 Process meter is acceptable.
3. One calibration pump, Model A-396A as manufactured by Dwyer Instruments, Inc., or equal.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. Instrumentation and accessory equipment shall be installed in accordance with manufacturer instructions. The indicated locations of equipment, transmitters, alarms, and similar devices indicated are approximate only. The exact locations of all devices shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control equipment and in case of 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 at no additional cost to the District.
- B. Provide brackets and hangers required for mounting of equipment.
- C. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.
- D. Investigate each space in the building through which equipment must pass to reach its final location. If necessary, ship material in sections sized to permit passing through restricted areas in the building. Provide on-site service to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval. Certify that field wiring associated with the equipment is installed in accordance with best industry practice. Coordinate work under this Section with that of the electrical work specified under applicable sections of Division 16
- E. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare and ultraviolet exposure on digital readouts.

END OF SECTION

SECTION 13302 TESTING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to complete the testing of all devices and systems furnished and installed as detailed on Drawings, and as specified herein.
- B. Refer to Section 13300 for other general requirements.

1.02 RELATED WORK

- A. Refer to Section 13300.

1.03 SUBMITTALS

- A. Refer to Section 13300.
- B. Testing Submittals - Submit, in one submittal, the following testing related documents:
 - 1. Status signoff forms:
 - a. Develop and submit project specific I/O Status and Automatic Control Strategy signoff forms to be used during factory and field testing to organize and track each loop's inspection, adjustment, calibration, configuration, and testing status and sign off. Include sign-off forms for each testing phase showing all loops.
 - 1) Example forms are shown in the Appendices.
 - 2) Separate forms for factory and field testing can be used, or they can be combined, at the discretion of the PCSS.
 - 3) Submit testing forms prior to start of testing.
 - 2. Testing Procedures:
 - a. Submit detailed procedures proposed to be followed for each of the tests specified herein. The test procedures shall serve as the basis for the execution of the required tests to demonstrate that the system meets and functions as specified.
 - b. Documents shall be structured in an orderly and easy to follow manner to facilitate an efficient and comprehensive test.
 - c. Test procedures shall indicate all pre-testing setup requirements, all required test equipment, and simulation techniques to be used.
 - d. Test procedures shall be structured in a cause and effect manner where the inputs are indicated, and the outputs are recorded.
 - e. Test procedures shall include the demonstration and validation under normal operating conditions and under various failure scenarios as specified in Contract Documents.
 - f. Testing may not start until all Testing Submittals have been approved.

C. Test Documentation:

1. Upon completion of each required test, document the test by submitting a copy of the signed off Testing Status forms. Testing shall not be considered complete until the signed-off forms have been submitted and approved. Submittal of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.

1.04 MAINTENANCE

- A. Refer to Section 13300.

1.05 COST OF TRAVEL

- A. Scheduled tests will only be attended once by Engineer /District. If test is not successful, all subsequent tests will be performed at Contractor's expense. Reimburse District for all costs, including labor and expenses, invoiced by Engineer and incurred by District for subsequent retests.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 TESTING - GENERAL

- A. Refer to Section 13300.
- B. Results of all testing shall be tracked on a project specific status sign off form or similar document. PCSS shall be responsible for maintaining the sheet. Appendix of this Section has an example template for this sheet.
- C. Tests the PCSS is required to perform are as follows:
 1. Factory Testing:
 - a. Unwitnessed Factory Test (UFT).
 - b. Witnessed Factory Test (WFT).
 2. Field Testing:
 - a. Operational Readiness Test (ORT).
 - b. Functional Demonstration Test (FDT).
 - c. Site Acceptance Test (SAT).
- D. 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 all special testing materials and equipment required for a suitable means of simulation.
- E. PCSS shall coordinate all required testing with Contractor, affected Subcontractors, Engineer, and District.

- F. No equipment shall be shipped to jobsite until Engineer or District has received all Factory Testing results and approved the system as ready for shipment.
- G. Engineer reserves the right to test or re-test any functions.
- H. Correction of Deficiencies:
 - 1. Deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to District.
 - 2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until specified requirements are met. This work shall be performed at no additional cost to District.

3.02 FACTORY TESTING - UNWITNESSED FACTORY TEST (UFT)

- A. Purpose of UFT is for PCSS to check system prior to Engineer and/or District attending factory testing. This type of testing shall be part of any quality firm's internal QA/QC procedures.
- B. Temporary network connections will be required to confirm the network configuration. Temporary wiring of primary elements, final control elements, and field-mounted transmitters is not required.
- C. Hardware to be tested shall include all control system devices shown on System Architecture drawings and provided by PCSS.
- D. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in Test Procedure submittal.
 - 1. All panels and enclosures being provided shall undergo a thorough inspection to verify integrity of cabinet enclosures, frame structures, paint work and finish, etc. Review panel drawings to ensure they accurately reflect panel layout and wiring.
 - 2. Perform a system audit to verify all components have been staged for test and have been documented properly with correct model numbers, serial numbers, etc. Following documentation of audit shall be provided at factory test and submitted as part of O&M Manual Documentation:
 - a. For each OIT , list of all software installed (including the operating system), with software revision number, software improvement modules or patches installed, license number and District registration information, warranty period, vendor and local distributor names and contacts.
 - b. For each microprocessor-based component connected to control communication backbone in system (PLCs, managed switches, protocol converters, communication cards on final field devices, radios, etc.), list firmware revision, vendor and local distributor information, and system, warranty information, configuration parameters (e.g., communication settings, fail position settings, etc.)
 - 3. Panel wire pull tests shall be performed to ensure all wiring has been connected with appropriate torque to prevent wires from coming loose.

4. UPS shall be tested to verify UPS switch power correctly while keeping all UPS powered loads online. Testing of UPS to determine if they have been sized correctly to maintain specified run time shall be performed during field testing.
 5. A 100 percent I/O point checkout shall be performed to verify proper operation of input/output points from panel terminations OIT nodes. At a minimum, I/O checkout shall consist of four steps.
 - a. Discrete input signals shall be jumpered at field terminal blocks in control panels to verify proper status in OIT nodes.
 - b. Analog input signals shall be connected to a signal generator at field terminal blocks in control panels to verify proper status in OIT nodes and signals shall be verified at zero percent, 50 percent, and 100 percent of full scale.
 - c. Discrete output signals shall be tested by switching equipment to manual control at OIT nodes and turning the output on or other means to turn the output on. Then verify the output is on by connecting a digital multimeter to measure continuity at terminations, thus verifying command from PLC has properly executed contact closure.
 - d. Analog output signals shall be tested by switching the equipment to manual control at OIT nodes and turning output on or other means to turn the output on. Then verify output by utilizing a digital multimeter to measure current or voltage generated at termination points.
 - e. All the records transferred and calculated to the Datalogger and Loggernet must be include as part of the I/O test.
 6. All control strategies shall be verified using simulation or other means to verify logic performs as expected. Verify faults and logical failure conditions for control strategies such instrument failures, equipment failures, loss of communication between HMI and PLC, loss of peer-to-peer communication, out of range testing (over and under scale) for analog inputs, and all other strategies specified in control strategy document.
 7. For each hardware enclosure, inspection shall include, but not be limited to, cabinet enclosures, frame structure, paint work and finish, dimensions, and hardware operability (i.e., fans, door hinges, keylocks, etc.).
 8. For each subpanel, inspection shall include, but not be limited to, I/O subsystem physical layout, power supply sizing and mounting, cable routing, wire runs across hinges properly installed, fans and blowers unobstructed and mounted to maximize air flow, power conditioning correctly installed, and overall layout and installation of components meets manufacturer's recommendations and standard industry accepted practices.
 9. All other control panel circuitry.
 10. Following systems tests shall be performed:
 - a. Demonstrate ability to share data between PLC and Datalogger and Loggernet.
 - b. Demonstrate ability of each workstation to reproduce data provided by Datalogger.
 - c. Demonstrate communication failure and recovering self-healing ring testing.
- E. Upon successful completion of UFT, PCSS shall submit a record copy of test results as specified in PART 1. As part of this test results submittal, notify Engineer and District in

writing that system is ready for WFT. No other notice of Factory test will be accepted. Engineer and/or District shall schedule a test date within 30 days of receipt of this submittal.

3.03 FACTORY TESTING - WITNESSED FACTORY TEST (WFT)

- A. Purpose of WFT is to allow Engineer or District representatives to witness functionality, performance, and stability of entire hardware and software system as a complete integrated system. WFT shall be run by PCSS and conducted at PCSS's facility.
- B. Required Documents for Test:
 - 1. Clean set of approved panel drawings and wiring diagrams.
 - 2. Set of Contract Documents - all drawings and specifications.
 - 3. All design change related documentation.
 - 4. Master copy of the PCSS developed factory testing signoff forms.
 - 5. Testing procedures.
- C. System shall operate continuously throughout WFT without failure, except where initiated per established test procedures. Unanticipated failures may, at District or Engineer's option, result in overall WFT being deemed unsuccessful. All deficiencies identified during these tests shall be corrected and re-tested prior to completing WFT or shipment of panels to jobsite as determined by District/Engineer.
- D. Tests to be performed during the WFT shall include, but not be limited to, the following:
 - 1. A repeat of all tests specified in the UFT.
- E. Daily schedule during these tests shall be as follows:
 - 1. Morning meeting to review the day's test schedule.
 - 2. Scheduled tests and sign-offs.
 - 3. End of day meeting to review day's test results and to review or revise next day's test schedule.
 - 4. Unstructured testing period by witnesses.
- F. Upon successful completion of WFT, PCSS shall submit a record copy of test results as specified in PART 1.

3.04 FIELD TESTING - OPERATIONAL READINESS TEST (ORT)

- A. Purpose of ORT is to check with Engineer or District representatives that process equipment, instrument installation, instrument calibration, instrument configuration, field wiring, control panels, and all other related system components are ready to monitor and control the processes. This test will determine if equipment is ready for operation.

- B. This test shall take place prior to FDT and startup. Prior to starting this test, relevant process equipment shall be installed and mechanically tested, instruments installed, control panels installed, and field wiring complete.
- C. Required Documents for Test:
 - 1. Master copy of the PCSS developed field testing signoff forms.
 - 2. Testing procedures.
 - 3. Calibration forms.
- D. These inspections, calibrations, and tests do not require witnessing. However, Engineer may review and spot-check testing process periodically. All deficiencies found shall be corrected by PCSS prior to commencement of Functional Demonstration Test.
- E. PCSS shall maintain Sign-off forms and Calibration forms at job site and make them available to Engineer/District at any time.
- F. Following tests shall be performed as part of ORT:
 - 1. Instrument calibration, configuration, and set-up.
 - 2. Input/Output (I/O) Testing to OITs.
 - 3. Testing of control strategies.
- G. Instrument calibration, configuration, and set-up:
 - 1. Calibrate, configure, and set-up all components and instruments to perform specified functions.
 - 2. Calibration form:
 - a. For any component or instrument requiring dip switch settings, calibration, or custom configuration, maintain a calibration form in field documenting this information. These forms shall provide a summary of the actual settings used in the field to allow an Instrument technician to replace the device entirely and configure it to function as it did before.
 - b. This information shall be added to Instrument data sheet, shall be added to a copy of manufacturer's standard "Configuration Sheet", or a separate form shall be created.
 - 1) If a separate form, the form shall list Project Name, Loop Number, ISA Tag Number, I/O Module Address, Manufacturer, Model Number/Serial Number, Output Range and Calibrated Value.
 - c. Some examples of required information are:
 - 1) For Discrete Devices: Actual trip points and reset points.
 - 2) For Instruments: Any configuration or calibration settings entered into instrument
 - 3) For Controllers: Mode settings (PID).
 - 4) For I/O Modules: Dip switch settings, module configuration (if not documented in native programming documentation).

- d. Maintain a copy of these forms in field during testing, and make them available for inspection at any time.
- e. For any device that allows a software back-up of configuration files to a laptop, make configuration files available to Engineer/District for inspection. Submit as part of Final System Documentation as specified in Section 13300.

H. I/O Testing:

1. Purpose of I/O testing is to check that process equipment, instrument installation, calibration, configuration, field wiring, and control panels are set-up correctly to monitor and control the processes. This test is commonly referred to as a "loop test" or an I/O checkout.
2. PCSS in conjunction with Contractor shall test signals under process conditions. Preferred test method will always be to execute test wherever possible to end elements. For example, preferred test will prove valve open/close limit switches by operating valve, not by installing a jumper on limit switch contacts. However if equipment or process is not available to test a signal over its entire calibrated range, PCSS may test using a simulation methods and make a note on sign-off form.
3. The following I/O tests shall be performed:
 - a. Discrete Input: At device or instrument, change signal condition from inactive to active state. Observe results on all indicators within loop such as, OIT screens, pilot lights, horns, beacons, etc.
 - b. Analog Input: Test analog signal over entire engineering range at various intervals including 0, 50%, and 100% as well as on increasing and decreasing range. Observe results on all indicators within loop such as, OIT screens, recorders, digital indicators, etc.
 - c. Discrete output signals shall be tested by switching equipment to manual control at the OIT nodes and turning output on or using other means to turn output on. Then verify equipment responds accordingly.
 - d. Analog output signals shall be tested by switching equipment to manual control at OIT nodes and turning output on or other means to turn output on. Then verify equipment responds accordingly.

I. Testing of Automatic Control Strategies:

1. All automatic control strategies shall be verified using actual process equipment and instruments, or other means, to verify logic performs as expected. Verify faults and logical failure scenarios for control strategies such as instrument failures, equipment failures, loss of communication between HMI and PLC, loss of peer-to-peer communication, out of range testing for analog inputs, loss of power, and all other strategies specified in control strategy document.

J. Repeat all systems tests specified under factory testing.

- K. UPS shall be tested to verify UPS switch power correctly while keeping all UPS powered loads online. Also, test sizing of UPS by switching off line power to UPS and verify if they maintain specified run time.

- L. For all panels with enclosures modified by this Contract, internal control panel temperature shall be tested under full running conditions to ensure proper cooling/ventilation is being provided.
- M. Upon successful completion of ORT, PCSS shall submit a record copy of test results as specified in PART 1 and request scheduling of FDT.

3.05 FIELD TESTING - FUNCTIONAL DEMONSTRATION TEST (FDT)

- A. After facility is started-up and running treatment process in automatic control to extent possible, a Functional Demonstration Test shall be performed. Purpose of FDT is to allow Engineer or District representatives to witness actual functionality, performance, and stability of system while connected to process equipment.
- B. Required Documents for Test:
 - 1. Set of panel drawings and wiring diagrams from ORT with corrections noted
 - 2. Set of Contract Documents - all drawings and specifications.
 - 3. All design change related documentation.
 - 4. Signed-off master copy of the PCSS developed field testing signoff forms.
 - 5. Testing procedures.
 - 6. Copy of completed calibration forms.
 - 7. One copy of all O & M Manuals for PCSS supplied equipment.
- C. A witnessed FDT shall be performed on each process area. To extent possible, repeat testing performed during ORT.
- D. Daily schedule specified to be followed during factory tests shall also be followed during FDT.
- E. After coordinating with Operations, a "Black Start" of the plant shall be performed to confirm plant operation recovers as specified in Contract Documents. Black start means shutting off power to the plant and turning it back on. Separate tests shall be performed by recovering the plant while on generator (if a generator is specified) and while on utility power.
- F. Punch list items and resolutions noted during test shall be documented on Punch list/Resolution form. In event of rejection of any part or function test procedure, PCSS shall perform repairs, replacement, and/or retest within 10 days.
- G. Upon successful completion of the FDT, PCSS shall submit a record copy of test results as specified in "Part 1 - General".

3.06 FIELD TESTING - SITE ACCEPTANCE TEST (SAT)

- A. After completion of FDT, and system is started-up and running treatment process in automatic control to extent possible, system shall undergo a test as defined in Division 01 "Equipment Testing and Start-up" Section.

- B. While this test is proceeding, Engineer and District shall have full use of system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain responsibility of District and decision of plant operators regarding plant operations shall be final.
- C. During this test, PCSS personnel shall be present as required to address any potential issues that would impact system operation. PCSS is expected to provide personnel for this test who have an intimate knowledge of hardware and software of system. When PCSS personnel are not on-site, PCSS shall provide cell phone/pager numbers that District personnel can use to ensure that support staff is available by phone and/or on-site within four hours of a request by operations staff.
- D. Any malfunction during test shall be analyzed and corrections made by PCSS. In event of rejection of any part or function, PCSS shall perform repairs or replacement within 5 days.
- E. Throughout duration of SAT, no software or hardware modifications shall be made to system without prior approval from District or Engineer.

3.07 CERTIFICATE OF INSTALLATION

- A. Following successful completion of SAT test, PCSS shall submit a Certification of Installation for system as required in Division 01 "Equipment Testing and Start-up" Section.

END OF SECTION

APPENDIX 13302-A: EXAMPLE INPUT/OUTPUT (I/O) STATUS SIGN OFF FORM

An example template for I/O Status signoff form to be used for documenting testing results to District is attached. PCSS is required, prior to testing, to create a project specific I/O Status signoff form based on attached template or approved equal. PCSS may obtain an electronic copy of template from Engineer or develop it on their own.

APPENDIX 13302-B: EXAMPLE AUTOMATIC CONTROL STRATEGIES SIGN OFF FORM

An example template for Automatic Control Strategies signoff form to be used for documenting testing results to District is attached. PCSS is required, prior to testing, to create a project specific Automatic Control Strategies signoff form based on attached template or approved equal. PCSS may obtain an electronic copy of template from Engineer or develop it on their own.

[Project Name] Appendix A - Input/Output (I/O) Status Sign-Off Form

4-Jun-14

All Sections below are required to be filled out by PCSS as part of Field Testing.

PLC	Signal Tag	Description	Range or Active State when closed	P&ID	Signal	Chan	Instru- ment Alarm Setpoint	Calibrate, Alarm and Wiring complete	PCSS I/O testing	Date	Date	Notes
PLC-SC	LI-4000-1	Secondary Clarifier No. 1 Sludge Level	0-10" H	8	AI	2	1					
PLC-SC	LI-4000-3	Secondary Clarifier No. 3 Sludge Level	0-10" H	8	AI	2	1					
PLC-SC	SI-4100-1	RAAS Pump No. 1 Speed Feedback	0-100%	14	AO	2	7					
PLC-SC	SI-4100-2	RAAS Pump No. 2 Speed Feedback	0-100%	15	AO	2	7					
PLC-SC	SI-4100-3	RAAS Pump No. 3 Speed Feedback	0-100%	14	AO	2	7					
PLC-SC	SI-4100-4	RAAS Pump No. 4 Speed Feedback	0-100%	14	AO	2	7					
PLC-SC	SI-4100-5	WAS Pump No. 1 Speed Feedback	0-100%	14	AO	2	7					
PLC-SC	SC-4100-1	Spare Slot	N/A	N/A	Spare	2	5					
PLC-SC	SC-4100-2	RAAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	SC-4100-3	RAAS Pump No. 2 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	SC-4100-4	RAAS Pump No. 3 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	SC-4110-1	WAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7					
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7					
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7					
PLC-SC	TS-4000-1	Secondary Clarifier No. 1 High Torque	Normal	8	DI	3	1					
PLC-SC	YA-4000-1	Secondary Clarifier No. 1 Motor On/Off	Normal	8	DI	3	1					
PLC-SC	WAH-4000-1	Secondary Clarifier No. 1 High Torque	Normal	8	DI	3	1					
PLC-SC	YRI-4000-1	Secondary Clarifier No. 1 On/Off	On	8	DI	3	1					
PLC-SC	YCI-4000-1	Secondary Clarifier No. 1 In Remote	In Remote	8	DI	3	1					
PLC-SC	YFI-4100-1	RAAS Pump No. 1 VFD Fault	Normal	14	DI	3	1					
PLC-SC	FAL-4100-1	RAAS Pump No. 1 Low Flow	Normal	14	DI	3	1					
PLC-SC	Spare	Spare	Normal	14	DI	3	1					
PLC-SC	YRI-4100-1	RAAS Pump No. 1 Running	Running	14	DI	3	1					
PLC-SC	YCI-4100-1	RAAS Pump No. 1 In Remote	In Remote	14	DI	3	1					
PLC-SC	FAL-4110-1	WAS Pump No. 1 VFD Fault	Normal	14	DI	3	1					
PLC-SC	Spare	Spare	Normal	14	DI	3	1					
PLC-SC	YRI-4110-1	WAS Pump No. 1 Running	Running	14	DI	3	1					
PLC-SC	YCI-4110-1	WAS Pump No. 1 In Remote	In Remote	14	DI	3	1					
PLC-SC	HSS-4000-2	Secondary Clarifier No. 2 Start Command	Start	8	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-4100-2	RAAS Pump No. 2 Start Command	Start	14	DO	4	6					
PLC-SC	HSS-7000-2	Sludge Holding Tank Blewer No. 2 Start Command	Start	17	DO	4	6					
PLC-SC	HSS-4100-5	RAAS Pump No. 5 Start Command	Start	15	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-4105-1	Secondary Sludge Pump No. 2 Start/Stop	Start	15	DO	4	6					
PLC-SC	HSS-4110-2	WAS Pump No. 2 Start/Stop Command	Start	15	DO	4	6					
PLC-SC	7160FQH1	Sludge Lostout LCP Pumping Indicator	Pumping	17	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-7115-2	Sludge Holding Tank Mixval No. 2 Start	Start	17	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					
PLC-SC	HSS-7117-2	Sludge Holding Tank Discharge Valve No. 2 Open CMD	Open	17	DO	4	6					
PLC-SC	HSS-7117-2	Sludge Holding Tank Discharge Valve No. 2 Close CMD	Close	17	DO	4	6					
PLC-SC	HSS-7120-2	Transfer Pump No. 2 Start Command	Start	17	DO	4	6					
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6					

[Project Name] Appendix B - Automatic Control Strategies Sign-Off Form

All Sections below are required to be filled out by PCSS as part of Testing

Auto. Control Strategies. - Loop operational in Automatic as defined in Control Strategies

Control Strategies Loop #	Control Strategy Description	P&ID	Auto. Control Strategy	Date	Notes
LOOP 281 - 284	LOW FLOW PUMPS	8			
LOOP 290	LOW EQ CHANNEL FLOW NO. 4	8			
LOOP 300	MICROFILTRATION AIR SUPPLY LOW PRESSURE	10			
LOOP 351, 352	SITE LIFT STATION PUMP NO.1 AND NO. 2	12			
LOOP 355	SITE LIFT STATION HIGH AND LOW LEVEL CONTROL	12			
LOOP 371, 372	SLUDGE HOLDING TANK NO.1 AND NO. 2 LEVEL	14			
LOOP 381, 382	SLUDGE TRANSFER PUMPS	14			
LOOP 385	SLUDGE TRANSFER PUMPS REMOTE START/STOP COMMAND	14			
LOOP 700	EFFLUENT PUMPING STATION LEVEL	14			
LOOP 701, 702, 703	EFFLUENT PUMP NO.1	14			
LOOP 840	POST AERATION CHANNEL AIR FLOW CONTROL	15			
LOOP 900	SLUDGE TRANSFER PUMPS DISCHARGE FLOW	8			
LOOP 971	CENTRIFUGE SLUDGE FEED PUMP NO.1	8			
LOOP 1001	CENTRIFUGE NO.1 SLUDGE FEED FLOW CONTROL	8			
LOOP 1411, 1412	SODIUM HYPOCHLORITE STORAGE TANKS LEVEL	8			
LOOP 1421, 1422	SODIUM HYPOCHLORITE PUMPS	8			
LOOP 1430	SODIUM HYPOCHLORITE STORAGE TANKS CONTAINMENT AREA HIGH LEVEL DETECTION	14			
LOOP 2051, 2052, 2053	DIESEL ENGINE GENERATOR STATUS	14			
LOOP 2055	TRANSFER SWITCH STATUS	14			
LOOP 2060	GENERATOR KILOWATTS MONITORING	14			
APPENDIX ONE	EQUIPMENT RESTART DURING A POWER LOSS WITH THE GENERATOR RUNNING	14			
APPENDIX TWO	EQUIPMENT RESTART WITH POWER RESTORED AFTER A POWER LOSS	14			
N/A	SELF-HEALING CAPABILITIES OF NETWORK	N/A			
N/A	REDUNDANT SCADA SERVER FAILOVER AND RECOVERY	N/A			

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SECTION 13305
CONTROL DESCRIPTIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section is provided to clarify the control strategies to be used to program the system.
- B. All PLC controller programming and SCADA Operator Interface Terminal (OIT) or Operator Workstation Station (OWS) graphics and programming shall be performed as defined in Section 13300.

1.02 RELATED WORK

- A. Refer to Section 13300 "I & C - General Provisions."

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The control descriptions are broken into areas. The following is a list of areas and the loop numbers associated with each area.

1. Screen Backwash	1000
2. Intake Pumps	1100
3. Water Backwash Motorized valve	1130
4. Flow/Pressure Monitoring	1140
- B. The control descriptions are sorted by loop number for each area. The loop index has three columns associated with it; Loop Number, Loop Description, and Page. Each loop is associated with a specific PLC I/O cabinet location to which it shall communicate.
- C. The control descriptions are broken into a hierarchical layer concept. There may be one layer or multiple layers per loop, depending upon that loop. An example of multiple layered loop is as follows. The lowest layer of control, local control, is at that piece of equipment or that piece of equipment's panel or drive. The second layer of control is at an intermediate control panel, if shown on drawings, between the equipment and the PLC I/O or vendor's PLC I/O. The third layer would be at the vendor's PLC or microprocessor touchscreen station. The highest layer of control is by the PLC System, if shown on drawings, with its Local Operator Interface Terminal (OIT) and Datalogger workstation (Loggernet), if shown on drawings, in the main control room, remote office locations, or local PLC panel.

3.02 CONTROL FUNCTION DEFINITIONS AND GENERAL CRITERIA

- A. The hardware and/or software functions noted by this paragraph reference are to be implemented by the OIT/PLC control system specified herein.
- B. The following list of ISA abbreviations is typical of those utilized. The description, following the abbreviation, summarizes the basic function to be implemented in the OIT/PLC software.

1. HS: Represent selector switches or pushbuttons, which shall be implemented by keyboard entry. Function shall be similar to their hardware counterparts. Examples are as follows:
 - a. HS-Valve Open Command
 - b. HS-Valve Close Command
 - c. HS-Motor Start/Stop Command
 2. RL/HS/XS: Represents equipment status (i.e., availability, running, in remote, etc.) implemented by a change of color on the OIT symbol for this equipment. For motor driven equipment such as pumps, blowers, compressors, etc., availability contact represents remote operation and no alarm conditions. Examples are as follows:
 - a. HS-Selector switch in computer, auto or remote position
 - b. RL-Motor running status
 - c. XS-Motor failure or overload status
 3. PAL, AAH, UA, etc.: Represent high or low alarms implemented on the OWS.
 4. FIC, PIC, AIC, etc.: Represent PID process controllers implemented in a computer logic algorithm incorporating proportional, integral, and/or derivative modes. Local/remote and manual/auto capabilities shall be provided.
 5. FIK, PIK, AIK, etc.: Represent control stations implemented in logic (via keyboard entry and CRT display) to allow downloading of a set point to a FIC, PIC, AIC, etc., and display of the process variable or controller output.
 6. FI, PI, AI, etc.: Represent digital output display on the CRT of a process variable in engineering units and/or a dynamic representation of the variable by symbol or graphical means.
 7. FIR, PIR, AIR, Represent values stored on the hard disk to provide the data for historical trend graphics of process variables against time (or other selected variables).
 8. ZSH, ZSL etc.: Represent high or low, open or close limit positions implemented on the OWS
- C. All interlocks that are represented, before the local operational descriptions, or are stated as hardwired interlocks, shall interlock all the controls locally and at the OIT/PLC or at the vendor PLCs.
- D. All flow shall be totalized and show the following register on the OIT screen:
1. Total today
 2. Yesterday Total.
 3. Total current month
 4. Total last month.
- E. The PLC shall calculate for each Pump the total runtime hour and the start counter, showing the following register on the OIT graphics:
1. Runtime Total today

2. Runtime Yesterday Total.
 3. Runtime Total current month
 4. Runtime Total last month.
 5. Start counter Total today
 6. Start counter Yesterday Total.
 7. Start Total current month
 8. Start Total last month.
- F. All status and register shall be able to be recorded on the datalogger.
- G. All interlocks that are represented in a particular layer of the operational descriptions, shall interlock all the controls in that layer and the layer after it. However, the interlock shall not interlock the commands in the layer before it.
- H. The OIT system shall stop a motor or drive in its program if it does not receive the auto or remote status or one of its software interlocks trip. If the drive or motor is in hand or remote it will continue to run but the OIT start/stop output will be open.
- I. All motors that are requested to start by an operator or an automatic program shall alarm if the run confirm status for that motor does not activate within two seconds. If a motor stops by an interlock or stops without any operator or OIT intervention, then that motor shall go into alarm. All motors that are stopped by a program or the operator shall not go into an alarm.
- J. All valves that are requested to open by an operator or an automatic program shall alarm if the open feedback status for that valve does not activate within ten seconds. All valves that are requested to close by an operator or an automatic program shall alarm if the close feedback status for that valve does not activate within 10 seconds.
- K. Motors that have an H/O/A shall indicate to the operator that the pump is being run in the "Hand" position. A motor is being run in "Hand" when the "Auto" position is not true, and the run confirm status is true. If not in "Auto" the PLC shall open up its output contact to stop (shutdown) the pump from OIT.
- L. Motors shall be programmed to restart on normal power if that motor is still in auto when the motor stops due to a power outage. If a motor stops and the HOA switch is not in auto, the motor shall not be restarted automatically by the OIT without operator or OIT logic intervention. Thus, the only way that motor when placed back in auto can be started by the OIT is if the operator reinitiates the start command for that motor on the OWS or when that motor control at the OWS is placed in complete automatic mode and the SCADA computer through logic/interlocks requests the motor to run.
- M. Terminology associated with interlocks is as follows:
1. When a contact or status is true, the OIT computer will receive power to its input channel. The OIT computer registers this as a binary bit of one.
 2. When a contact or status is false, the OIT computer will receive no power (open circuit) to its input channel. The OIT computer registers this as a binary bit of zero.
- N. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card, the following OIT programming shall take place:

1. Alarm the signal at any local OITs
 2. If the analog signal is used in a calculation, that calculation shall use the last good analog signal. The computer shall place the control loop in manual if using the calculation.
- O. All interlocks that shutdown (Stop a piece of equipment and prevent it from being restarted or moved) shall be shown on the faceplate pop-up graphic for that piece of equipment.
- P. The run confirms or on status of all motors and lamps shall be accumulated to calculate a run time status of the equipment on the OIT graphic. Each run time accumulation shall come with a reset button on the OIT screen.
- Q. All flow indications shall be totalized. Do not totalize if the analog signal is outside the 4-20 mA range. Each flow totalization shall come with a reset button on the HMI screen. Do not totalize if the value of the flow input is less than two percent of the full range of the input.

LOOP INDEX

LOOP No.	LOOP DESCRIPTION	PAGE No.
LOOP 1100	INTAKE PUMPS	4
LOOP 1000	SCREEN BACKWASH CONTROL	7
LOOP 1130	WATER BACKWASH MOTORIZED VALVE	9
LOOP 1140	FLOW / PRESSURE MONITORING.....	9

LOOP 1100 INTAKE PUMPS

General: On/off operation and speed adjustment of the pump. The Operation of the pump is either at pump's variable frequency drive (VFD) controller panel or at the OIT/PLC.

Control:

Hardwired Interlocks:

The emergency stop pushbutton (ES) when tripped shall shutdown the VFD or starter for the pump.

VFD Panel:

Hand: When the Hand/Off/Remote selector switch (HS) is in the "Hand" position, the pump can be started as a constant desire speed that is set local "Start Pushbutton" is activated.

Off: When the Hand/Off/Remote selector switch (HS) is in the "Off" position, the pump is shutdown.

Remote: When the Hand/Off/Remote selector switch (HS) is in the "Remote" position, control of the pump as a constant speed pump is transferred to the OIT/PLC

Local: When the Local/Remote pushbutton is in the "Local" position, the drive is started and stopped through local pushbuttons on the drive. The speed of the drive shall be able to be adjusted locally through the keypad on the VFD.

On/Off Features when in VFD & in Remote

Hand: When the Hand/Off/Remote selector switch (HS-A) is in the "Hand" position, the VFD drive for the pump can be started and stopped through the Hand pushbutton station (HS-B).

Off: When in the "Off" position, the VFD drive for the pump is off.

Remote: When the Hand/Off/Remote selector switch (HS) is in the "Remote" position, control of the VFD is transferred to the OIT/PLC.

OIT/PLC:

Software Interlock:

If emergency stop (ES) is tripped the PLC shall stop the pumps.

A high - high level on Alligator Creek or Lake Brooklyn shall shutdown the intake pumps.

A high differential level across the intake structure shall shutdown the intake pumps.

A high-high level alarm at the treatment storage tank shall shutdown the intake pumps.

Screen backwash in progress shall stop the pumps.

Water backwash in progress through the opening of the motorized valve 1130 shall stop the pump

On/Off and Speed Features

Manual: The pump can be manually started or stopped (HSS) by the operator at the OIT/PLC. Also, the operator will be able to manually adjust the speed (SC) of the VFD at the OIT/PLC.

Remote: The pump shall be manually started or stopped by the operator at remotely from the Loggernet Workstation. Also, the operator will be able to manually adjust the speed (SC) of the VFD at the OIT/PLC

Auto: When the loop is placed in automatic mode, the pumps' on/off control is based upon the pumps' speed feedback. The speed of the pumps is controlled from the output of software flow controller, FIC-

1010. The flow setpoint and number of pumps is define by the intake level LT-1010 as indicate in the below table. Refer to the control sequence write-up below:

The operator shall be able to choose the sequence of operation as to which pumps shall be called at a time. The selection shall be shown as a selection of four options by lead pump.

The base numbers of pumps and flow setpoint will be called based on level using the below table that show reference values that should be able to be changes from the OIT. If a pump fails or does not start, the computer shall go to the next pump in the sequence.

The operator shall be able to change the pump sequence only when one pump or no pumps are on. When changing the pump sequence when one pump is on, the first pump from the last sequence shall remain on until the first pump of the new sequence starts, and then the pump from the old sequence shall stop. Thus, if go from sequence 1 to sequence 2, Pump 1 shall remain running until Pump 2 is running, and then Pump 1 shall shut down. The computer shall change the sequence if the first pump in the sequence does not start.

LIT-1010 *	Number of pumps to be called	Pumping rate (gpm) Flow Setpoint	Max Speed %	Min Speed %
<A	0	0		
A to B	1	2,446	90%	75%
B to C	2	4,590	100%	75%
C to D	3	6,109	100%	75%
>D	4	7,792	100%	75%

* Level setpoint to be determined during startup.

The following pump controls shall take place:

The speed output controlled by software controller FIC and shall be used and converted to a speed set point between 0-100%. The output to the pumps shall be the same regardless of whether one, two, three or four pumps are running. Once placed in auto, the pump sequence shall start. At the indicate level the setpoint is to maintain the flow until the speed feedback signal for that pump reaches the max speed %. Once the max % speed is reached for a predetermine period, an additional pump shall be called. When the pump speed feedback falls below the minimum % speed, for predetermine period of time, one pump should stop. The running pumps shall ramp down and the additional pump shall start to ramp up from its minimum load position until both pumps are running at the same speed.

Alarms / Monitoring / Control:

VFD panel:

Multiple information on keypad

OIT/PLC:

VFD Run Confirm Status
VFD in Remote
VFD Fault Status
VFD Speed Indication
VFD Speed command
Flow Setpoint
Levels Limits Setpoint
Lead pumps
Pumps Sequence of operation.

DATALOGGER/ LOGGERNET:

Events
 VFD Status Local/Remote
 VFD Running
 VFD Fail
 Discharge pressure Alarm

Commands
 Lead pump
 Start/stop VFD
 Speed Setpoint
 Flow Setpoint

Record
 Speed Feedback
 Daily Speed Feedback Average
 Daily Speed Feedback Max
 Daily Speed Feedback Max

LOOP 1000 SCREEN BACKWASH CONTROL

General: Backwash initialization command to backwash control panel and screen monitoring.

Control:

Local:

Refer to local controls shown at the P&ID for the LCP 1000

PLC /OIT:

The operator shall indicate the differential level between the screen pit and the reservoir level measurement LIT1015, and LIT1010. At the screen pit differential level reaches the high alarm setpoint for a predetermine period, all pumps should be stopped, and the backwash command shall be sent. The backwash in progress signal and the backwash system alarm should be monitor during the backwash process

DLIT1015 = LIT1010 - LIT1015

When the backwash in progress signal fall from the active status, the initiate differential level monitoring shall be resume.

Alarms / Monitoring:

Local:

Compressor Running
Backwash in progress
Backwash panel in Fail.
Inadequate air pressure for backwash
Air Valve to screen 1-3 Open/Close
Air Valve to screen 4-6 Open/Close
System Enable
System ON

PLC/OIT:

Level indication
High - High level alarm
High level alarm
Low level alarm
Low - low level alarm
Differential Level indication
Differential High-level alarm
Differential High - High level alarm
Backwash screen 1-3 Open/Close
Backwash screen 4-6 Open/Close
Levels limits Setpoint

DATALOGGER/ LOGGERNET:

Events

High - High level alarm
High level alarm
Low level alarm
Low - low level alarm
Differential High-level alarm
Differential High - High level alarm
Backwash systems fail
Backwash in progress

Record

Backwash duration
Level indication
Daily Level Average
Daily Level Max
Daily Level Min

Daily Differential Level Average
Daily Differential Level Max
Daily Differential Level Min

LOOP 1130 WATER BACKWASH MOTORIZED VALVE

General: A water backwash pulse by motorize valve BV-1130.

Control:

Local:

Refer to local controls at valve shown at the P&ID for the LCP 1130

Remote: The valve shall be manually open or close by the operator remotely from the Loggernet Workstation.

PLC /OIT:

The operator shall be able to open/close the valve 1130 to produce a water pulse to backwash the screen.

Alarms / Monitoring:

Local:

Valve open
Valve close

PLC/OIT:

Valve Open
Valve Close
Valve Fail to Open
Valve Fail to Close

DATALOGGER/ LOGGERNET:

Events
Water backwash in progress

Command
Open Valve
Close Valve

Record
Water backwash executed
Water backwash duration.

LOOP 1140 FLOW / PRESSURE MONITORING

General: Flow and Pressure monitoring and flow totalization

Control:

Local:

None

PLC /OIT:

The PLC shall provide instant flow and pressure and flow totalization to be display on the OIT

Alarms / Monitoring:

Local:

None

PLC/OIT:

Flow indications
Flow Totalization
Pressure indication
High - High Pressure alarm
High Pressure alarm
Low Pressure alarm
Low - low Pressure alarm
Flow Setpoints
Pressure Setpoints

DATALOGGER/ LOGGERNET:

Events

High - High Pressure alarm
High Pressure alarm
Low Pressure alarm
Low - low Pressure alarm

Record

Flow indications
Daily Flow average
Daily Flow Max
Daily Flow Min
Flow Totalization
Daily Totalization
Pressure indication
Daily Pressure average
Daily Pressure Max
Daily Pressure Min

END OF SECTION

SECTION 13306
INSTRUMENTATION AND CONTROLS –
APPLICATIONS ENGINEERING SERVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Refer to Section 13300.
- B. If referred to anywhere else in the project manual, Application Engineering (AE) or Applications Engineering System Supplier (AESS) services are those services specified in this Section. If the Process Control System Supplier (PCSS) is providing Application Engineering services, then the terms PCSS and AESS shall be considered equivalent.
- C. Provide all programming, configuration, and related services required to achieve a fully integrated and operational system as specified herein. All equipment shall be controlled in full conformity with the contract drawings, process control descriptions, specifications, engineering data, instructions, and recommendations of the equipment manufacturer. Coordinate the 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.
 - 1. Provide programming of the Programmable Logic Controllers (PLCs) provided for all equipment shown on the drawings, except for controls equipment shown being provided as part of a vendor package system.
 - 2. Provide configuration of the Operator Interface Terminals, datalogger and related software and drivers provided for all equipment shown on the drawings, including equipment provided by vendor package systems.
 - 3. Provide configuration of firewall, and cellular equipment.
 - 4. Provide for and test communications and functionality between all connected devices such as PLCs, the OIT, Dataloggers, and related software packages, including devices supplied by others, as depicted on the system architecture drawings in order to provide a comprehensive working system of data collection, storage, and reporting.
 - 5. Provide integrations of data provided from SJRWMD as shown in drawings.
- D. All work shall be coordinated with plant operating personnel to minimize impacts on daily operation. Delays caused for any reason shall be noted and formally submitted to the Engineer and the District in the form of a letter.

1.02 RELATED WORK

- A. Refer to Section 13300.

1.03 SUBMITTALS

- A. Provide all required submittals in accordance with Section 01300, Submittals. The submittals listed below shall be provided as a minimum.
 - 1. System Standards and Conventions
 - 2. Operator Interface
 - 3. Controller Program
 - 4. Operations and Maintenance Manuals
 - 5. Datalogger
- B. Supplement to Project Plan Submittal
 - 1. Supplement the "Project Plan, Deviation List, and Schedule" submittal in Section 13300 by adding the following items to the submittal requirements:
 - a. List of all graphics intended to be created for this project.
 - b. List of all PLC programs that will be created or modified for this project.
- C. Supplement to Input/Output (I/O) List Submittal
 - 1. Supplement the "Input/Output (I/O) List " submittal in Section 13300 by adding the following item to the submittal requirements:
 - a. LOGICAL POINT ADDRESS: I/O address of each point.
- D. System Standards and Conventions Submittal
 - 1. Submit the standards and conventions that will be used on this project. The submittal shall define, at a minimum:
 - a. Graphic display standards, including color conventions, equipment symbols, display format, equipment control pop-up displays, trend displays, and display navigation. Include samples of each proposed type of graphic display (i.e., overview, detail, diagnostic, tabular, etc.)
 - b. System naming conventions, such as graphic displays naming, database naming, tag names, and computer naming.
 - c. System configuration, including network addressing for all provided equipment.
 - d. Alarm configuration standards, including priorities and logging
 - e. Security configuration standards, including user groups and privileges
 - f. PLC standard programming modules, including analog input scaling, flow totalization, equipment runtime, motor start/stop, valve open/close, and any other standard logic planned to be used.
 - 2. To facilitate the District's future operation and maintenance, the submitted standards and conventions shall be used as the basis for programming and configuration of the system. System programming and configuration shall not begin prior to the System Standards and Conventions Submittal.

E. Operator Interface

1. Following the approval of the standards and conventions submittal, submit a draft of all proposed graphic displays, examples of each type of pop-up (faceplate) display, and examples of trends. For those graphics which will be duplicated more than once for a similar type of equipment, submit the graphics for the first equipment only.
2. Following the draft graphics review meeting and prior to the factory test, submit a ready-for testing version of all graphic displays. These graphics should be completely finished other than the incorporation of comments and changes resulting from testing.
3. Submitted graphic displays and trends shall be no less than A4 paper and in full color.

F. PLC/Datalogger Program Submittal

1. For each controller, submit the following using the controller manufacturer's built in printing functions. Electronic submission of Adobe Portable Document Format ("pdf") files in lieu of paper submittals is acceptable. A review will be for general program organization, level of documentation, and overall programming standards (basic pump and valve control, for example). The review will not attempt to confirm the logic works correctly for every loop.
 - a. Programs showing ladder logic, Scripting program for datalogger, function block, high-level language, or other controller language used. Include individual rung, network, and/or command descriptions with abundant comments to clearly identify the function and intent of each code segment. Each logic segment shall be clearly presented, the function of each timer described, the purpose of each subroutine call labeled and defined, etc. Program documentation shall be sufficiently clear to allow determination of compliance with the process control requirements included in the control descriptions and with the Drawings. The submittal shall demonstrate that all logic provided under this project follows the same structure and format and reflects a common programming approach.
 - b. Submit a memory usage report for the PLC and datalogger. This report shall indicate total memory capacity and unused memory capacity.
 - c. Submit cross-reference index of I/O allocation and controller memory address. Every physical I/O point, as well as calculated or virtual I/O required for the implementation of the process scheme, shall be included.
 - d. Datalogger configuration, data record, data management, and real-time monitoring as shown in drawings.
 - e. Communication configuration for integration with data provided by SJRWMD as shown in drawings.
2. Submit details of control system communication. Submit a "memory map" or other means showing which signals are exchanged between PLCs. Also, submit an OIT tag database showing all signals exchanged between the PLCs and OIT. Any specific communication block memory addresses shall be defined.

G. O&M Manuals - Software Maintenance Manuals

1. Include these manuals as part of 13300 "Final System Documentation". This required information is in addition to any requirements of Section 13300.

2. Software Listings and Databases- Submit hard copies of the same information required in the "Controller Program Submittal" except including files updated to reflect the as built system. Include PDF versions of these files in the CD specified below.
3. PID Loop Tuning Parameters - Submit annotated chart recorder traces or computer system trend screen printouts showing tuned control loop response to plus and minus 40 percent of full span step changes of loop setpoint for each individual loop. For cascade loops, submit charts showing the response of the secondary loop with secondary setpoint on manual and also the response of the entire cascade control loop in automatic mode. Include a description of the tuning methodology used.
4. If available as part of the software provided, supply hard copies of configuration information for the OIT, datalogger, and any other programs developed under this Contract.
5. Machine Readable Documentation - Provide two sets of as-built software documentation on CD-ROMs in original electronic format for all PLC, OIT, reporting systems, Historian Systems, and any other programs developed under this Contract. Any changes made during or after testing, start-up, and commissioning shall be incorporated.

H. O&M Manuals - Operator Manuals

1. Provide Operator's Manuals prior to final acceptance of the system.
2. These manuals shall be separately bound and shall contain all information necessary for the operator to monitor and control the plant from the control system. The manuals shall be written in non-technical terms and shall be organized for quick access to each detailed description of the operator's procedure. Manuals shall contain, but not be limited to, the following information:
 - a. A comprehensive table of contents of the manual.
 - b. A simple overview of the entire system indicating the function and purpose of each piece of equipment.
 - c. A detailed description of the operation of the OIT including all appropriate displays. Including a screenshot of each OIT display screen and annotating each function in the text is an acceptable format for presenting this information.
 - d. Step-by-step procedures for starting up or shutting down an individual component of the control system and also of the entire system.
 - e. Login/logout procedures.
 - f. Complete, step-by-step procedures for printing reports and entering manual data.
 - g. Complete, step-by-step procedures for performing system or selected file backup and restoration including archiving historical data. Include recommended archiving schedule for historical data.
 - h. A complete glossary of terms and definitions of acronyms.
 - i. List of personnel to be contacted for warranty and emergency services, including name, address, telephone number, pager or cell phone number, fax number, and email address
3. Include these manuals as part of 13300 "Final System Documentation". This required information is in addition to any requirements of Section 13300.

1.04 MAINTENANCE

- A. Refer to Section 13300.

1.05 WARRANTY:

- A. Refer to Section 13300 and supplement that with the requirements below.
- B. All application work shall be warranted in accordance with Section 01740.
- C. Provide telephone technical support within four hours of warranty claim. If failure cannot be resolved by telephone, provide onsite technical support within 24 hours of warranty claim.

1.06 COORDINATION MEETINGS AND WORKSHOPS

- A. Refer to Section 13300.
- B. Schedule and conduct a draft graphics review meeting. The purpose of this meeting shall be to present draft graphics for the District's and Engineer's review and feedback prior to creating the full set of graphics for review. For repetitive graphics such as graphics for multiple process trains, include an example of the first graphic only for discussion. Include a discussion of process and overview displays, examples of pop-ups, trends, and system navigation tools. Expect major comments and incorporate any changes resulting from those comments.
- C. Schedule and conduct a factory testing coordination meeting two weeks prior to factory testing. The purpose of this meeting is to discuss the specifics of the proposed tests and to provide a forum for coordinating the required factory testing.
- D. Schedule and conduct a field-testing coordination meeting two weeks prior to field testing. The purpose of this meeting is to discuss the specifics of the proposed tests and to provide a forum for coordinating the required field testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. The system specified herein shall perform the following generalized functions:
 - 1. The system shall allow the operator to control equipment such as pumps and valves as shown on the Drawings and as defined in Section 13305 control descriptions.
 - 2. Perform real-time process control, including proportional integral derivative control action, sequencing, process calculations, etc.
 - 3. Collect, calculate, and store accurate, reliable operating information for present and future uses.
 - 4. Assist remote site operating personnel by noting and communicating off normal operating conditions and equipment failures.

5. Accumulate and store equipment running times for use in preventative maintenance.
6. Provide color graphic displays and reports for use by the system operating and supervisory personnel.
7. Provide trending for all analog values.
8. Provide control system diagnostics.
9. All process control functions including PID, calculations, sequencing, timing, etc., shall be done in the process controller. The OIT software shall perform the real-time database, report generation, graphic screens, program development, setpoint modification, data archiving, etc.
10. The system shall allow the operator to manually control (by keyboard entry and mouse type pointing device) the status of pumps, valves, etc. (i.e., on-off, open-close, setpoint value, etc.) when viewing the appropriate graphic screen on the OIT.

3.02 CONTROLLER PROGRAMS (PLC)

- A. All applications programs shall be developed in a structured manner and shall follow an intuitive arrangement so that an instrumentation technician with basic programming knowledge will be able to understand. Programs shall utilize standard program templates or subroutines for repetitive logic such as equipment control, flow total calculations, and equipment runtime calculations.
- B. Make changes to the application programs and software configuration, based on comments during the submittals, the factory tests, the field tests, and during the commissioning process to meet the design intent, at no additional cost to the District.

3.03 GRAPHIC DISPLAYS – GENERAL (OIT/LOGGERNET)

- A. 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. All process variables shall be displayed on their associated display(s) with correct engineering units. Process variables shall display their associated data quality flags.
- B. All operator commands related to controlling field devices or system attributes shall require multiple keystrokes or mouse actions to protect against inadvertent operations. The operator shall receive confirmation of the selected point to be controlled, at which time cancellation of the control can be affected.
- C. Process graphic displays, shall be based on the P&IDs, site plan drawings, mechanical drawings, and electrical drawings included in these Contract Documents. The graphic displays shall depict process flow streams, process structures, and all major items of process equipment and control devices in a schematic format.
- D. All main graphical screens shall include a title bar, main graphic area, navigational buttons, and alarm summary bar. The title bar shall be displayed on the top of each screen and include the display name, description, and time/date. The main graphical area shall contain primary screen

data in graphical format. Navigational buttons shall include a minimum of the main menu, trends, main alarm summary, and security log in. The alarm summary bar shall display the last three valid alarms on the bottom of each screen.

- E. Animation shall be provided to mimic level changes in tanks or vessels, and to mimic rotation of rotating equipment when running. Valve colors shall change when opened and closed.
- F. Unless specifically noted, all timers, setpoints, alarm actuation levels, etc., shall be adjustable from the operator interface.
- G. The system shall show field conditions with text that can alternate (i.e., OPEN/CLOSE, START/STOP, HIGH/LOW) and change color correspondingly. Field devices that are tri state must be represented in three conditions.
- H. Conditions in the field designated as alarm conditions shall report to the operator workstation, actuate an audible alarm, and provide a visual blinking image on the associated graphic page. All alarms and events should be displayed on the screen and archived.
- I. All interlocks that affect equipment operation shall be identified both by alarm and by OIT indication.
- J. All analog inputs shall be checked for out of range (via high and low limit checks) and alarmed.
- K. All process flow streams shall be labeled and color-coded using the project color schedule in Division 9. All structures and equipment shall be identified by name and appropriate equipment and loop tags.
- L. Color coding for equipment status and alarms shall be as follows:
 - 1. Red for on or open.
 - 2. Green for off or closed.
 - 3. Active, unacknowledged alarms are indicated by flashing amber.
 - 4. Active, acknowledged alarms are indicated solid amber.
- M. Automatically record all alarm and events should any of the following sequences or events occur:
 - 1. Date/Time entry
 - 2. Limit changes
 - 3. Any commanded or uncommanded change of any point
 - 4. Alarm conditions
 - 5. PLC activation or deactivation
 - 6. Operator login or logout activity

- N. There may be additional general programming requirements listed in PART 1 of the Section 13305 control descriptions section that impact the OIT configuration.

3.04 SPECIFIC GRAPHIC SCREENS (OIT/LOGGERNET)

- A. At a minimum, provide the following types of the graphic screen indicated below.
 - 1. Main menu screen shall be developed to link to all screens and process areas. The screen shall be a complete and logical listing of the names and numbers of all screens
 - 2. Overall plant process block flow diagram screen shall show all major processes in block form with flow arrows. Each block shall include a text description of key individual treatment processes. Navigational buttons to the individual treatment processes shall be performed by pressing on the text description.
 - 3. Individual unit process screens depicted from the P&IDs are used for control and screen of each major item of process equipment, process variables, and control devices, including pumps, blowers, valves, gates, mixers, drives etc. Navigational buttons shall consist of the P&ID's flow arrows to other individual unit processes. The unit process screens shall provide the ability for the operator to go to individual equipment popup screens. These diagrams shall be generally depicted from the P&ID's and there shall be at least two screens per P&ID on average.
 - 4. Popup screens shall be provided for each piece of equipment to start/stop equipment, open/close valves, implement automatic control, adjust set points, establish and adjust tuning parameters, set alarm limits and initiate a sequence.
 - 5. Communications diagnostic screens, showing the details of network status, communications status of all major components .
 - 6. Trend screens with the capability to screen up to eight, operator-assigned, analog and/or digital process variables. Each analog value will be shown on a trend screen.
 - 7. Main alarm summary screen shall screen the following information on each alarm: Time, tag name, description, alarm type, current value and status. An acknowledge alarm button shall acknowledge all new unacknowledged alarms. The acknowledged and unacknowledged alarms shall be different colors. Acknowledged alarms shall clear automatically after the condition is corrected.
 - 8. Analog variable screens showing a tabular summary of all plant process variables, in operator assigned groupings.

3.05 SECURITY (OIT/ LOGGERNET)

- A. The system shall be configured and implemented with security to prevent unauthorized access. The system shall allow authorized changes to system operation through defined user accounts and password verification.
- B. Coordinate with District user account information, including login name and password for each account.

- C. Security levels of "display only", "operator mode", "supervisor mode", and "engineer mode" shall be available through assignable passwords. On system startup, the "display only" security level shall automatically be entered. In the "display only" mode, information is available to be displayed on the screen but no changes may be made. In the "operator mode", changes may be made to process set points, times, etc.; however, the overall control concepts may not be modified. In the "supervisor mode", all operator functions can be modified and any special reports or critical process setpoints (data can be modified; however, the overall control concepts may not be modified). In the "engineer mode" level, all user-modifiable parameters of the system shall be available for modification.

3.06 ALARM/EQUIPMENT STATUS REPORTING (OIT/LOGGERNET)

- A. 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.
- B. The equipment status shall be logged whenever a change in status occurs (i.e., start, stop). The equipment status log shall include the time, equipment name, tag number, and the particular change in status.

3.07 TESTING

- A. Refer to Section 13302.
- B. Supplement to Field Testing requirements
 - 1. Prior to leaving the site, use the District's programming computer to monitor all PLC processors online, make on-line changes, upload and download the processor to ensure programming software version compatibility.
 - 2. Loop Tuning - All PID control loops (single or cascade) shall be tuned following device installation but prior to commencement of the Functional Demonstration Test.
 - a. Optimal loop tuning shall be achieved either by auto-tuning software or manually by trial and error, Ziegler-Nichols step-response method, or other documented process tuning method.
 - b. Determine and configure optimal tuning parameters to assure stable, steady state operation of final control elements running under the control PID. Each control loop that includes anti-reset windup features shall be adjusted to provide optimum response following startup from an integral action saturation condition.
 - c. Tune all PID control loops to eliminate excessive oscillating final control elements. Loop parameters shall be adjusted to achieve a decay ratio of 1 / 4 or better. In addition, loop steady state shall be achieved at least as fast as the loop response time associated with critical damping.
 - d. Loop performance and stability shall be verified by step changes to setpoint in the field.
 - e. Submit loop tuning documentation as specified in Part 1 of these Specifications.

3.08 TRAINING

A. Furnish training is shown in the table below.

Description	Minimum Course Duration (hours)	Maximum Number of Trainees per Course	Number of Times Course to be Given	Intended Audience
Onsite Training				
Operator Training (Pre start-up)	2	4	2	Operations
Operator Training (Post-start-up)	2	4	2	Operations
Software Maintenance	4	4	2	Maintenance

B. Operator Control System Training (pre and post start-up)

1. Operator training shall cover plant operation with the control system and use of the OIT display screens, including at a minimum all the following items:
 - a. Basics of OIT control and navigation
 - b. Alarming and Interlocks
 - c. Auto functionality of automated processes and OIT control.
 - d. Failure modes of equipment and operator responses.
2. Minimum of two operator training sessions (Pre-Startup) for operators shall be held 1 week before system startup. The pre-startup training shall make use of the Simulator specified in this project. Additional one or two operator training sessions (post-Startup) for operators shall be held one week after system startup.
3. Operator training shall be held at the convenience of the District. This training may be held during the day, late at night, or very early in the morning to accommodate the District's shift schedule.
4. Operator training shall be introductory in nature during pre-startup training and more in-depth and detailed during post-startup training.
5. At a minimum, the following teaching aids shall be available for distribution during Operator training sessions:
 - a. Preliminary O&M Manuals (pre-startup); Final O&M Manuals (post-startup).
 - b. P&IDs.
 - c. Daily syllabus.
6. Fifty percent of all Operator training shall be "hands-on" utilizing the installed Control System to the fullest extent possible. Confirm the operability of the Control System before commencing training. Training performed using a non-functioning Control System shall be rejected and repeated.

C. Software Maintenance

1. Provide training of how to back-up PLCs, OITs, DATALOGGER and any other software in this system.

2. Provide training on all aspects covered in the O&M Software Maintenance Manuals.
3. Provide training on PLC program structure, OIT configuration structure, tips in how to edit programming code, and other items which will supplement the maintenance staff's ability to edit and maintain the programs.

END OF SECTION

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SECTION 13311
PLC AND DATALOGGER HARDWARE AND SOFTWARE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section includes Programmable logic controllers for control of process equipment, process-oriented machinery, and process systems.

1.02 RELATED WORK

- A. Section 13300 "Instrumentation and Controls - General Provisions."
- B. Section 13330 "Control Panel Enclosures and Panel Equipment."

1.03 SUBMITTALS

- A. Refer to Section 13300.
- B. Descriptive literature, bulletins, catalog cuts and Drawings for the equipment specified herein.
- C. Submit list of three firms that are located within 100 miles of the project site that are actively installing, programming, supporting, and maintaining the submitted PLC.
- D. Complete bill of materials for the equipment.
- E. Any deviation of the hardware or software systems from the preliminary submittal included in the Project Plan shall be described in detail.
- F. Spare parts list.

1.04 REFERENCE STANDARDS

- A. ASTM D 999-91: Vibration.
- B. (CFR) Title 47, Part 18 (European EN 55011 (formerly CISPR 11)).
- C. CSA Certification Class I, Division 2, Group A, B, C, D Hazardous or non-hazardous locations.
- D. IEC 60068-2.1 Environmental testing – Part 2-1: Tests - Test A: Cold, 2.2 Environmental testing - Part 2: Tests. Tests B: Dry heat, 2.3, 2.6 Environmental testing - Part 2: Tests - Test Fc: Vibration (sinusoidal) and 2.27 Environmental testing. Part 2: Tests. Test Ea and guidance: Shock.
- E. IEC 61000 Electromagnetic compatibility (EMC) - Testing and measurement techniques:
 - 1. Part 4-2: Electrostatic discharge immunity test.
 - 2. Part 4-3: Radiated, radio-frequency, electromagnetic field immunity test.
 - 3. Part 4-4: Electrical fast transient/burst immunity test.

- 4. Part 4-5: Surge immunity test.
- 5. Part 4-6: Immunity to conducted disturbances, induced by radio-frequency fields.
- F. IEC 61131-3: Programmable controllers - Part 3: Programming languages.
- G. IEC 801-3: RFI Immunity.
- H. IEC 801-5: Ground Continuity.
- I. IEC 801-2: Electrostatic Discharge.
- J. IEEE 472-1974/ANSI C37.90/90A-1974 (Surge Withstand) IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
- K. MIL STD 461B CS02: RFI/EMI Susceptibility.
- L. NEMA Pub No ICS2-230.42: Showering Arc Test.
- M. NSTA Project 1A.
- N. UL 508 and CSA Standard C22.2 No. 142 (Isolation Voltages).

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer shall be capable of providing training, parts, and coordination of emergency maintenance and repairs.
- B. To be considered for the work under this Section, there shall be at least three firms located within 100 miles of the project site that have local staff actively installing, programming, supporting, and maintaining the submitted PLC for the PLC to be considered as an "or equal" to the listed manufacturers.
- C. Programmable controller and all of the corresponding components within the family of controller products shall be manufactured by a company who regularly manufactures and services this type of equipment.
- D. Manufacturer shall comply with ISO9001 standards for "Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing".
- E. Manufacturer shall provide complete technical support for all of the products. This shall include factory or on-site training, regional application centers, local or factory technical assistance, and a 24/7/365 technical support phone service.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver PLC components in packaging designed to prevent damage from static electricity and physical damage.

- B. Store PLC equipment according to manufacturer requirements. At a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect PLCs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the PLC from all forms of electrical and magnetic energy that could reasonably cause damage.

1.07 NOMENCLATURE AND IDENTIFICATION DEFINITIONS

- A. AI: Analog Input.
- B. AO: Analog Output.
- C. Fixed I/O: A PLC style consisting of a fixed number of I/O, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.
- D. CPU: Central Processing Unit.
- E. DI: Discrete Input.
- F. Distributed I/O: Hardware specially designed to function as Remote I/O.
- G. DO: Discrete Output.
- H. HMI: Human-Machine Interface.
- I. I/O Input and/or Output.
- J. Master/Slave: Communication between devices in which one device, the master, controls all communications. The other devices, the slaves, respond only when queried by the master. Typically used in a Remote I/O application.
- K. Modular: A PLC style consisting of cards that are assembled to comprise a complete unit. All I/O, CPU, and Power Supply are dedicated cards. Typically, these cards are inserted into a chassis.
- L. Peer to Peer: Communication between two or more devices, typically PLCs, in which each device can control the communication exchange.
- M. PID: Control action, proportional plus integral plus derivative.
- N. PLC: Programmable Logic Controller.
- O. Remote I/O: I/O that is located remotely from the processor. Remote I/O can communicate over a variety of communication protocols and can use standard rack based I/O, or special Remote I/O hardware referred to as Distributed I/O.
- P. SCADA: Supervisory Control and Data Acquisition.

1.08 SPARE I/O AND SLOTS

- A. Each panel containing PLC I/O shall include at least 20 percent (minimum of four) points of each type (AI, AO, DI, and DO) for future use, regardless of whether any of those point types are used in that panel or not. The spares shall be the same type of I/O modules supplied.

- B. For chassis-based PLC systems, provide at least two spare slots for addition of future I/O in each chassis provided. For non-chassis-based PLC systems, provide adequate space to the right of the last I/O card in each row of I/O cards for at least two future I/O cards (width should be based on the widest I/O card provided in panel).
- C. Spare output points that require the use of an external relay shall be supplied with the external relay.
- D. Regardless of the spare requirement, all installed unused points on all I/O modules shall be wired to terminal blocks in the order that they occur on the I/O modules. Unwired spares shall not be acceptable.

1.09 MANUFACTURER SUPPORT

- A. Provide a written proposal for a manufacturer support agreement for products specified herein for a minimum of 12 months starting at completion of the project. The cost of this manufacturer support agreement shall not be included in the Contract Price. The support agreement shall be executed in the name of, and for the benefit of, the District. At a minimum, this agreement shall provide the District with:
 - 1. 8 AM to 5 PM, five day per week manufacturer telephone support.
 - 2. Access to the manufacturer's technical support website.
 - 3. Software and firmware updates.

PART 2 PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER SYSTEM

- A. General:
 - 1. Provide Programmable Logic Controller equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.
 - 2. Processor Systems shall include processor, power supply, input/output modules, communication modules, redundancy modules, and remote interface modules as required to meet system requirements.
 - 3. Furnish products listed and classified by Underwriters Laboratories (UL), CSA, or FM approval as suitable for purpose specified and indicated.
 - 4. All equipment and devices furnished hereunder shall be designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production.
 - 5. All equipment furnished shall be designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored.

6. PLCs shall communicate between the operator workstation and field-mounted transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI).
7. PLC shall be capable of stand-alone operation in the event of failure of the communication link to the HMI subsystem.
8. Backup Processor Systems, if indicated on the drawings, shall consist of two chassis with power supplies, each containing a processor, redundancy module and communications module(s). Remote chassis shall be provided with communication modules to meet I/O and communication requirements.
9. Remote Input/Output Units shall include input/output modules, interface modules, communication modules, and power supply to meet system input and output requirements.
10. Agency and environmental specifications:
 - a. Electrical supply voltage to the PLC shall be 120VAC, plus or minus "15 percent, 48 - 63Hz. PLC system power supplies shall be fused for overload protection.
 - b. Vibration: 3.5 mm Peak-to-Peak, 5 - 9 Hz: 1.0G, 9 - 150\Hz. The method of testing is to be based upon IEC 68-2-6 and JIS C 0911 standards for vibration. The system is to be operational during and after testing. Vibration Rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:
 - 1) Installed rating: DIN rail mounted PLC: 10 - 57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz.
 - 2) Panel or plate mounted PLC: 2 - 25 Hz, amplitude 1.6mm, acceleration 25 - 200 Hz.
 - 3) In compliance with IEC 60068 and IEC 61131.
11. Shock: 15G, 11 msec. Method of testing is to be based upon IEC 68-2-27 and JIS C 0912 standards for shock. The system is to be operational during and after testing.
12. Temperature: All PLC hardware shall operate at an ambient temperature of 0° to 60° C (32° to 140° F), with a storage ambient temperature rating of -25° to 70° C (-40° to 185° F).
13. Relative Humidity: Programmable Controller hardware shall function continuously in the relative humidity range of 10 percent to 95 percent non-condensing.
14. Noise Immunity: Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.
15. Altitude:
 - a. Operation: 0 - 6,500 feet.
 - b. Storage: 0 - 9,800 feet.
16. Degree of protection: NEMA 1 (IP20).
17. All products shall have corrosion protection.

- B. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating:
 - 1. Modules product type such as analog or digital.
 - 2. Modules catalog number.
 - 3. Modules major revision number.
 - 4. Modules minor revision number.
 - 5. Module manufacturer vendor.
 - 6. Module serial number.

- C. All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer recommendations.

- D. Central Processing Unit (CPU):
 - 1. CPU shall be, at a minimum, a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.
 - 2. CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers, and service special function modules every scan. The CPU shall process the I/O with user program(s) stored in memory, then control the outputs based on the results of the logic operation.
 - 3. Supply the CPU with a battery-backed time of day clock and calendar.
 - 4. CPU family shall allow for user program transportability from one CPU model to another.

- E. Diagnostics:
 - 1. CPU shall perform on-line diagnostics that monitor the internal operation of the PLC. If a failure is detected, the CPU shall initiate system shutdown and fail-over. The following, at a minimum, shall be monitored: Memory failure, memory battery low, and general fault, communications port failure, scan time over run, I/O failure, and analog or special function I/O module failure.
 - 2. All diagnostic information shall be accessible to the host communications interfaces and to the PLC program.
 - 3. PLC shall have indicators and on-board status area to indicate the following conditions:
 - a. CPU run.
 - b. CPU error or fault.
 - c. I/O failure or configuration fault.
 - d. Status of Battery or back-up power module.
 - e. Communications indicator.

F. Memory:

1. User program and data shall be contained in non-volatile battery backed memory of type CMOS RAM program memory or equivalent.
2. Memory Backup System: provide lithium battery backup or equivalent capable of retaining all memory for a minimum of three months and a Flash memory system capable of reloading program in the event of memory loss.
 - a. Backup Storage: The backup battery or module shall be capable of being replaced without disrupting memory integrity. Provide a visual indication of low battery voltage or module error and an alarm bit in the PLC program.
 - b. SD Memory Card: Memory card storage capacity shall be greater than processor memory capacity. Memory cards shall be installed in processors for factory testing.
3. Operating system shall be contained in non-volatile firmware. The memory containing the operating system shall be field updateable via a separate update tool.

G. Programming Environment:

1. Programming port: The PLC shall utilize a serial USB or Ethernet port for programming.
2. On-Line programming: Application programs may be modified or stored while the CPU is running, with minimal impact on the scan time.
3. Online programming including runtime editing.
4. IEC 61131-3 programming languages supported: Ladder logic, function block, sequential function chart, and structure text.
5. Supply all hardware and software necessary to program the CPU in these languages.

H. Communication Ports:

1. CPU shall be expandable and supplied with additional modules to support the required communication interfaces.

I. Power Supplies:

1. PLC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules.
2. Power supplies shall have a clearly visible LED to indicate that the incoming power is acceptable, and the output voltage is present.
3. Power supplies shall feature over-current and over-voltage protection and should be designed to operate in most industrial environments without the need for isolation transformers.
4. Power supplies shall be sized to accommodate the anticipated load plus 30%.
5. DC power supplies shall be capable of handling ripple up to 2.4V peak to peak.

6. AC Line Voltage rating of 85 to 265Vac, 47 - 63Hz.
 7. Power supplies shall allow for brown outs of at least 1/2 of a cycle, a harmonic rate of 10%, and will sustain continuous operation through momentary interruptions of AC line voltage of 10ms or less.
 8. Automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power.
 9. Provide surge protection, isolation, and outage carry-over up to two cycles of the AC line.
- J. Discrete Input & Output Modules:
1. General:
 - a. Digital input and output modules shall provide ON/OFF detection and actuation.
 - b. I/O count and type shall be as required to implement the functions specified plus an allowance for active spares, as noted below.
 - c. Modules shall be designed to be installed or removed while chassis power is applied.
 - d. Modules shall have indicators to display the status of communication, module health and input / output devices.
 - e. Each module shall have the following status indicators.
 - 1) On/Off state of the field device.
 - 2) Module's communication status.
 2. Module Specifications (120VAC Input Module):
 - a. Nominal Input Voltage: 120VACc.
 - b. On-State Current: 15mA @132V AC, 47 - 63Hz maximum.
 - c. Maximum Off-State Voltage: 20V.
 - d. Maximum Off-State Current: 2.5mA.
 - e. Number of Points per Card: 16.
 3. Module Specification (120 VAC Solid State Output Module):
 - a. Each triac type discrete output shall have an associated interposing relay located in the same control panel. 120 VAC power for relay outputs shall be provided from the associated motor starter control circuit (when used with motor starters) or other 120 VAC source (when I/O is not associated with a particular motor starter).
 - b. Output Voltage Range: 74 - 265 VAC, 47 - 63 Hz.
 - c. Output Current Rating:
 - 1) Per Point: 0.5A maximum @ 30 degrees C; 0.25A maximum @ 60 degrees C; Linear Derating.
 - 2) Per Module: 4A maximum @ 30 degrees C; 2A maximum @ 60 degrees C; Linear Derating.
 - d. Surge Current per Point: 5A for 43ms each, repeatable every 2s @ 60 degrees C.
 - e. Minimum Load Current: 10mA per point.
 - f. Maximum On-State Voltage Drop: 1.5V peak @ 2.0A and 6V peak @ load less than 50mA.
 - g. Maximum Off-State Leakage: 2.5mA per point.
 - h. Number of Points per Card: 16.

K. Analog Input & Output Modules:

1. General:

- a. Analog input modules shall convert an analog signal that is connected to the module's screw terminals into a digital value. The digital value representing the magnitude of the analog signal shall be transmitted on the backplane. Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals.
- b. Modules shall be designed to be installed or removed while chassis power is applied.
- c. Modules shall have indicators to display the status of communication, module health and input / output devices.
- d. Each analog module shall provide both hardware and software indication when a module fault has occurred. Each module shall have an LED fault indicator and the programming software shall display the fault information.
- e. Analog modules shall be software configurable through the I/O configuration portion of the programming software.
- f. Following status shall be capable of being examined in ladder logic:
 - 1) Module Fault Word: Provides fault summary reporting.
 - 2) Channel Fault Word: Provides under-range, over-range and communications fault reporting.
 - 3) Channel Status Words: Provides individual channel under-range and over-range fault reporting for process alarm, rate alarms and calibration faults.
- g. 24 VDC power for analog instrument loops shall be provided as a part of the system. 24 VDC power supply shall be derived from the 120 VAC input power circuit to the PLC. Field side of the 24 VDC power sources(s) shall have individual or grouped (of logically associated circuits) fusing and be provided with a readily visible, labeled blown fuse indicator.

2. Isolated Analog Output Current Module:

- a. Output Current Range: Four to 20 mA.
- b. Current Resolution: 12 bits across 20 mA.
- c. Open Circuit Detection: None.
- d. Output Overvoltage Protection: 24V ac/dc maximum.
- e. Output Short Circuit Protection: 20 mA or less (electronically limited).
- f. Calibration Accuracy: Better than 0.1% of range from 4 mA to 20 mA.
- g. Calibration Interval: 12 months typical.
- h. Number of Points per Card: Eight.

L. Communications Interfaces:

1. PLC will be capable of the following communication protocols as shown on the drawings:
 - a. 10BASE-T/100BASE-TX Ethernet communication.
 - b. EthernetI/P
 - c. Modbus TCP
 - d. Asynchronous serial link capable of communicating up to 19.2 Kbps.
2. When required provide a Communications Interface Module mounted in the chassis or the equivalent port directly on the CPU.

M. Manufacturers:

1. Provide all PLCs from a single manufacturer. If the PLC manufacturer has authorized third party vendors to provide modules that are compatible with their platforms, then products manufactured by these authorized third-party vendors will be acceptable.
2. Provide the PLC system by one of the following:
 - a. Rockwell Automation: CompactLogix. 5370
 - b. No substitution.

2.02 PLC SOFTWARE

- A. Provide a PLC configuration and application development software package complete with documentation and disks. The PLC software package and associated licensing and/or activation shall be installed on the computers shown on the Drawings.
- B. Software package shall allow on-line/off-line program development, annotation, monitoring, debugging, uploading, and downloading of programs to the PLCs.
- C. All required hardware (including cables, cable adapters, etc.) for connection to PLCs shall be furnished.
- D. All software licenses required to achieve the functionality described in the Specifications shall be provided.
- E. Software package shall include a software license agreement allowing the District the right to use the software as required for any current or future modification, documentation, or development of the PLCs furnished for this project.
- F. Software provided shall be capable of the following IEC 61131-3 functions:
 1. Ladder logic.
 2. Function block.
 3. Sequential function chart.
 4. Structure text.
- G. In addition to the above editors, an add-on instruction editor shall work with any of the above-mentioned editors to create custom reusable function blocks. This software shall allow any of the derived function blocks to be modified on-line.
- H. Software shall be Microsoft Windows-based and run on the supplied computers.
- I. Software shall include a security feature to prevent unauthorized personnel from modifying and downloading the programs.
- J. Provide an I/O simulator which allows the PLC application load program to be tested on a PC with simulated analog and digital inputs and outputs, allowing I/O testing and debugging to be performed in a safe, isolated environment without the need for running the PLC CPU and process I/O boards.

2.03 OPERATOR INTERFACE TERMINAL (OIT)

- A. OITs shall be mounted on control panels and shall run its own interface software
- B. Manufacturers:
 - 1. Provide operator interface terminals (OIT) from one of the following:
 - a. Allen-Bradley PanelView Plus 7 series.
 - b. No substitution.
- C. Software:
 - 1. Operator Interface Terminal shall be pre-packaged with all configuration and programming software necessary to perform functions as shown on drawings and within the specifications.
 - 2. Integrated OIT software shall have the following features:
 - a. Trending.
 - b. Data Logging.
 - c. Alarms.
 - d. Graphic Symbols.
 - e. Animations.
- D. I/O Ports and Devices:
 - 1. OIT shall have a minimum of one Ethernet 10/100 Mbps for connectivity or programming.
 - 2. Compact flash ports shall be Type 2.
 - 3. OIT shall have a minimum of one USB port.
- E. Display:
 - 1. OIT display size shall be a minimum of 12".
 - 2. The type of display for the OIT shall be Color Active Matrix TFT.
 - 3. Display resolution shall be a minimum of 320 x 240 for four-in. to six-in. displays, 800 x 600 for eight-in. to 12" displays, 1024 x 768 for 15" displays, and 1280 x 1024 for 19" displays.
- F. Environmental:
 - 1. Rating: OIT shall be rated to maintain the rating of the control panel it will be mounted in.
 - 2. Temperature: Operating temperature range of the OIT shall range 0 - 50 °C.

2.04 DATALOGGER

- A. General:
 - 1. Provide a modular datalogger with the required memory and functional capacity to perform the logging functions as shown in the drawings.

- B. Physical and System Power Requirements:
 - 1. Operational Temperature: -25° to +50°C
 - 2. Voltage: 9.6 to 16 Vdc
 - 3. External Batteries: 12 Vdc nominal; reverse polarity protected.
- C. Network Features:
 - 1. Ethernet
 - 2. Modbus TCP
- D. Additional Features:
 - 1. Provide Loggernet software with datalogger.
- E. Manufacturers:
 - 1. Campbell Scientific Model CR1000X

2.05 SPARE PARTS

- A. General requirements for spare parts are specified in Section 13300.
- B. The following PLC spare parts shall be furnished:
 - 1. Processors: Provide spare processor unit(s) for each unique processor installed.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

- A. Maintain area free of dirt and dust during and after installation of programmable controller products.
- B. Anchor PLCs within enclosures as recommended by the PLC manufacturer.
- C. Ventilation slots shall not be blocked or obstructed by any means.
- D. Examine areas, surfaces, and substrates to receive PLCs for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Install in accordance with manufacturer's instructions.
- F. Unload, unpack and transport equipment to prevent damage or loss.
- G. Replace damaged components as directed by Engineer.

3.02 PANEL LAYOUT (PLC/DATALOGGER)

- A. Coordinate size and configuration of enclosure to meet project requirements. Drawings indicate maximum dimensions for PLC and DATALOGGER , minimum clearances between PLCs, and adjacent surfaces and other items.
- B. Comply with indicated maximum dimensions and clearances, or with PLC vendors required distances if they are greater than the distances indicated.
 - 1. Provide spacing around PLC and DATALOGGER as required by the manufacturer to ensure adequate cooling. Ensure that the air surrounding the PLC and DATALOGGER has been conditioned to maintain the required temperature and humidity range.
 - 2. Wires entering and exiting PLC components shall be sized to comply with the PLC manufacturers requirements. Doors on all components shall be able to be fully closed when all the wires are installed.
 - 3. For chassis mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.
 - 4. PLC lights, keys, communication ports, and memory card slots shall be accessible at all the times. Lights shall be visible always when enclosure door is opened.
- C. Control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements.
- D. Control panel designer shall insure that communication signals, 4-20 mA signals (including those with embedded HART), are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics.
- E. Each PLC (including all I/O) shall be powered from the UPS power conditioning system in Section 13330.
- F. Where multiple sets of mechanical equipment are provided for process redundancy, arrange their field connections to I/O modules so that the failure of a single I/O module will not disable the redundant system. This applies to all I/O types. The acceptability of the I/O arrangement shall be at the discretion of the Engineer.
- G. Provide all required cables, cords, and connective devices for interface with other control system components.

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SECTION 13323
INSTRUMENTATION AND CONTROLS –
CELLULAR TELEMETRY SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor and materials required and install a complete and functional cellular telemetry system as shown on the drawings and as specified herein.
- B. Auxiliary and accessory devices necessary for system operation or performance shall be included whether specified or not.
- C. Obtain required construction permits for equipment installation.
- D. Cellular telemetry hardware shall be installed at the Black Creek Pump Station and the District's control center. The PCSS shall utilize a 4G LTE Network and configure a Virtual Private Network (VPN) to communicate data transfer across these two sites and the Pump Station and the datalogger workstation.
- E. Meet all applicable federal (FCC, etc.), state, and local codes and regulations.
- F. After installation, submit field cellular measurements that confirm that the minimum signal strength requirements of each communication link are met.

1.02 RELATED WORK

- A. Furnish materials, labor, and services specified in the following Sections as required to supply a single coordinated cellular telemetry system:
 - 1. Electrical is included in Division 16.
 - 2. Section 13330 Control Panels and Panel Mounted Equipment.
- B. Refer to Section 13300.

1.03 SUBMITTALS

- A. Provide shop drawings and product data, in accordance with Section 13300, showing materials of construction and details of installation for:
 - 1. Data sheets and catalog literature for hardware (modems, antenna, cabling and accessories)
 - 2. Physical dimension drawings of all hardware and components
 - 3. Antenna installation details
 - 4. Installation and interconnection/wiring diagrams depicting the proposed installation of the equipment, in conformance to the requirements specified on the Plans. These drawings shall be detailed to the extent possible and then modified after installation to reflect "AS-BUILT" conditions as part of Operations and Manuals.

5. A complete telemetry system block diagram(s) showing in schematic form, the interconnections between major hardware components. The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communication links.
6. Equipment specification sheets shall fully describe the device, the intended function, how it operates and its physical environmental and performance characteristics. As a minimum the specification sheets shall include the following:
 - a. Dimensions and any clearance requirements.
 - b. Mounting or installation details.
 - c. Connection requirements.
 - d. Electrical power requirements.
 - e. Materials of construction.
 - f. Environmental characteristics.
 - g. Performance characteristics.
7. Furnish specific system information regarding the following:
 - a. A narrative of the communication strategy
 - b. Any assumptions made in developing the system.

1.04 REFERENCE STANDARDS

- A. Refer to Section 13300.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 13300.

1.06 MAINTENANCE

- A. Refer to Section 13300.

B. SPARE PARTS

1. Modems: Provide 1 cellular modem of each model provided with same revision firmware as those installed.
2. Provide a kit of cellular antenna, cable, and surge protection.

PART 2 PRODUCTS

2.01 GENERAL

- A. Equipment shall perform under conditions ranging between minus 30 degrees C and plus 60 degrees C, and humidity range of five to 90 percent, non-condensing.
- B. Transmission Cable and Accessories
 1. A single continuous piece of transmission cable shall be provided and installed between each 4G LTE cellular modem and antenna.

2. Connectors
 - a. Furnish connectors for terminating both ends of each transmission cable.
 - b. The connectors shall be sealed with three-inch sections of Alpha FIT321-1-0 sealant shrink tubing or equivalent.
 - c. All outdoor coaxial connectors shall be wrapped with two layers of Scotch Super 88 UV resistant tape, and then coated with two layers of Scotch-Kote or equivalent.
3. Grounding Kit
 - a. Coaxial cable grounding kits shall be furnished. Furnish two kits for each transmission cable.
4. Jumper Cable
 - a. Provide one three-foot section of “super flexible” jumper cable with type N and type SMA connectors to connect between the modem and the bulkhead surge protector where the transmission cable connects to the control panel.
5. Coaxial Cable Clamping Hardware
 - a. Provide coaxial cable hanger kits and clamping hardware. The coax cable shall be secured to the mast/pole with E.V.A.-coated 316 stainless steel cable ties. The cable ties shall meet or exceed the quality, reliability, and performance of AE112 cable ties manufactured by Band-It.

2.02 OMNI-DIRECTIONAL ANTENNAS

- A. Antennas shall be provided and installed at each site configured for cellular telemetry.
- B. Identical antennas shall be used as much as possible throughout the system to reduce spare parts inventory.
- C. Where a site uses multiple antennas, in the same frequency band (or integer multiples of that band) install them with no less than 10 feet of vertical separation for signal isolation.
- D. Technical Specifications:
 1. Operational Temperature: -22°F to +140°F
 2. Radiation: Omni-directional
 3. Frequency Range: 806 – 924 / 1850 – 1990 MHz
 4. Gain: 5 dBi (at both Frequency Ranges)
 5. Bandwidth: 118/140 MHz
 6. Maximum Power Input: 10 watts
 7. VSWR: Less than 2.0
 8. Polarization: Vertical
 9. Input Impedance: 50 Ohms

E. Physical:

1. Material of construction: Fiberglass
2. Connector: Female type N
3. Mounting Hardware: U-bolt and screw assembly for attachment to handrail on top of the tank.

F. Manufacturers

1. SureCall SC-100S.
2. Or Approved Equal.

2.03 FIREWALL

A. General:

1. Firewall appliance for secure connection of the wired Ethernet data from a PLC/Datalogger for transmission over a 4G LTE cellular communications network.
2. Firewall shall be configured for compatibility with the District's existing cellular virtual private network.

B. Physical:

1. Supply voltage range of 9 VDC to 30 VDC, nominal 24 VDC. Capable of accepting redundant power inputs. Power connections shall be pluggable.
2. 4 copper 10/100/1000 Base-T RJ45 Ethernet port
3. USB 2.0 Micro-B Connector
4. 3 Antenna Connectors (on wireless models only)
5. DIN Rail mountable.
6. Alarm contact to indicate malfunction with power supply unit or loss of port communication.
7. Capable of accepting a SD card for securely storing configuration file of device.
8. Operating temperature of -20 C to 60 degrees C.
9. LED Indicators:
 - a. Two LEDs for indicating port status.

C. Networking:

1. Copper ports shall be 10/100 base-T(X), auto-negotiation and auto-crossing. Ports shall be configurable to be enabled/disabled via the management interface.

2. Device shall have a transparent or stealth mode for drop in protection of end devices regardless of network configuration.
3. Device shall support stateful inspection as a firewall.
4. Device shall support Deep Packet Inspection for Modbus TCP and OPC Classic protocols.
5. Firewall rules shall be configurable by the user and include inspection on Source/Destination IP address, MAC address, protocols and/or Source/Destination TCP/UDP port.
6. Provide four-port managed 10/100 Mbps integrated switch with DMZ port for further network segregation.
7. Support protection against IP Spoofing, Denial of Service and Syn Flood Protection.
8. Support Virtual Private Network (VPN) functionality up to 250 licenses with ability to act as client or server of VPN requests. IPSec shall be the supported VPN protocol with encryption meeting the military standard of AES-256. Provide hard-wired contact to initiate VPN tunnel.
9. Support static routing between two or more networks.
10. Support One to One Network Address Translation (NAT) routing.
11. Support dynamic device addressing via BootP.
12. Supports multiple VLANs.
13. Supports the use of SNMP management, up to v3 for maximum security.

D. Manufacturer:

1. Phoenix Contact, mGuard 4000 Series.
2. Or approved equal.

2.04 CELLULAR MODEM

A. General:

1. Modem for converting wired Ethernet data from a PLC/Datalogger for transmission over a 4G LTE cellular communications network.
2. Shall support Allen-Bradley Ethernet/IP communications.

B. Physical:

1. RS-232 Serial Port on DB-9 connector
2. 10/100 Base-T RJ45 Ethernet Port

3. USB 2.0 Micro-B Connector
4. 3 SMA antenna connectors (Primary, Secondary/Diversity, GPS)
5. Active GPS antenna support
6. LED Indicators:
 - a. Power
 - b. Activity (transmit / receive status)
 - c. Signal (color indicates quality of RSSI)
 - d. Network (color indicates LTE network readiness)

C. Performance:

1. Power: 9 VDC – 36 VDC
2. Accuracy: less than two m (50%); less than five m (90%)
3. Satellite Acquisition Time: 1s Hot start
4. Satellite Tracking Sensitivity: -145 dBm
5. Operating Temperature: -22°F to +158°F
6. Relative Humidity: 90% at 140°F
7. Supported Frequency Bands:
 - a. LTE: 1900 (B2), AWS (B4), 850 (B5), 700 (B13), 700 (B17), 1900 (B25)
 - b. WCDMA: 2100 (B1), 1900 (B2), AWS (B4), 850 (B5), 900 (B8)

D. Manufacturer:

1. Sierra Wireless Air Link GX-450/ RV50
2. Or Approved Equal.

2.05 TRANSMISSION CABLE AND ACCESSORIES

1. Provide cable and accessories compatible for cellular modem.

2.06 SURGE PROTECTION

- A. Surge protection shall be provided for all telemetry sites and shall include both coaxial surge suppressors and AC line surge protectors.
- B. For AC line surge protection refer to Section 13300
- C. RF Bulkhead Coaxial RF Surge Protector
 1. An in-line coaxial cable surge protector shall be furnished for each transmission cable.

2. Surge protector shall be a DC pass arrestor for applications with active antenna systems requiring DC voltage such as GPS, 3G and 4G.
3. Supply with N-connectors
4. Manufacturer
 - a. Polyphaser model GTH-NFM-AL.
 - b. Or Approved Equal.

PART 3 EXECUTION

3.01 TESTING

- A. Refer to Section 13300 for testing requirements.

3.02 INSTALLATION

- A. Install the cellular telemetry system as shown on the Drawings and in accordance with manufacturer's instructions and approved shop drawings.
- B. The equipment locations are approximate only. Exact locations shall be as approved by the Engineer/District during construction. Obtain in the field all information relevant to the placing of work and in case of any interference with other work, proceed as directed by the Engineer/District and furnish all labor and materials necessary to complete the work in an approved manner.
- C. 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 system supplier shall bear full responsibility for such violations and assume all costs arising there from.
- D. Brackets, hangers, etc., required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

3.03 FIELD TESTS AND ACCEPTANCE

- A. Prior to start-up, cellular communications equipment shall be inspected for proper alignment, proper connection and satisfactory performance.
- B. The grounding of all antennas assemblies shall be checked for the antenna, mast, supports, and where applicable, towers.
- C. The installed RF feedlines and antennas shall be tested for VSWR and other losses using a time domain reflectometer (TDR). Submit test results for approval.
- D. The received signal at all locations not be less than 20 dB fade margin based on the cellular modem manufacturer's published receiver sensitivity of 10-6 bit error rate.

3.04 ADJUSTMENTS

- A. Transmitter power shall be adjusted if needed to comply with FCC rules and regulations before acceptance testing.

END OF SECTION

SECTION 13330
CONTROL PANEL ENCLOSURES AND PANEL EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Refer to Section 13300.
- B. Furnish and install control panels and panel mounted equipment as specified herein and shown on the Drawings.
- C. All new panels and panel components shall match existing equipment makes and models wherever possible, so that system additions can be most easily integrated with respect to operation and maintenance training, spare parts inventory, and service contracts. Even when exact matches are not possible, equipment furnished must be fully compatible with the existing system. Color, size, and material of new panels should conform to that of existing panels.
- D. Each panel shall be supplied with full sub-panels with the minimum specified dimensions regardless of the quantity of mounted components inside the panel. All panel mounted components shall be mounted on the single rear-of-panel sub-panel unless the density of devices exceeds the panel mounting space permitted by the minimum panel dimensions specified. Side panel mounted components shall only be permitted after review and approval of the Engineer.
- E. Furnish the following panels [and consoles].

PANEL SCHEDULE

Panel Designation	Minimum Panel Size	Maximum Space Available	Enclosure Rating & Type
PLC Enclosure	62-inch high by 48-inch wide by 24-inch deep	72-inch high by 48-inch wide by 24-inch deep	NEMA Type 12, 2-door, steel construction, free standing. Front Access Only
INSP1 (Intake Level transmitter terminal points)	10-inch high by 10-inch wide by 08-inch deep	12-inch high by 12-inch wide by 8-inch deep	NEMA Type 6P, Submersible up to 15 ft

1.02 RELATED WORK

- A. Refer to Section 13300 "I & C - General Provisions."

1.03 SUBMITTALS

- A. Refer to Section 13300.
- B. Descriptive literature, bulletins, catalog cuts and Drawings for the equipment specified herein.
- C. Complete bill of materials for the equipment.

D. Spare parts list.

E. Panel Layout Drawings and Wiring Diagrams Submittal:

1. Where direct hardwired interfaces exist between the PCSS control panels and vendor provided control panels furnished under other Divisions, Contractor shall provide to PCSS approved submittals in order for PCSS to provide complete wiring diagrams showing all wiring connections in the I/O system. This includes but is not limited to terminal block numbering, relay contact information, instruments, equipment, and control panel names. These drawings shall be included in Final O&M submittal. Leaving this information blank on Final Documentation drawings is not acceptable.
2. Panel Layout Drawings: Submit Drawings for all panels, consoles, and equipment enclosures specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11"x17" in size. At a minimum, the panel drawings shall include the following:
 - a. Interior and exterior panel elevation drawings to scale.
 - b. Nameplate schedule.
 - c. Conduit access locations.
 - d. Panel construction details.
 - e. Cabinet assembly and layout drawings to scale. Assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. Bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify all components of the assembly by manufacturer and model number.
 - f. Fabrication and painting specifications including color (or color samples).
 - g. Construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
 - h. For every control panel, heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
 - i. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. Costs associated with obtaining the UL seal and any inspections shall be borne by Contractor.
3. Panel Wiring Diagrams: Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. Diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the PCSS. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the PCSS and approved by the Engineer. I/O wiring shall be numbered with rack number, slot number, and point number.

Two-wire and four-wire equipment shall be clearly identified, and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11" x17" in size.

1.04 COORDINATION MEETINGS

- A. Refer to Section 13300.

1.05 REFERENCE STANDARDS

- A. Refer to Section 13300.

1.06 QUALITY ASSURANCE

- A. Refer to Section 13300.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 13300.

1.08 NOMENCLATURE AND IDENTIFICATION

- A. Refer to Section 13300.

1.09 MAINTENANCE

- A. Refer to Section 13300.

1.10 AWARRANTY

- A. Refer to Section 13300.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to Section 13300.

2.02 LIGHTNING/SURGE PROTECTION

- A. Refer to Section 13300.

2.03 CONTROL PANEL GENERAL REQUIREMENTS

- A. Dimensions within this Section and on Contract Drawings are for general reference only. Ensure that final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as specified herein and in Contract Documents.
- B. Each control panel and terminal cabinet shall bear the UL label. UL label shall apply to the enclosure, the specific equipment supplied with the enclosure, and the installation and wiring of the equipment within and on the enclosure. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and any other equipment necessary to achieve compliance with UL 508 requirement. Drawings do not detail all UL 508A requirements.
- C. Panel doors shall have a lock installed in door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.

- D. Devices 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. Heat generating devices such as power supplies shall be located at or near the top of the panel.
- E. Panels shall be completely fabricated, instruments and devices installed and wired at the PCSS's facility.
- F. 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. Component mounting shall be oriented in accordance with manufacturer's recommendations. Internal components shall be identified with suitable plastic or metal engraved nametags mounted adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and PCSS's data.
- G. Exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.
- H. Nameplates:
 - 1. Panels and panel devices shall be supplied with suitable nameplates, which identify the panel and individual devices as required. Unless otherwise indicated, each device nameplate shall include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).
 - 2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, nameplates shall be 3/32-inch thick, black and white, Lamicoid with engraved inscriptions. The letters shall be Black [White] against a White [Black] background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.
 - 3. Nameplate fasteners and mounting shall be epoxy adhesive or stainless-steel screws for cabinet mounted nameplates
 - 4. For every panel, provide a panel nameplate with a minimum of one-in. high letters. Provide legend plates or one-in. by three-in. engraved nameplates with 1/4-in. lettering for identification of door mounted control devices, pilot lights, and meters.
 - 5. Single lamicoid nameplates with multiple legends shall be used for grouping of devices such as selector switches and pilot lights that relate to one function.
- I. Mounting Elevations:
 - 1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.
 - 2. Centerline of indicators and controllers shall be located no lower than 48-inches or higher than 66-inches above the floor on a panel face.

2.04 PANEL MATERIALS AND CONSTRUCTION

A. Structure and Enclosure:

1. Panels shall be of continuous welded-steel or FRP construction as shown on the Panel Schedule. Provide angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural framework for instrument support purposes and panel bracing. Internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation.
2. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with a three-point stainless steel latch (except for NEMA 4X panels) and heavy duty stainless steel locking handle. Rear access doors (if included) shall be conveniently arranged and sized such that they extend no further than 24-inches beyond the panel when opened to the 90-degree position. Front and side access doors shall be as shown. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments.
3. Panels, including component parts, shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.
4. Panel shall be suitable for top and bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry, panel top shall be provided with nominal one-foot square removable access plates, which may be drilled to accommodate conduit and cable penetrations.

Conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, and other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.

5. Panels in indoor, dry, non-corrosive environments shall be NEMA 12 unless otherwise noted. Panels in outdoor, wet, and non-chemically corrosive environments shall be NEMA 4 unless otherwise noted. Panels in chemically corrosive environments shall be NEMA 4X unless otherwise noted. Panels located in a hazardous location shall be rated for the type of hazard (e.g., NEMA 7 for Class 1, Division 1).

B. Freestanding and Floor-Mounted Vertical Panels:

1. Freestanding and floor-mounted vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. Panels shall be constructed of 12 gauge sheet steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated panels shall be constructed of Type 316 stainless steel, unless FRP is specifically indicated to be provided. Front panels or panels containing instruments shall be not less than 10 gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.

C. Wall and Unistrut Mounted Panels:

1. Wall and Unistrut mounted panels shall meet the NEMA classification as shown on the Drawings or specified herein. Panels shall be constructed of not less than USS 14 gauge steel,

suitably braced internally for structural rigidity and strength. NEMA 4X rated wall mounted panels shall be constructed of Type 316 stainless steel, unless FRP is specifically indicated. FRP panels shall be used in chlorine areas. FRP panels located in direct sunlight shall be provided with a protective coating and sun shield to prevent discoloration and cracking.

D. Terminal box outdoor in submersible area.

1. NEMA 6P / IP68 protection rater against water and dust ingress at depths up to 15ft / 5m
2. Manufactured from 14 gauge Type 316 Marine Grade Stainless Steel
3. Seams continuously welded.
4. Manufacturer:
 - a. Slayson
 - b. NEMACO
 - c. Approved equal.

E. Finish Requirements:

1. Sections shall be descaled, degreased, filled, ground and finished. Enclosure when fabricated of steel shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels will not require a paint finish.
2. Panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.
3. 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 sand-ing shall be applied to the intermediate exterior coat before top coating.
4. Apply a minimum of two coats of manufacturer's standard, flat light-colored lacquer, on the panel interior after priming.
5. Unless otherwise noted, the finish exterior colors shall be ANSI 61 gray with a textured finish.

F. Print storage pockets shall be provided on the inside of each panel. Storage pockets shall be steel, welded on to the door, and finished to match the interior panel color. Storage pocket shall be sufficient to hold all of the prints required to service the equipment, and to accommodate 8.5 inch by 11 inch documents without folding.

G. A folding shelf shall be provided on the inside of the door on all free-standing and floor-mounted panels. Shelf shall be suitable for a laptop computer and shall be placed such that an open laptop computer does not interfere with any door-mounted devices. Folded shelf shall not interfere with any internal panel components when the door is closed. Folding shelf shall automatically lock in the horizontal position when raised. Folding shelf shall be approximately 18 inches wide by 12 inches deep and shall have a minimum distributed load rating of 100 pounds. Parts shall be made of heavy gauge steel and shall be painted white or finished to match the interior panel color.

2.04 ENVIRONMENTAL CONTROL

- A. Panels shall be provided with louvers, heat sinks, forced air ventilation, or air conditioning units as required to prevent temperature buildup inside of panel. Internal temperature of all panels shall be regulated to a range of 45 Deg F to 104 Deg F under all conditions. Under no circumstances shall panel cooling or heating equipment compromise the NEMA rating of the panel.
- B. Except for panels mounted with their backs directly adjacent to a wall, louvers shall be in the rear of the panels, top and bottom, and shall be stamped sheet metal construction.
- C. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides.
- D. Forced air ventilation fans, where used, shall provide a positive internal pressure within the panel, and shall be provided with washable or replaceable filters. Fan motors shall operate on 120-volt, 60-Hz power.
- E. For panels with internal heat that cannot be adequately dissipated with natural convection and heat sinks, or forced air ventilation, an air conditioner shall be provided.

2.05 CORROSION CONTROL

- A. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Technologies International Corporation, Model Zerust VC; Hoffman Model AHCI; or equal.

2.05 CONTROL PANEL - INTERNAL CONSTRUCTION

- A. Internal Electrical Wiring:
 - 1. Interconnecting wiring shall be stranded, type MTW, and shall have 600 volt insulation and be rated for not less than 90 degrees Celsius. Wiring for systems operating at voltages in excess of 120 VAC shall be segregated from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Panel layout shall be developed such that technicians shall have complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.
 - 2. Power distribution wiring on the line side of fuses or breakers shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 16 AWG minimum. Electronic analog circuits shall utilize 18 AWG shielded, twisted pair, cable insulated for not less than 600 volts.
 - 3. Power distribution blocks shall be covered with protective guards to meet “finger-safe” requirements of IP20.
 - 4. Power and low voltage DC wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least six inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.

5. Terminations:
 - a. Wiring shall terminate onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable.
 - b. Multi-level terminal blocks or strips are not acceptable unless they are approved by the Engineer in advance of panel wiring diagrams. If approved, they shall be mounted on angled din rail elevated from the back panel.
 - c. Terminal blocks shall be arranged in vertical rows and separated into groups (power, AC control, DC signal). Each group of terminal blocks shall have a minimum of 25 percent spares.
 - d. Terminal blocks shall be the compression type, fused, unfused, or switched as shown on the Contract Drawings or specified elsewhere in Division 13.
 - e. Discrete inputs and outputs (DI and DO) shall have two terminals per point with adjacent terminal assignments. All active and spare PLC and controller points shall be wired to terminal blocks.
 - f. Analog inputs and outputs (AI and AO) shall have three terminals per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. All active and spare PLC and controller points shall be wired to terminal blocks.
 - g. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers.
 - h. Only one side of a terminal block row shall be used for internal wiring. Field wiring side of the terminal shall not be within six inches of the side panel or adjacent terminal or within eight inches of the bottom of free standing panels, or within three inches of stanchion mounted panels, or three inches of adjacent wireway.
 - i. Circuit power from the PLC cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards shall be isolated with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. Isolation switch block shall be an Allen Bradley Model 1492-H7 or equal. One isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.
 - j. All PLC discrete outputs to the field shall be isolated with an isolating fuse switch terminal block with a flip cover and a neon blown fuse indicator. The single circuit fusible terminal block shall be an Allen Bradley 1492-H4 or equal.
6. Wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection, shall be clearly identified as such.
7. Wiring shall be clearly tagged and color coded. Tag numbers and color coding shall correspond to panel wiring diagrams and loop drawings prepared by the PCSS. Power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. Color coding scheme shall be:
 - a. Incoming 120 VAC Hot – Black.
 - b. 120 VAC Hot wiring downstream of panel circuit breaker – Red.
 - c. 120 VAC Hot wiring derived from a UPS system – Red with Black stripe.
 - d. Three phase power – Brown, Orange, Yellow, and Green ground or as specified in Division 16.
 - e. 120 VAC neutral – White.
 - f. Ground – Green.
 - g. DC power or control wiring – Blue.
 - h. DC analog signal wiring – Black (+), White (-).

- i. Foreign voltage – Yellow.
 8. Provide surge protectors on all incoming power supply lines at each panel per requirements of Section 13300.
 9. Each field instrument furnished under Division 13 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication. Instruments requiring 120VAC power shall be powered from the UPS source in the panel where the instrument signals lands.
 10. Provide redundant 24 VDC power supplies to power field instruments and panel devices. Twenty-four VDC power supplies shall be as specified in this Section.
 11. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. Side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.
 12. 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.
 13. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate cover. Convenience receptacle shall not be powered from a UPS and shall be protected by a dedicated fuse or circuit breaker.
 14. 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.
 15. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
 16. Each panel shall have control, signal, and communication line surge suppression in accordance with Section 13300.
 17. Microprocessor-based electronic devices in the panel that are powered by 120VAC shall be powered by the UPS.
 18. Each panel shall be provided with a circuit breaker to interrupt incoming power.
 19. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 16.
- B. Pneumatic Tubing:
1. Refer to Section 13300.
 2. Pneumatic tubing shall be a minimum of 1/4-inch O.D. Type 316 stainless steel with compression fittings. Tubing shall be rigidly supported and run in horizontal or vertical planes.

3. Pneumatic equipment shall be provided with separate shut-off valves. Flexible polyethylene tubing shall be used on all devices mounted on hinged doors, etc.
 4. A screened vent shall be provided on enclosures using pneumatic instruments.
 5. Pneumatic tubing shall be routed in separate bundles or wireways and shall be separated from electrical wiring by a minimum of three inches.
- C. Relays not provided under Division 16 and required for properly completing the control function specified in Division 13, Division 16, or shown on the Drawings shall be provided under this Section.
- D. Orientation of devices including PLC and I/O when installed shall be per the manufacturer's recommendations. No vertical orientation of PLC racks shall be allowed unless specifically indicated by the manufacturer as an acceptable mounting alternative and also approved by the Engineer.

2.06 ELECTRICAL COMPONENTS

- A. Main circuit breaker shall be a thermal-magnetic molded case breaker, by Square D Company, or equal. 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.
- B. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical equipment requirements, the P&IDs Division 13, the Control Wiring Diagrams Division 16 and as shown on the Drawings.
- C. Operating control devices and instruments shall be securely mounted on the exterior door. Controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Electrical Contract Drawings.
- D. Control panel shall be provided with a lightning and surge protection unit on the line side of the main circuit breaker. Unit shall be 600 Volt, 3 Phase, General Electric "Tranquell" Series, or equal.
- E. Specific control devices, control descriptions and other data are specified under the detailed specification for the mechanical equipment with which the control panel is supplied.

2.07 SINGLE PHASE UPS - INTERNAL TO CONTROL PANELS

- A. System Description:
1. Provide an industrially rated continuous duty, on-line, solid state, line interactive, single-phase uninterruptible power system.
 2. UPS shall provide power conditioning and power backup for PLC, communications hardware, and other critical electronic loads as indicated on Drawings.
 3. UPS system shall consist of the following major components:
 - a. Rectifier and battery charger.
 - b. Inverter.
 - c. Batteries.

d. Other features as described in this Section and as indicated on Drawings.

4. UPS shall be:

- a. Allen Bradley 1609-B UPS.
- b. Phoenix Contact QUINT UPS.
- c. Or approved equal.

B. General Requirements:

1. Battery protection shall be provided an internal circuit breaker disconnect.
2. Current limiting circuitry shall protect inverter output under any load condition.
3. AC output neutral shall be electrically isolated from UPS chassis. UPS chassis shall have an equipment ground terminal. Provisions for installation of a bonding connector shall be provided.
4. UPS shall be suitable for installation in a UL508A listed panel.
5. UPS shall be DIN rail mountable.
6. UL recognized components for industrial applications in accordance with UL508 without derating.

C. Performance Requirements:

1. Ratings:
 - a. Output power: 350VA – 1000VA.
 - b. Battery runtime: 60 minutes at full load, 120 minutes at half-load.
2. Environment:
 - a. Ambient temperature: 0 to 40 degrees C.
 - b. Elevation: Up to 500 ft above mean sea level.
 - c. Relative humidity: 1 to 95 percent non-condensing.
3. System Input - Primary source:
 - a. Single input: Nominal Input Voltage: 120 VAC.
 - b. Frequency: 45 to 65 Hz.
 - c. Input Power Factor: 0.95 lag minimum, 50 to 100 percent load.
 - d. Input Surge Withstandability: Per IEEE 587/ANSI C62.41. Category A and B, (6 kV).
4. System Output:
 - a. Nominal Output Voltage: 120 VAC
 - b. Frequency: 60 Hertz plus or minus 3 Hertz.
 - c. 100 percent load with 3:1 Crest Ratio
 - d. Frequency Slew Rate: 1 Hz/second. (Adjustable at startup)
5. AC to AC Efficiency (100 percent load @ rated PF): 88 percent online, 86 percent on battery.
6. Acoustical Noise: Noise generated by UPS under normal operation shall not exceed 65 dBA (60 dBA typical) at one meter from any surface, measured at 25 degrees C (77 degrees F) and full load.

7. EMI Suppression: UPS shall meet FCC Rules and Regulation 47, Part 15, Subpart J, for Class A devices.

D. Batteries:

1. Batteries shall be High Temperature sealed, maintenance-free, high-rate discharge, lead-acid cells suitable for use indoors with no off gassing, or water addition requirements. Batteries shall not require special ventilation. Battery shall consist of one or more battery banks with number of cells required to meet requirements of rest of these specifications.
2. Battery Design Life: two - four years.

E. Controls and Monitoring:

1. Remote alarm and status indication: Isolated SPDT dry contacts shall be provided to indicate UPS status for remote monitoring. Contacts shall be rated for 250VAC @ 5A or 30VDC @ 5A Individual contacts wired to the PLC for indication at OIT and datalogger shall be provided for separate annunciation of the following alarm and status conditions:
 - a. UPS ON battery
 - b. Battery Fail.

2.08 POWER SUPPLIES (24VDC)

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Allen-Bradley.
 - b. Phoenix Contact.
 - c. SOLA HD.
 - d. Substitutions: Or equal

B. Type:

1. 24 VDC Power Supply to power field instruments and panel devices as shown on the drawings.

C. Function/Performance:

1. Input power: 115VAC, plus or minus 10 percent, 60 Hz.
2. Output voltage: 24VDC.
3. Output voltage adjustment: five percent.
4. Line regulation: 0.05 percent for 10V line change.
5. Load regulation: 0.15 percent no load to full load.
6. Ripple: 3 mV RMS.

7. Operating temperature: 32 to 140 degrees F.
8. Sized to accommodate the design load plus a minimum 25 percent spare capacity.

D. Physical:

1. Mounting: DIN rail. Mounted such that heat dissipation does not adversely affect other panel components.
2. Equipped with power on/off circuit breaker.
3. Provide relay contact (internal to the power supply or external if the power supply is not so equipped) to indicate on/off status of the power supply.
4. Provide relay contact to indicate power supply fault.
5. Output overvoltage and overcurrent protective devices to protect from damage due to power supply failure and external failure.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Panels shall be installed at locations as shown on the Contract Drawings.
- B. Refer to Section 13300.

3.02 TESTS

- A. Refer to Section 13300.

END OF SECTION

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SECTION 13340 INSTRUMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the furnishing, installation, and services for instruments.

1.02 RELATED WORK

- A. Refer to Section 13300 "I & C - General Provisions."

1.03 SUBMITTALS

- A. Submit complete documentation of all field instruments using ISA-TR20.00.01-2007 data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment. The list shall be sorted by Loop Number.
- B. Submit separate data sheets for each instrument including:
 - 1. Plant Equipment Number and ISA tag number per the Drawings.
 - 2. Product (item) name used herein and on the Drawings.
 - 3. Manufacturer's complete model number.
 - 4. Location of the device.
 - 5. Input - output characteristics.
 - 6. Range, size, and graduations in engineering units.
 - 7. Physical size with dimensions, enclosure NEMA classification and mounting details in sufficient detail to determine compliance with requirements.
 - 8. Materials of construction for enclosure and wetted parts.
 - 9. Instrument or control device sizing calculations where applicable.
 - 10. Certified calibration data for all flow metering devices.
 - 11. Two-wire or four-wire device type as applicable.
- C. Submit catalog cuts for all instruments. Submit descriptive literature for each hardware component, which fully describes the units being provided.
- D. Submit index and data sheets in electronic format as well as hard copies on 8-1/2" x 11" formats. Electronic format shall be in Microsoft Excel or Word. Submit electronic copy on CD-ROM or DVD disk.

1.04 MAINTENANCE

- A. Refer to Section 13300.
- B. Test equipment:

1.05 INSTRUMENT TAGS

- A. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section and related sections. Equipment shall be tagged before shipping to the site.
- B. Provide 1/8-in by 3/8-in, Type 316 stainless steel button head machine screws.
- C. All supplied instrument transmitters and instrument transmitter elements shall have a stainless steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via stainless steel chain or stainless steel wire (24 gauge min) to a non-removable part of the device. The tag size shall be a minimum of 1.5 square inches. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-in high alphanumeric characters.

1.06 APPROVALS/CERTIFICATIONS

- A. Instruments for hazardous locations shall have Factory Mutual (FM), Canadian Standards Association (CSA), and CENELEC approvals and certifications as specified herein and as indicated on the Drawings or in the Instrument Device Schedule. The instrument specifications in Part 2 state the Class, Division, and gas groups for FM/CSA approval, followed in parenthesis by the CENELEC certification; however, instruments provided are only required to have the approval/certification stated above. The instrument shall have a stainless steel tag identifying the relevant approval or certification.

PART 2 PRODUCTS

2.01 INSTRUMENTS

A. SUBMERSIBLE LEVEL TRANSMITTER

- 1. Type:
 - a. Submersible, hydrostatic pressure type level transmitter.
- 2. Function/Performance:
 - a. Range: Range selected shall be the manufacturer's standard range closest to the span to be measured.
 - b. Temperature Compensation: Temperature compensated over a range of zero to 50 degrees C.
 - c. Accuracy: Plus or minus 0.25 percent of range.
 - d. Over Pressure: Transducer shall be protected for overpressure of 1.5 times the span.

- e. Output: 4-20 mA proportional to the calibrated span.
3. Physical:
 - a. The transmitter assembly shall have a Type 316 stainless steel or titanium body with a bottom diaphragm.
 - b. Sensors shall be suspended by cable. Cable shall include a vent tube for the transducer.
 - c. Sensor shall be suspended with a tension-relieving mounting clamp from a four-inch (100 mm) flange. Clamp and flange shall be Type 316 stainless steel.
 - d. Sensor shall be submersible (IP68) and shall be CSA approved or CENELEC (EEx ia IIC T4) certified intrinsically safe when intrinsically safe barriers are provided for the instrument loop.
 - e. 24 VDC loop powered.
 4. Accessories Required:
 - a. Sufficient manufacturer's cable for installation between the sensor and the transmitter as indicated on the Drawings. Cable shall be reinforced to support the weight of the transducer and cable.
 - b. Cable clamp for suspending instrument provided by instrument supplier.
 - c. All fittings required for pressure calibration of the instrument.
 5. Manufacturers:
 - a. SOR 510LT.
 - b. GE PTX1290.
 - c. Or equal.
 6. Range
 - a. LT1010
 - 1) 0-50 feet
 - b. LT1015
 - 1) 0-50 feet
- B. Pressure Gauge
1. Refer to section 15120 "Piping Specialties"
- C. Pressure Switch
1. Type:
 - a. Diaphragm actuated.
 2. Function/Performance:
 - a. Repeatability: Better than 1 percent of full scale.
 - b. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.

- c. Dead Band: Fixed unless adjustable dead band requirement is noted in the Instrument Device Schedule.
 - d. Reset: Unit shall be of the automatic reset type unless noted otherwise in the Instrument Device Schedule.
 - e. Over Range Protection: Over range protection to 150 percent of the maximum process line pressure.
 - f. Output: Single pole double throw (SPDT) unless requirement for double pole double throw (DPDT) switch is shown on the instrument device schedule. Switch rating shall be 10 A at 230 VAC.
3. Physical:
- a. Housing: NEMA 4X (IP65) for non-hazardous areas. For installation in hazardous areas, housing shall be explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIB).
 - b. Switch Assemblies: Hermetically sealed switches.
 - c. Wetted Parts: Type 316L stainless steel diaphragm, viton seals, Type 316 stainless steel connection port.
4. Accessories/Options Required:
- a. Shutoff Valve: Provide a Type 316 stainless steel shutoff valve. Valve shall be by D/A Manufacturing, Anderson Greenwood, or Equal.
 - b. Where indicate on the instrument device schedule, provide a Type 316 stainless steel snubber for pulsation dampening.
5. Manufacturers:
- a. Static-O-Ring (SOR).
 - b. Ashcroft.
 - c. Mercoid.
 - d. Equal.
6. Range
- a. PSH-1100-1/2/3/4
 - 1) 0-200 psig
 - 2) Set point field adjustable
7. Diaphragm Seal - Threaded
- a. Refer to section 15120 "Piping Specialties"
- D. Pressure Transmitters
- 1. Type:
 - a. Microprocessor based, intelligent type.

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: 0.05 percent of upper range limit for one year.
 - g. Display: Digital indicator displaying pressure or level in the engineering units indicated in the Instrument Device Schedule.
 - h. Diagnostics:
 - 1) Self-diagnostics with transmitter failure driving output to above or below out of range limits.
 - 2) Simulation capability for inputs and loop outputs.
 - 3) Test terminals available to ease connection for test equipment without opening the loop.
 - 4) Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to shall be available.
 - 5) Run-time clock available to determine usage for warranty purposes. Five-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 Type 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.
 - 1) Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device.
 - 2) NOTE: Siemens, ABB and Foxboro have this capability.
 - b. For each transmitter provide a Type 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. Manufacturers:
 - a. Smar LD301M.
 - b. ABB 264HS.
 - c. Rosemount 3051CG.
 - d. Foxboro IGP20.
 - e. Siemens Sitrans P DS III.
 - f. Or equal.

6. Range

- a. PIT-1150
 - 1) 0-200 psig

7. Diaphragm Seal - Threaded

- a. Refer to section 15120 "Piping Specialties"

E. MAGNETIC FLOWMETER

1. Flow Element:

- a. Type:
 - 1) Pulsed DC type.
- b. Function/Performance:
 - 1) Operating Temperature: Process liquid temperatures of 0 to 140 degrees F or greater dependent upon liner and an ambient of minus 30 to 150 degrees F.
 - 2) Radio Frequency Interference (RFI) protection: RFI protection shall be provided as recommended by the manufacturer.
 - 3) Pressure rating: Equal to piping system where meter is installed.
 - 4) Additional: Meter shall be capable of running empty indefinitely without damage to any component.
- c. Physical:
 - 1) Metering Tube: Type 304 stainless steel or equivalent.
 - 2) Flanges: ANSI 150 lb. or DIN PN 16 carbon steel, as required by the piping system, unless otherwise indicated. ANSI 150 lb. or DIN PN 16 stainless steel flanges shall be used on all SS process pipes.
 - 3) Liner: Polyurethane or composite elastomer unless otherwise indicated on the Drawings or in the Instrument Device Schedule.
 - 4) Electrodes: Type 316 stainless steel standard minimum requirements. All electrodes to be compatible with process fluid as indicated on the Drawings or electrodes to be supplied as listed in the Instrument Device Schedule.
 - 5) For sludge, polymer, or any slurry application where the electrodes will be coated, a self-cleaning or a removable electrode option must be provided with that meter.
 - 6) Housing: For meters with remote mounted transmitters, meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft (nine m). Meters above grade shall be NEMA 4X (IP65). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.
 - 7) Finish: All external surfaces shall have a chemical and corrosion resistant finish.

- d. Power Requirements:
 - 1) Meter shall be 24 VDC powered instrument, receiving its power from transmitter.
 - e. Accessories/Documentation Required:
 - 1) Factory calibration: All meters shall be factory calibrated. A copy of the calibration report shall be included in the O&M manual.
 - 2) Grounding: Meter shall be grounded in accordance with the manufacturer's recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for the liquid being measured and must be compatible with process fluid and with the process pipe.
 - 3) For meters with remote mounted transmitters, signal cable for installation between the flow tube and the transmitter. Length shall be as required by installation as indicated on the Drawings.
2. Flow Converter/Transmitter:
- a. Type:
 - 1) Micro-processor based, intelligent transmitter compatible with flow tube provided.
 - 2) Integral mount or mounted remote from the flow tube as shown on the drawings or as required by the physical location.
 - b. Functional/Performance:
 - 1) Accuracy (including flow tube): Plus/minus 0.5 percent of flow rate or better.
 - 2) Operating Temperature: -20 to 140 degrees F.
 - 3) Output: Isolated 4-20 mA with HART protocol. Current output adjustable over the full range of the instrument. Provide a dry contact to indicate reverse flow.
 - 4) Diagnostics: Self diagnostics with on screen display of faults.
 - 5) Display: Digital indicator displaying flow in engineering units indicated in the Instrument Device Schedule.
 - 6) Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.
 - 7) Empty Tube Zero: The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.
 - 8) Provide electrode cleaning unit to match flow element requirements.
 - c. Physical:
 - 1) Transmitter shall be suitable for surface or pipe stand mounting.
 - 2) Enclosure shall be NEMA 4X (IP65).
 - d. Power Requirements:
 - 1) The transmitter shall be 120 VAC powered instrument.
 - e. Accessories/ Required:
 - 1) Keypad where required for transmitter configuration.
3. Manufacturer:
- a. Proline Promag W 400 Endress+Hauser
 - b. ABB Instruments WaterMaster.
 - c. Krohne Optiflux 2000 or 4000 Series.
 - d. Siemens Sitrans FM MAG.

- e. Rosemount Series 8705 Meter and 8712 Transmitter for remote mounted transmitter, or 8732E meter/transmitter for integral mounted.
 - f. Or approved equal.
4. Range
- a. FIT-1140
 - 1) 0-1000 gpm

2.02 SPARE PARTS AND ACCESSORIES

- A. General requirements for spare parts are specified in Section 13300.
- B. Furnish following field Instrument related Spare Parts:
 - 1. One flow indicating transmitter for each type of flow element provided.
 - 2. One level indicating transmitter for each type of level element provided.
 - 3. One pressure transmitter for each type provided.
- C. Furnish following Accessories:
 - 1. All mounting hardware required for pipe stand, surface, or other mounting.
 - 2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

PART 3 EXECUTION

3.01 GENERAL

- A. See execution requirements in Section 13300.
- B. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, five-valve manifolds for calibration, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

END OF SECTION

SECTION 15064
PLASTIC PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install 1/8-in to six-in. non-buried plastic piping and appurtenances as shown on the Drawings and as specified herein.
- B. Refer to Section 15051 for additional general piping requirements.

1.02 RELATED WORK

- A. High density polyethylene pipe is specified in Division 2.
- B. Pipe hangers and supports are included in Section 15140.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data required to establish compliance with this Section. Submittals shall include the following:
 - 1. Shop drawings including piping layouts and schedules shall be submitted to the Engineer and shall include dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.
 - 2. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layout for each piping submittal.

1.04 REFERENCE STANDARDS

- A. ASTM International.
 - 1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - 2. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - 3. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
 - 4. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - 5. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

6. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 7. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 8. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
 9. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
 10. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
 11. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
 12. ASTM D3311 - Standard Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns.
 13. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
 14. ASTM D5260 - Standard Classification for Chemical Resistance of Poly(Vinyl Chloride) (PVC) Homopolymer and Copolymer Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
 15. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 16. ASTM F438 - Standard Specification for Socket - Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
 17. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
 18. ASTM F441 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
 19. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
 20. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
 21. ASTM F594 - Standard Specification for Stainless Steel Nuts.
- B. Plastic Pipe Institute (PPI)
1. PPI Handbook of Polyethylene Pipe
- C. Handbook of PVC Pipe Design and Construction, Uni-Bell PVC Pipe Association

- D. American National Standard Institute (ANSI)
 - 1. ANSI B16.5 Pipe Flanges and Flanged Fittings.
- E. National Sanitation Foundation (NSF)
- F. 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 plastic pipe and fittings of each type shall be furnished by a single manufacturer who is experienced in the manufacture of the items to be furnished; however, it shall not be a requirement that the pipe and fittings be manufactured by the same manufacturer, provided that the pipe and fittings are compatible in both compounding and size. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall be suitable for the intended service.

1.06 SYSTEM DESCRIPTION

- A. Piping shall be installed in those locations as shown on the Drawings.
- B. The equipment and materials specified herein are intended to be standard types of plastic pipe and fittings for use in transporting wastewater, water, air and chemicals.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Poly (Vinyl Chloride) Pipe and Fittings - PVC
 - 1. Pipe shall be manufactured from PVC compounds meeting ASTM D1784, Class 12454 in accordance with ASTM D1785, PVC 1120. The pipe shall have a minimum hydrostatic design stress of 2,000 psi at 73 degrees F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes as shown on the Drawings and shall be Schedule 80 unless otherwise shown.
 - 2. Fittings shall be the socket type for solvent welded joints conforming to ASTM D2467 or ASTM D2466 where Schedule 40 pipe is shown on the Drawings. Fittings shall be manufactured from PVC compound meeting ASTM D1784, Class 12454. Solvent cement shall be as specified in ASTM D2564.
 - 3. Pipe, fittings and solvent for use with potable water shall be certified by NSF in accordance with NSF Standard No. 14 and the seal shall be included on the pipe.
- B. Threaded joints shall be as specified under the applicable ASTM standard for the pipe and fittings being used. Thread sealer shall be thread tape which shall be standard industrial quality Teflon, Type 1.

C. Flanged Joints

1. Where flanged joints are shown on the Drawings, they shall be supplied with 1/8-in thick full-faced Viton-N gaskets or equal.
 2. Flange bolt spacing, number and dimensions shall conform to the requirements of ANSI B16.5. CPVC and PVC flanges shall be suitable for solvent cementing to the pipe and shall be suitable for a minimum pressure of 150 psi.
 3. Bolts, nuts and washers for flanged joints shall be for corrosive service conditions and shall be ASTM F593 and F594, Type 316 stainless steel. Anti-seize compound for stainless steel bolts and nuts shall be of a molybdenum disulfide base such as Molycoat-G or equal.
- D. Fittings, specials, unions and flanges shall be of the same schedule number and manufactured of the same materials as the pipe. Whenever unions are called out on the Drawings, flanged connections may be substituted, provided that dimensional controls do not preclude use of flanges.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The installation of plastic pipe shall be strictly in accordance with the manufacturer's technical data and printed instructions.
- B. Joints for PVC and CPVC pipe shall be solvent cemented unless flanged or threaded are otherwise shown on the Drawings or are specified as other types herein. In making solvent cemented connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth to remove any shoulder or burrs created by cutting of the pipe. Solvent cement joints shall be made in accordance with ASTM D2855 except that solvent cement formulated especially for and as specified above shall be used for joining CPVC pipe and fittings. Primer shall be used whenever recommended by the pipe, fitting, or cement manufacturer and in all cases for joints on pipe systems four-in. in diameter or larger. Making solvent cement joints shall not be performed and the work shall stop when the temperature, measured in the shade, is 40 degrees F and falling.
- C. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings nor shall plastic piping be threaded into metal valves, fittings or couplings. Only socket to thread adaptors shall be used for threaded plastic pipe connections to other threaded devices.

END OF SECTION

SECTION 15066
STAINLESS STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install, test, complete and ready for operation all stainless steel pipe as shown on the Drawings and as specified herein.
- B. Where the word "pipe" is used it shall refer to pipe, fittings, hangers, supports and appurtenances unless otherwise noted.
- C. The work includes, but is not necessarily limited to:
 - 1. Furnishing and installing interior, above grade, stainless steel pipe, fittings and specials with screwed, butt welded, or flanged and plain ends.
 - 2. Furnishing stainless steel pipe sleeves and stainless steel pipe wall castings for interior and exterior wall and foundation wall penetrations.

1.02 RELATED WORK

- A. Testing is included in Section 01445.
- B. Concrete work is included in Division 3.
- C. Field painting is included in Section 09902.
- D. Instrumentation and controls, other than those specified herein, are specified under their respective Sections of Division 13.
- E. Valves and appurtenances are included in Section 15100.
- F. Piping specialties are included in Section 15120.
- G. Pipe hangers and supports are included in Section 15140.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, the following:
 - 1. Within 30 calendar days following effective date of the Agreement submit the name of the pipe, fitting and appurtenances manufacturers and a list of the material to be furnished by each manufacturer. Also include information on local representative for each manufacturer, if product is sold through a distributor.
 - 2. Shop drawings including piping layouts and schedules, including dimensioning, fittings, expansion joints, locations of valves and appurtenances, joint details, wall penetration details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished. Shop drawings shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual

equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each pipe submittal. Not all dimensions will be checked by the Engineer, nor will detailed review be performed. Contractor shall be responsible for accurate dimensioning of piping systems.

3. Proposed cleaning method, including pre-cleaning, descaling, chemicals to be used, or mechanical descaling method and final cleaning/passivation
4. Certifications that welders are qualified, in accordance with ANSI B31.1, Paragraph 127.5 for shop and project site welding of pipe work.

1.04 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM A312 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
2. ASTM A530 - Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
3. ASTM A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

B. American National Standards Institute (ANSI):

1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125 and 250.
2. ANSI B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.
3. ANSI B36.19 - Stainless Steel Pipe.

C. American Water Works Association (AWWA):

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

D. American Society of Mechanical Engineers (ASME):

1. ASME B31.1 - Power Piping.

E. American Welding Society (AWS):

- F. 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. Stainless steel pipe and fittings shall be furnished by a single manufacturer who is fully experienced, reputable, qualified and regularly engaged for the last five years in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section.

1.06 SYSTEM DESCRIPTION

- A. Piping shall be installed in those locations as shown on the Drawings.
- B. The equipment and materials specified herein are intended to be standard types of stainless steel pipe and fittings for use in transporting raw water, and air,.
- C. Stainless steel piping for the system listed below shall be designed for the following conditions:
 - 1. System: Intake Screens Air Scour System
 - a. Material: Type316L.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe and fittings. Pipe and fittings shall not be dropped. Pipe and fittings shall be examined before installation and no piece shall be installed which is found to be defective.
- B. In handling the pipe, wide cushioned slings or other devices and methods acceptable to the Engineer shall be used. No uncushioned ropes, chairs, wedges or levers shall be used in handling the pipe, fittings and couplings.
- C. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe by the Contractor, at the Contractor's own expense. All pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until they are put into service.

1.08 NOT USED

PART 2 PRODUCTS

2.01 MATERIALS

- A. Stainless steel pipe and fittings 8-in and larger shall be fabricated from stainless steel sheet and conform to ASTM A312 Type 304L. Stainless steel pipe and fittings 6-in and less shall be fabricated from stainless steel sheet and conform to ASTM A312 Type 316L. Carbon content of Type 316L material shall be 0.03 percent maximum. Finish shall be No. 1 or No. 2B.
- B. Pipe shall be die-formed or rolled true to dimension and round. Tolerances for length, inside and outside diameter and straightness shall conform to ASTM A530. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe. Ends of pipe and fittings shall be perpendicular to the longitudinal axis. Longitudinal seams on pipe and fittings shall be welded by either the tungsten gas or the metallic-gas method. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16-in. All pieces shall be marked with gauge and type of stainless steel and with the initials of the inspector marked on the inside of each piece, at each end.
 - 1. Use procedure to calculate required wall thickness for internal pressure (positive or negative) and external loads. See Chapter 4 of AWWA M-11 using applicable coefficients for type of stainless steel selected. Refer to Table below.

PIPE	TENSILE STRENGTH	MIN. YIELD STRENGTH
TYPE 304L	70,000 PSI	25,000 PSI
TYPE 304	75,000 PSI	30,000 PSI
TYPE 316L	70,000 PSI	25,000 PSI
TYPE 316	75,000 PSI	30,000 PSI

2. Select wall thickness to specify by using either gauge, schedule or thickness in inches that is closest to, but not less than the calculated thickness.
- C.
- C. Fittings shall be smooth curve type up to 18-in diameter and mitered type 20-in diameter and greater. Fittings shall conform to ANSI B16.9.
 - D. Flanges for pipe four-in. and smaller shall be of the type of stainless steel as the pipeline, and shall be welded directly to the pipe end, and shall be drilled to the 125 lb ANSI B16.1 standard. Flanges for pipe larger than four-in shall have stub ends or rolled angle rings of the type of stainless steel as the pipeline welded to the pipe end, with suitable gaskets between the mating surfaces and joined through the use of 125 lb rated back-up flanges, drilled to ANSI B16.1, and made of materials as shown on the Drawings. Where the pipe stub is to pass through a sleeve during installation, a split-type back up flange shall be used. Bolts, washers, nuts and other hardware for flange bolting shall be Type 316 stainless steel.
 - E. Gaskets for flanged connections shall be a minimum of 1/16-in thick and shall be rubber, hypalon, teflon, BUNA-N, SBR, NBR or viton.
 - F. Shop fabricated multiple output headers may be used in lieu of individual flanged fittings.
 - G. Wall pipes shall have integral shop welded wall stops.
 - H. All stainless steel pipe and fittings shall be pickled at the point of manufacture, scrubbed and washed until all discoloration is removed in accordance with ASTM A380.
 - I. Pipe ends shall be prepared for couplings or other type ends where required by transport and handling limitations, where required by the support layout requirements and where noted on the Drawings. Plain end pipe may be coupled with "Vic-Press "-style connectors, for pipe/tubing sizes two inches and smaller, manufactured by the Victaulic Co. or by the use of grooved end couplings. Grooving (RX grooves or built-up ends for Schedule 5s or 10s pipe) shall be of the coupling manufacturer's standard type. [Split ring, grooved end couplings shall not be used for Ozone, Ozone off-gas or Ozonated water lines.] Contractor is responsible for ensuring rigidity of joints where required. All normal pipe joints at valves, bends, and fittings shall be flanged, drilling per ANSI B16.1, Class 125.
 - J. Grooved joint couplings for stainless steel pipe shall consist of two ductile iron housing segments conforming to ASTM A536, Grade 65-45-12 and ASTM A449 zinc-electroplated steel bolts and nuts; or stainless steel housings conforming to ASTM A351, Grade CF8M, with ASTM F593 and F594 stainless steel nuts and bolts.
 1. Rigid Type to 12 Inches: Victaulic Series 89 (DI) and Series 489 (SS) with coupling housing key to engage the bottom of the groove.

2. Rigid Type 14 Inches and Larger: Victaulic Style W89 (rigid) with AGS series two-segment couplings with lead-in chamfer on housing key and wide-width Flush Seal gasket.
 3. Flexible: Victaulic Style 77S.
 4. Schedule 5S and 10S pipe shall be grooved using a Victaulic grooving tool equipped with RX roll sets, specifically designed for stainless steel pipe.
- K. Shop welding of fabrications shall be done according to the procedures and by welders certified per ASME Section IX. Welds shall be by an inert gas shielding process using only extra low carbon filler metals. Welds shall have a bead height of no more than 1/16-in. Butt welds shall have 100 percent penetration to the interior or backside of the weld joint. Cross-sectional thickness of welds shall be equal or greater than that of the parent metal.
- L. Where shown on the Drawings or where approved by the Engineer, plain end pipe shall be joined by all stainless steel flexible couplings. Sleeve type couplings shall be of the Type 316L stainless steel and shall be Style 38 as manufactured by Dresser Manufacturing Division of Dresser Industries; coupling 411 as manufactured by Smith Blair, Inc. or equivalent couplings manufactured by Depend-O-Lok Co.
- M. Where shown on the Drawings or where approved by the Engineer, flanged coupling adaptors shall be used to connect plain end pipe to equipment, fittings and valves. Flanged coupling adaptors shall be of the Type 316L stainless steel and shall comply with AWWA C207. Flanged coupling adaptors shall be manufactured by Dresser Manufacturing Division of Dresser Industries; Smith Blair, Inc. or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Pipe and fittings shall be installed true to grade and alignment and pipe anchorage and/or restraint shall be provided where required. Manufacturer's instructions shall be strictly followed.
- B. Pipe and fittings shall be protected from dirt, dust, oil, grease and other foreign matter during installation to prevent damage to pipe and to assure no foreign matter is left in the piping.
- C. To assemble the joints in the field, thoroughly clean all joint surfaces and gaskets, if any, with soapy water before assembly. Bolts shall be tightened alternately, evenly to the manufacturer's specified torques. Under no condition shall extension wrenches or pipe-over-handle ratchet wrenches be used to secure greater leverage. All electrical bonding or insulation shall be installed as joints are made up.
- D. Fittings, in addition to those shown on the Drawings, shall be provided if required. Due consideration shall be given to thermal expansion/contraction over a temperature range of 200 degrees F.
- E. When cutting of pipe is required, the cutting shall be done by machine neatly, without damage to the pipe. Cut ends shall be smooth and at right angles to the axis of the pipe.
- F. After installation, stainless steel pipe lines shall be washed clean with steam or hot water to remove any foreign material picked up during transport.

3.02 JOINING MECHANICAL AND RESTRAINED JOINTS

- A. Mechanical joints shall be in accordance with the "Notes on Methods of Installation" under AWWA C111 and the instructions of the manufacturer.
- B. Restrained joint pipe and fittings shall be installed in the locations shown on the Drawings and as acceptable to the Engineer.

3.03 JOINING FLANGED JOINTS

- A. Flanged joints shall be made with gasket, bolts and nut bolts stud with a nut on each end, or studs with nuts where the pipe is tapped. The number and size of bolts shall conform to the same standard requirements as the flange.

3.04 FIELD WELDING

- A. Welding in the field shall be done only if approved by the Engineer. Field welds shall be made by welders certified under ASME Section IX and be equal in all respects to shop welds. After field welding has been done, all joints shall be thoroughly cleaned and buffed using deburring and finishing wheels.

3.05 FIELD PAINTING

- A. Final field painting is included in Section 09902 except that for all stainless steel pipe, only bands, labels and arrows rather than full pipe painting will be required.

3.06 DISINFECTION AND CLEANUP

- A. After installation, completed lines shall be cleaned with Oakite deoxidizer or similar deoxidizer as recommended by the manufacturer to remove all foreign matter, construction stains or shop markings. Cleaned lines shall be rinsed clear with steam or hot water.

3.07 FIELD TESTING

- A. Field Testing of the pipe is specified in Section 01445.

END OF SECTION

ATTACHMENT A

STAINLESS STEEL PIPE WALL THICKNESS GUIDE

NOTE: This information is for guidance in selecting wall thickness. It should not be used without first calculating minimum wall thickness based on design conditions of internal pressure and external loads. Thickness should be specified either as schedule 5S, 10S, 40S or 80S gauge or as a wall thickness.

PRESSURE 0 TO 25 PSIG:

Pipe or Tube Diameter	Wall Thickness *
10-in and less	16 Gauge (0.064-in)
12-in	14 Gauge (0.079-in)
14-in	12 Gauge (0.109-in)
16-in	12 Gauge (0.109-in)
18-in	11 Gauge (0.124-in)
24-in	10 Gauge (0.138-in)

PRESSURE TO 150 PSI AT 200 DEGREES F:

Tube OD or Pipe Diameter	Tube Wall Thickness *	Pipe Wall Thickness *
3 to 6	14 Gauge (0.079-in)	Schedule 5 (0.065 to 0.109) **
8 to 12	12 Gauge (0.109-in)	12 Gauge (0.109-in)
14 to 16	11 Gauge (0.124-in)	11 Gauge (0.124-in)
18 to 20	10 Gauge (0.138-in)	10 Gauge (0.138-in)
24	8 Gauge (0.168-in)	8 Gauge (0.168-in)
30	3/16-in	3/16-in
36	1/4-in	1/4-in

*Verify thickness in inches and gauge thickness. Some manufacturers use different gauge definitions.

**Depends on diameter.

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SECTION 15072
DUCTILE IRON PIPE AND FITTINGS ABOVE GRADE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required, install, and test ductile iron pipe and fittings for plant mechanical piping as shown on the Drawings and as specified herein.
- B. Mechanical piping shall include all piping and fittings installed above grade.
- C. Mechanical piping shall be installed as shown on the Drawings. Provide pipe supports, hangers and couplings as required to achieve a complete pipe system.
- D. Where the word "pipe" is used, it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

1.02 RELATED WORK

- A. Delivery, Storage and Handling is included in Section 01600.
- B. Ductile Iron Pipe and Fittings Below Grade is included in Section 02616.
- C. Painting is included in Section 09901 and Section 09902.
- D. Valves and Appurtenances are included in Section 15100.
- E. Piping Specialties are included in Section 15120.
- F. Pipe Hangers and Supports are included in Section 15140.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data required to establish compliance with the Section. Submittals shall include the following
 - 1. Tabulated layout drawings showing actual pipe lengths, diameters, fittings and appurtenances.
 - 2. Prior to shipment of pipe, submit a certified affidavit of compliance from the pipe manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this project have been manufactured and tested in accordance AWWA and ASTM standards and requirements specified herein.

1.04 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM C150 - Standard Specification for Portland Cement.

B. American National Standards Institute (ANSI):

1. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125 and 250.
3. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings. (3-in Through 48-in (80mm Through 1200mm) for Water).
3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
5. AWWA C116 - Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings.
6. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
7. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
8. AWWA C153 - Ductile-Iron Compact Fittings for Water Service.
9. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
10. AWWA C606 - Grooved and Shouldered Joints.
11. AWWA C651 - Disinfecting Water Mains.

D. 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. Each length of ductile iron pipe supplied for the project shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any

rupture of the pipe wall. Certified test results shall be furnished in duplicate to the Engineer prior to time of shipment.

- B. Ductile-iron pipe and fittings to be installed under this project shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results prior to the shipment of the pipe.
- C. Pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the District, at the District's expense.
- D. Inspection of the pipe and fittings will also be made by the Engineer or representative of the District after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specified requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.
- E. Pipe and fittings shall be permanently marked with the following information:
 - 1. Manufacturer, date.
 - 2. Size, type, class, or wall thickness.
 - 3. Standard produced to (AWWA, ASTM, etc).

1.06 DELIVERY, STORAGE AND HANDLING

- A. See Section 01600 for general requirements.
- B. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or internal lining of the pipe.
- C. Materials, if stored, shall be kept safe from damage. The interior of all piping, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.
- D. Pipe ends including flange faces shall be protected from damage. All openings shall be adequately covered to prevent entrance of dirt, water and debris, and keep the pipe interior clean.
- E. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations.
- F. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe:

1. Ductile iron pipe shall conform to AWWA C151 and ANSI A21.51 and shall be Special Thickness Class 53 minimum. Where threaded taps in ductile iron pipe are indicated on the Drawings, ductile iron pipe shall be Special Thickness Class 55 minimum.
2. Pipe shall be supplied in standard lengths as much as possible.
3. Ductile iron pipe shall be as manufactured by U.S. Pipe and Foundry Company, Inc.; American Cast Iron Pipe Company; Clow Water System Company, or equal. All pipe shall be made in the United States and supplied by a single manufacturer.

B. Joints:

1. Ductile iron pipe and fittings for above-grade service shall have flanged joints except where otherwise shown on the Drawings. Rubber-gasket joints shall conform to AWWA C111. Gasket shall conform to AWWA C111 and ANSI A21.1 and shall be EPDM.
2. Bolts and nuts on flange joint pipe and fittings shall be 304 stainless steel and conform to ANSI B16.1.

C. Fittings:

1. Pipe fittings shall be ductile iron with pressure rating of 350 psi for 24-in and smaller piping and 250 psi for 30-in and larger piping. Fittings shall meet the requirements of AWWA C110 or AWWA C153 as applicable. Fittings shall have the same pressure rating, as a minimum, of the connecting pipe. Fittings may be made outside the United States, but shall be supplied by one of the named pipe manufacturers or Engineer approved equal.

D. Interior Lining:

1. Interior surfaces of all ductile iron pipe shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. Ductile iron fittings shall be double cement lined. Ductile iron pipe fittings need not have the cement-mortar lining applied centrifugally. The lining machines shall be of the type that has been used successfully for similar work. At the option of the supplier, fittings may be lined in accordance with AWWA C550. Every precaution shall be taken to prevent damage to the lining. If the lining is damaged or found faulty at the delivery site, the damaged or unsatisfactory portion shall be repaired in the field in accordance the ANSI/AWWA C104.
2. All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with NSI/AWWA C104.

E. Exterior Coatings:

1. Unless otherwise specified, all coatings shall be shop applied with "hold-backs" provided as required at pipe and fitting ends for satisfactory installation for joint connections in the field. Provide all necessary coating materials to perform field coating applications at joints. Unless otherwise noted, field applied coating material shall be compatible with or equal to the shop applied material. Field repair of pipe with damaged coating shall receive prior approval of the Engineer. If, in the opinion of the Engineer that the coating damage is beyond repair the pipe shall be replaced at the expense of the Contractor. All flange bearing surfaces shall be uncoated.
2. Unless otherwise specified, all exposed exterior ferrous surfaces shall be painted with an applicable paint system as specified under Division 9. Surface preparation and application thereof shall be in conformance with applicable provisions of Division 9.
3. All exterior coating and linings shall be applied to the ductile iron surface that has been mechanically cleaned or brush blasted. Chemical cleaning or wiping with solvent as a preparation method is not acceptable.

F. Pipe Hangers and Supports:

1. Pipe hangers and supports shall be provided at suitable distance along the pipeline regardless whether they are shown or not shown on the Drawings.
2. Pipe hangers and supports shall be as specified in Section 15140.

G. Harnessed Flanged Adaptor Couplings

1. Harnessed flanged adapter couplings, where shown on the Drawings, shall be Smith-Blair Type 913 with Type 907 Restraint Plates and Rods, Dresser Style 128-W with Style 441 Tie Plates and Rods. Tie rods and nuts shall be in accordance with AWWA Manual M11. Anchor studs will not be permitted.
2. All couplings shall be furnished with the pipe stop removed.
3. Couplings shall be provided with EPDM gaskets.
4. Harness rods and bolts shall be low alloy high-strength carbon steel and shall be furnished by flange adaptor coupling manufacturer. Size and number of harness rods shall be determined by manufacturer based on maximum pressure of 250 psi.
5. Interior and exterior ferrous metal surfaces shall have a factory applied epoxy coating.

PART 3 EXECUTION

3.01 PIPE INSTALLATION

A. General:

1. Piping and fittings shall be installed true to alignment and rigidly supported. Anchorage shall be provided where required. Damage to linings shall be repaired to the satisfaction of the Engineer before the pipe is installed. Each length of pipe shall be cleaned out before installation. All of manufacturer's recommendations shall be complied with.
2. Deflection at joints shall not exceed that recommended by the pipe manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in areas where conflict exists with the existing facilities.
3. When pipe cutting is acceptable to the Engineer, the cutting shall be done by abrasive saw, leaving a smooth cut at right angles to the axis of the pipe. Damage to the lining shall be repaired to the satisfaction of the Engineer. Field cut ends shall be sealed with approved epoxy coating in accordance with manufacturer's instructions.

B. Jointing:

1. Flanged joints shall be made using gaskets, bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI Standard as the flanges.
2. Bolts in flanged joints or mechanical joints shall be tightened alternately and evenly.
3. Sleeve type couplings and grooved joints using split ring couplings shall be installed in accordance with the procedures recommended by their respective manufacturers.

C. Pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit a certification stating that such requirements have been complied with.

D. Sleeves of proper size shall be installed for all pipes passing through floors or walls. Sleeves shall be installed as shown on the Drawings. Where indicated on the Drawings or required for liquid or gas-tightness, the pipe shall be sealed with a mechanical seal similar to Link-Seal as manufactured by Thunderline Corporation, or equal.

3.02 TESTING

- A. Piping shall be subject to acceptance tests. Provide all necessary utilities, labor and equipment for flushing and testing and dispose all waste after the test including water.
- B. Pipe and fittings shall be pressure tested to 200 psi for two hours and the pipeline shall show no leakage.
- C. Correct leakage and repair all damage to the pipe and pipe appurtenances or to any structures resulting from, or caused by tests. All leaks shall be repaired and lines retested.

3.03 CLEANING

- A. Clean the pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. All debris shall be removed from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal.

3.04 PIPE MARKING

- A. Exposed piping, exterior and interior, shall be identified by painted legend markers, directional arrow markers and number markers as required. Pipe marking colors shall contrast with pipe color for ease of visibility. Pipe marking shall match the existing markings. Letters and markers 1-1/8-in in width shall be installed on pipes under three in. in diameter. Markers 2-1/2-in in width shall be installed on pipes three in. in diameter and larger. Legend markers, directional arrow markers and number markers shall be placed as directed by the Engineer. Markers shall be located where pipes pass through walls or floors, at piping intersections and maximum 15-ft spacing on piping runs.

END OF SECTION

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SECTION 15100
VALVES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation and test all valves as shown on the Drawings and as specified herein.
- B. The equipment shall include, but not be limited to, the following; however not all items specified herein may be included in this project.
 - 1. General Requirements.
 - 2. Valve Actuators - Manual.
 - 3. Valve Actuators - Powered.
 - 4. Butterfly Valves.
 - 5. Plug Valves.
 - 6. Resilient Wedge Gate Valves
 - 7. Check Valves.
 - 8. Solenoid Valves.
 - 9. Air Release and Vacuum Relief Valves.
 - 10. Surge Relief Valves

1.02 RELATED WORK

- A. Buried valves and appurtenances are included in Division 2.
- B. Shop and Finish painting is included in Sections 09901 and 09902.
- C. Instrumentation, not specified herein, is included in Division 13.
- D. Valves on all HVAC and plumbing systems are included in their respective sections of Division 15.
- E. Electrical work is included in Division 16.
- F. Certain items similar to those specified in this Section may be specified to be furnished and installed with individual equipment or systems. In case of a conflict, those individual equipment or system requirements shall govern.

1.03 SUBMITTALS

- A. Submit to Engineer, in accordance with Section 01300, materials required to establish compliance with this Section. First submittal shall be valve schedule described in Paragraph 1.09. Approval of valve schedule submittal is required prior to Contractor submitting any of equipment in this specification. Subsequent Equipment Submittals shall include at least the following:
1. Valve tag number.
 2. Manufacturer and supplier.
 3. Address at which equipment will be fabricated or assembled.
 4. Drawings showing assembly details, materials of construction and dimensions.
 5. Descriptive literature, bulletins and/or catalogs of the equipment.
 6. Total weight of each item.
 7. A complete bill of materials.
 8. Additional submittal data, where noted with individual pieces of equipment.
 9. Individual electrical control schematics and wiring diagrams for each valve operator with external interfaces, identified exactly as detailed on Electrical and Instrumentation Drawings. Standard catalogue cut sheets that show typical wiring diagrams only are not acceptable. Valve actuators shall be coordinated with electrical requirements shown on Drawings and valves as specified herein.
- B. Test Reports:
1. Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP-61 for valves.
- C. Certificates:
1. For each valve specified to be manufactured, tested and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with appropriate standards, including certified results of required tests and certification of proper installation.
- D. Manufacturer's Installation and Application Data.
- E. Operating and Maintenance Data.
1. Operating and maintenance instructions shall be furnished to Engineer as provided in Section 01730. Instructions shall be prepared specifically for this installation and shall include required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE STANDARDS

A. ASTM International:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
5. ASTM A436 - Standard Specification for Austenitic Gray Iron Castings.
6. ASTM A536 - Standard Specification for Ductile Iron Castings.
7. ASTM B30 - Standard Specification for Copper-Base Alloys in Ingot Form.
8. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

B. American Water Works Association (AWWA):

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C500 - Metal-Seated Gate Valves Supply Service.
3. AWWA C504 - Rubber-Seated Butterfly Valves.
4. AWWA C507 - Ball Valves, 6-in through 48-in (150mm through 1200mm).
5. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in (50mm through 24-in (600mm) NPS.
6. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.
7. AWWA C511 - Reduced-Pressure Principle Backflow-Prevention Assembly.
8. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates.
9. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane Type Actuators for Valves and Slide Gates.
10. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
11. AWWA C800 - Underground Service Line Valves and Fittings.

C. American National Standards Institute (ANSI):

1. ANSI B1.20.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).

2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 3. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
 4. ANSI B16.104 - Butterfly Valves.
- D. American Iron and Steel Institute (AISI).
- E. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):
1. MSS-SP-61 - Pressure Testing of Steel Valves.
 2. MSS-SP-67 - Butterfly Valves.
 3. MSS-SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
 4. MSS-SP-71 - Cast Iron Swing Check Valves, Flanges and Threaded Ends.
 5. MSS-SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Services.
 6. MSS-SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 7. MSS-SP-80 - Bronze Gate, Globe, Angle and Check Valves.
 8. MSS-SP-82 - Valve Pressure Testing Methods.
 9. MSS-SP-98 - Protective Coatings for the Interior of Valves, Hydrants and Fittings.
- F. National Electrical Manufacturers Association (NEMA).
- G. Underwriters Laboratories (UL).
- H. Factory Mutual (FM).
- I. 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. Valves and appurtenances shall be products of well established firms who are fully experienced, minimum 10 years, reputable and qualified in manufacture of particular equipment to be furnished.
 2. Equipment shall be designed, constructed and installed in accordance with best practices and methods and shall comply with this Section as applicable.
 3. Units of the same type shall be the product of one manufacturer.

4. All 480 volt motor actuators shall be product of one manufacturer. Contractor shall coordinate this requirement with vendors who supply actuated valves as part of systems specified in Division 11 and 15. Specifically note; Process Blowers in Paragraph 1.02.

B. Certifications:

1. Manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified in Paragraph 1.03C above. Refer to PART 3 for testing required for certain items in addition to that required by referenced standards.

C. Provide services of a qualified and factory-trained service representative of manufacturer to provide operational and maintenance instruction, for a one-day, eight-hour period for each type of the following equipment:

1. Valve motor operators.
2. Pressure regulating valves.
3. Air release, air and vacuum valves.
4. Surge relief valves.
5. Pinch valves.
6. Hydraulic cylinder actuators.

- D. Inspection of units may also be made by Engineer or other representative of District after delivery. Equipment shall be subject to rejection at any time due to failure to meet any of specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from job site at once.

1.06 SYSTEM DESCRIPTION

- A. Equipment and materials specified herein are intended to be standard for use in controlling flow of water, wastewater, sludge, air, and chemicals as noted on Drawings.
- B. Valves, appurtenances and miscellaneous items shall be installed as shown on Drawings and as specified, so as to form complete workable systems.
- C. Unless otherwise noted, powered valve operators shall have:
1. Valves larger than 3-in: electric operators 460 Volt, 3 Phase, 60 Hz.
 2. Valves 3-inch and under: electric operators, 120 Volt, 1 Phase, 60 Hz.
 3. Solenoid valves: 120 volt, single phase, 60 Hz, NEMA 4 enclosure, continuous duty Class F coils and manual operator. Solenoid valves for seal water systems shall be "fail open" design; others shall be "fail closed" unless otherwise noted on Drawings or in the Instrumentation specifications.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Reference is made to Section 01600 for additional information.
- B. Packing and Shipping:
 - 1. Care shall be taken in loading, transporting and unloading to prevent injury to the valves, appurtenances, or coatings. Equipment shall not be dropped. Valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Damage to the coatings shall be repaired as acceptable to Engineer.
 - 2. Prior to shipping, ends of valves shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.
 - a. Valves three in. and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.
 - b. Valves smaller than 3 in. shall be shipped and stored as above except that heavy cardboard covers may be used on the openings.
 - c. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until the valve is installed and put into use.
 - d. Corrosion in evidence at the time of acceptance by the District shall be removed, or the valve shall be removed and replaced.
- C. Storage and Protection:
 - 1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation. See the individual piping sections and manufacturer's information for further requirements.

1.08 MAINTENANCE

- A. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance, shall be supplied with the equipment in accordance with Section 01730 and where noted, as specified herein. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.
- B. Provide one operations and maintenance manual for each type of valve and operator supplied under this specification in accordance with Section 01730.
- C. Included within operations and maintenance manuals, provide a list of all spare and replacement parts with individual prices and location where they are available.

1.09 VALVE DESIGNATIONS AND SCHEDULE

- A. Valves shall be identified by a unique valve tag as identified in valve schedule prepared by Contractor. Specific type of valve to be used will be identified by symbol and/or call out on Drawings. Contractor shall identify each valve by its assigned tag number on shop drawings and equipment submittals.

- B. Contractor shall refer to the P&IDs and mechanical plans for type of each valve called out by abbreviation or drawing symbol. Prior to first valve submittal, Contractor shall submit a detailed valve schedule listing process valves to be furnished along with Contract Drawing P&IDs edited electronically which shall include valve tag numbers prepared by Contractor identifying each valve. This valve schedule shall NOT include valves furnished under Division 2 or in Plumbing and HVAC sections of Division 15. Valve schedule shall include: valve tag number; valve designation; valve size; end connections and operator type. Valve tag convention shall be four digits long, numbering shall be linked to the P&ID Sheet on which it is shown. Identical valves in same position in parallel processes (EX. Pump inlet/outlet isolation valves where there are three parallel pumps of same type) shall have same tag number followed by a hyphen and quantifier -1, 2, 3 etc. Where electric, hydraulic or pneumatic actuators are supplied their type shall be so noted with an E, H or P. Modulating duty actuators shall be noted with an M following the actuator type notation. An excerpt of an EXAMPLE schedule is as follows:

Valve Tag.	Designation	Size	Ends	Operator	Notes
1000-1	BFV1	8-in	Flanged	Gear/Handwheel	Extra description as necessary
1000-2	BFV1	8-in	Flanged	Gear/Handwheel	
1005	PV1	6-in	Flanged	EM	

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT - GENERAL

- A. Reference is made to Division 1 for additional requirements, including nameplates, provisions for temporary pressure gauges, protection against electrolysis and anchor bolts.
- B. Use of a manufacturer's name and/or model or catalog number is for purpose of establishing standard of quality and general configuration desired.
- C. Valves and appurtenances shall be of size shown on the Drawings or as noted and as far as possible equipment of same type shall be identical and from one manufacturer.
- D. Valves and appurtenances shall have name of maker, nominal size, flow directional arrows, working pressure for which they are designed and standard referenced, cast in raised letters or via riveted stainless steel nameplate upon some appropriate part of the body.
- E. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of same working pressure as pipe they connect to, whichever is higher and suitable for pressures noted where they are installed.
- F. Joints, size and material - unless otherwise noted or required by Engineer:
1. Except where noted, joints referred to herein shall be of same type, nominal diameter, material and with a minimum rating equal to pipe or fittings they are connected to.
 2. Valves and appurtenances shall be of same nominal diameter as pipe or fittings they are connected to.

3. Valves exposed to view, or in vaults:
 - a. Plastic valves in chemical service - solvent cement, or flanged ends.
 - b. Three in. and smaller - threaded ends- unless noted otherwise herein or on Drawings.
 - c. Four in. and larger - flanged ends.
- G. Provide special adaptors as required to ensure compatibility between valves, appurtenances, and adjacent pipe.
- H. No alternative materials will be considered for approval unless complete documentation is provided regarding their satisfactory long-term use in similar conditions; in addition, the consideration of any substitution will be considered only if superiority of proposed materials is the intent of substitution, and only if sufficient evidence is provided to document that superiority.

2.02 VALVE ACTUATORS - GENERAL/ MANUAL

- A. Geared actuators shall be suitable for all weather service, with mechanical shaft seals, shall be permanently greased, or shall have provisions for greasing. Actuators for submerged duty shall be so rated, with certification by manufacturer for submerged service.
- B. Valve manufacturer shall supply, mount, and test all actuators on valves at factory. Valves and their individual actuators shall be shipped as a unit.
- C. Unless otherwise noted on Drawings, valves shall be manually actuated; non-buried valves shall have an operating wheel, handle or lever mounted on operator; those with operating nuts shall have a non-rising stem with an AWWA two-in. nut; At least two tee handles shall be provided for operating nuts. Unless otherwise noted, operation for valves shall be CCW open.
- D. Manually actuated butterfly valves six inches and smaller for fluid service shall have a 10 position, spring retained ratcheting handle. Handle shall be fusion bonded epoxy coated steel or cast iron, hardware, spring and ratcheting plate shall be Type 316 stainless steel. Manually actuated butterfly valves for air service six inches and smaller shall have a memory stop handle with infinite throttling position capability. Memory stop plate and hardware shall be Type 316 stainless steel.
- E. Except as otherwise shown on Drawings or specified herein, valves three-in. diameter or larger, with valve hand wheel center line located seven ft or more above operating floor, shall be provided with chain wheel operators complete with chain guides and hot dipped galvanized steel chain, which loop within four ft of operating floor. These requirements shall supersede positioning lever actuator requirements of manual butterfly valves six-inch and smaller.
- F. Actuators shall be capable of moving valve from full open to full close position and in reverse and holding valve at any position part way between full open or closed.
- G. Each operating device shall have cast on it the word "OPEN" and an arrow indicating direction of operation.
- H. Floor boxes for operating nuts recessed in concrete shall be standard cast iron type, cast-in-place, with fastening top, and Type 316 stainless steel hardware.

- I. Stem guides shall be of the adjustable wall bracket type, bronze bushed, with maximum spacing of 10-ft as manufactured by Clow; Rodney Hunt or equal. Extended operating nuts and/or stems shall have universal joints and pin couplings, if longer than 10-ft and a rating of at least five times the maximum operating torque. Stem adaptors shall be provided.
- J. Where required by installation, or as specified, provide the following: extended stem; floor stand and handwheel; position indicator and etched or cast arrow to show direction of rotation to open the valve; resilient, moisture-resistant seal around stem penetration of slab.
- K. Gear Actuators:
 - 1. Unless otherwise noted, gear actuators shall be provided for the following: plug and ball valves larger than three-in. diameter; butterfly valves larger than six-inch diameter; where specified and/or indicated on Drawings; where manual operator effort is greater than 40 lbs rim pull.
 - 2. Actuators shall be capable of being removed from valve without dismantling the valve or removing valve from the line.
 - 3. Gear actuators for quarter turn valves shall be of worm or helical worm gear type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on output shaft. Where shown on Drawings, a two inch cast iron operating nut shall be provided. Actuators shall conform to AWWA C504 except where more stringent requirements are provided hereinafter. Gearing shall be machine cut steel designed for smooth operation. Bearings shall be permanently lubricated, with bronze bearing bushings provided to take thrusts and mechanical shaft seals to contain lubricants. Housings shall be sealed to exclude moisture and dirt, allow reduction mechanisms to operate in lubricant and be constructed of cast iron, ASTM A 126, Grade B, or of ductile iron, ASTM A 536. Gear housing bodies for thermoplastic valves may be cast aluminum or fabricated steel to reduce weight. Gear actuators shall indicate valve position and have adjustable stops.
 - 4. Where indicated on Drawings, gear actuators for butterfly valves shall be of travelling nut type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on output shaft. Unless noted they shall conform to AWWA C504. Stem shaft shall be machine cut alloy steel, nut and cross head shall be bronze, lever shall be ductile iron. Nut Actuators for valves 24-in and smaller shall be slotted lever design, actuators for valves greater than 24 inch shall be link and lever design. Mechanism shall be lubricated with water resistant extreme pressure NLGI No. 2 grease. Bevel gear reduction box shall be mounted on the actuator when required to meet specified manual operating effort requirements Gear actuators shall have mechanical, external indication of valve position and have adjustable threaded stops secured to the stem with spring pins. Stop shall be capable of withstanding 450-fts-lb of input torque. Stop adjustment requiring shims are not acceptable.
 - 5. Manual Input torque to produce required valve operating torque for worm and travelling nut gear operators shall not exceed 80 ft-lbs. In addition, hand wheel rim pull shall not exceed 20 lbs for valve sizes up to 12 inches, 40 lbs for valve size between 14 and 20 inches, 60 lbs for valve size 24 and greater. Minimum hand wheel size shall be eight inches for up to 12 inch valve size, 12 inches for up to 16 inch valve size, 18 inches for up to 20 inch size.

6. Gear actuators for multi turn valves shall be of bevel or spiral bevel type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on output shaft. Gearing shall be machine cut steel designed for smooth operation. Bearings shall be permanently grease lubricated, with dual anti-friction ball bearings on output shaft and mechanical shaft seals to contain lubricants. Output flange of primary gear reducer shall be designed to meet an appropriate MSS or ISO standard to allow mounting to secondary gear reducer. Ring gear shall ride on ball bearings. Stem nut shall be bronze alloy, shouldered, and ride on needle bearings. Housing components shall be O-ring sealed to exclude moisture and dirt, constructed of cast iron, ASTM A 126, Grade B, or of ductile iron, ASTM A 536. Gear housing bodies for thermoplastic valves may be cast aluminum or fabricated steel to reduce weight. Manual operator input effort to the hand wheel shall be a maximum of 30 lbs for operating the valve from full open to full close, under any conditions. Maximum hand wheel size shall be 24-in diameter.
- L. Additional valve actuator requirements are included with the individual valve types and as noted in Paragraph 1.02 above.
- M. Position indication and direction of opening arrows shall be embossed, stamped, engraved, etched, or raised castings. Decals or painted indications shall not be allowed.
- N. Unless otherwise noted, valves larger than three-in. nominal diameter shall be provided with position indicators at the point of operation.

2.03 VALVE ACTUATORS - POWERED

A. General:

1. Electric actuators for 1/4 turn valves three inches and under, which do not have submergence requirements, and which exhibit a maximum torque specified below shall be operated on 120 volt single phase power as specified below. Other actuators shall be operated on 480 volt power.
2. Actuators shall conform to AWWA Standard C540, insofar as applicable and as herein specified. Actuators shall be O-ring sealed, watertight to standard NEMA 4X/6, submersion to six feet for 30 minutes. Actuators installed in vaults below grade and elsewhere subject to submergence shall be watertight to standard NEMA 6P/IP68, 15 ft for 72 hours minimum. Actuators installed in hazardous locations as noted on the Electrical Drawings and/or area classification sheets of the Architectural Drawings shall be FM certified explosion proof for Class 1 Division 1 & 2, Groups C & D and also meet the standard NEMA 4X/6 rating.
3. Valve service/operation shall be as indicated on the P&IDs and as specified in the Process Control Strategies in Section 13305.
4. 480 Volt powered actuators shall be Rotork IQ/IQM; Limitorque MX; EIM TEK 2000; AUMA SA/SAR. Actuators shall be configured as required to provide for part turn or multi-turn and be coupled with gearboxes as required to obtain the speed and operating torque as required for the valve or gate it controls.

5. Modulating actuators shall contain proportional control unit and be capable of 1200 starts per hour, open-closed valve actuators shall not require a proportional control unit, and be capable of 60 starts per hour.
 6. Where shown on Instrumentation Drawings, actuators shall have a digital control module, to allow valves or gates to be positioned remotely via a two-wire non-proprietary field bus protocol. Digital control module shall be equipped with serial communication ports to allow actuation to be linked by a two wire local area network utilizing Modbus function code (report by exception) and arranged in a self-healing ring configuration, with multi-drop taps to each actuator.
- B. 480 Volt Powered Actuators for Part Turn or Multi-Turn Valve Operation:
1. Operation:
 - a. Capabilities shall be provided to position valve (or gate) locally via Local/Off/Remote selector switch and Open/Stop/Close push buttons.
 - b. For on/off service, when in remote, actuator shall accept one remote signal to open valve or gate and a second remote signal to close valve or gate.
 - c. For modulating service, when in remote actuator shall accept a 4-20mADC position control signal, and shall position valve 0-90 degrees or gate 0-100% of travel in proportion to control signal.
 - d. Unless stated otherwise in valve specifications, actuator and gearing size shall be designed to operate valve at a disc speed of one foot travel per minute of operation. For quarter turn valves, valves shall rotate from stop to stop in 30 seconds per foot of throat diameter.
 2. Functional:
 - a. Motor operated valve controller shall include motor, operator unit gearing, limit switch gearing, limit switches, control power transformer, position transmitter (when required), torque switches, bored and key-wayed drive sleeve for non-rising stem valves, declutch lever and auxiliary handwheel as a self-contained unit. Valve contacts shall be capable of handling the current equivalent of a NEMA 1 size starter.
 - b. Reversing starters shall be integral with actuator, and shall be solid-state starters for modulating service. Electro-mechanical reversing starters shall be acceptable for open-close service and shall be mechanically and electrically interlocked.
 - c. Limit switches and gearing shall be an integral part of valve control. Limit switch gearing shall be made of bronze or stainless steel and shall be fully lubricated, intermittent type and totally enclosed to prevent dirt and foreign matter from entering gear train. Limit switches shall be of adjustable type capable of being adjusted to trip at any point between fully opened valve and fully closed valve. Limit and torque switches shall be provided for stopping valve in both directions. Mid-travel switches shall be provided as required. Set position shall not be lost if over travel occurs in either manual or electric modes of operation.
 - d. Valve position transmitter shall be a gear actuated, two-wire device, producing 4-20 mADC signal proportional to 0-90 degree valve position or to 0-100% of valve travel. Transmitter shall be provided with easily accessible zero and span adjustment potentiometers. Valve actuator shall be provided with a local digital or mechanical indicator integral with operator with a 0-100 percent scale. DC power supply shall be provided integral with operator and powered from 110 volt AC internal transformer.

Positioner board shall provide repeatable accuracy to 0.25% of span. There shall be separate trim pots on positioner board for zero, span and dead band adjustment.

- e. Speed of actuator shall be responsibility of system supplier with regards to hydraulic requirements and response compatibility with other components within control loop. Each valve controller shall be provided with a minimum of two limit switch functions, one for opening and one for closing. Each limit switch will have two normally open and two normally closed contacts. Gear limit switches shall be geared to driving mechanism and in step at all times whether in motor or manual operation. Provision shall be made for two extra sets of limit switches as described above, each to have two normally open and two normally closed contacts. Each valve controller shall be equipped with a double torque switch. Torque switch shall be adjustable and responsive to load encountered in either direction of travel. Limit and torque switch contacts shall be silver inlay type.
 - f. Each actuator shall include monitor relays to remotely indicate fault signal for indication of power failure, phase failure, thermal switch tripped, torque switch tripped between travel stops and Local-Off-Remote selector switch position.
3. Physical:
- a. Operator shall be equipped with open-stop-close push-buttons, a local-off-remote selector switch and indicating lights mounted on operator. Where operator will not be situated between two-ft-0-in and seven-ft-0-in above operator platform, and where shown on Drawings provide a separate remote valve operating station.
 - b. Motor shall operate on 460 volt, 60 hertz, three phase power and shall be sized by actuator manufacturer to provide the required output torque for service intended. Motor shall have Class F insulation, with a duty rating of at least 15 minutes at 40 degrees C ambient temperature. Motor shall be specifically designed and built by actuator manufacturer for electric actuator service. Commercially available motors shall not be acceptable. Actuator shall include a device to ensure that motor runs with correct rotation for required direction of valve travel regardless of connection sequence of the power supply.
 - c. Operators utilizing multiple reduction power gearing shall consist of spur, helical, or bevel gearing and worm of hardened alloy steel, and the worm gear shall be alloy bronze. Operators utilizing single-stage reduction shall be single-stage worm gear totally enclosed in a fully lubricated gearcase, with filling and drain plugs. Non-metallic, aluminum, or cast gearing shall not be allowed. Output shaft shall incorporate thrust bearings of the ball or roller type at the base of the actuator.
 - d. An operating wheel shall be provided for manual and/or emergency operation, engaged when motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. Operating wheel drive shall be mechanically independent of motor drive, and any gearing shall be such as to permit emergency manual operation, using a 40-pound force in a reasonable time. Clockwise operation of handwheel shall give closing movement of valve unless otherwise stated.
 - e. Each actuator shall be supplied with a start-up kit including installation instructions, wiring diagrams, and spare cover screws and seals to provide for losses during commissioning.
 - f. Continuous mechanical dial indication of valve and position shall be provided. Mechanical dial position indicator shall be in step with actuator at all times in both hand wheel and motor operation. For modulating applications, mechanical dial position indicator shall include graduations of 0-100 percent scale.

4. Wiring and Terminals:

- a. Internal wiring shall be of tropical grade PVC insulated stranded cable of five amp minimum rating for control circuits and of appropriate size for the motor three phase power. Each wire shall be clearly identified at each end.
- b. Terminals shall be of stud type embedded in a terminal block of high tracking-resistance compound. The three-phase power terminals shall be shrouded from control terminals by means of an insulating cover.
- c. Terminal compartment shall be separated from inner electrical components of actuator by means of a watertight seal. Terminal compartment of actuator shall be provided with three threaded cable entries.
- d. Each actuator shall be provided with a commissioning kit consisting of a wiring diagram and installation and operation manual. A separate wiring diagram shall be provided inside the terminal cover. No special tools, devices or parts shall be required for commissioning.
- e. Actuators shall have separately sealed motor and control compartments. Operators shall have space heaters in their limit switch, motor, and control compartments.

5. Performance Test:

- a. Each actuator shall be shop performance tested, and individual test certificates shall be supplied without additional charge to the District. Test certificates shall be submitted prior to shipment of valve actuators. Test equipment shall simulate a typical valve load, and the following parameters shall be recorded:
 - 1) No load current.
 - 2) Current at maximum torque setting.
 - 3) Stall current.
 - 4) Torque at maximum torque setting.
 - 5) Stall torque.
 - 6) Test voltage and frequency.
 - 7) Flash test voltage.
 - 8) Actuator output speed.

2.04 BUTTERFLY VALVES

- A. Butterfly valves and operators up to 72-in diameter shall conform to AWWA C504, Class B, except as specified herein. Manufacturer shall submit an affidavit of compliance stating that valves have been manufactured and tested in accordance with AWWA C504 and specifically listing all exceptions. Valves shall have a minimum 150 psi pressure rating or higher as noted on Drawings or in this Section and be manufactured by M&H; Dezurik; Val-Matic; Henry Pratt; or equal.
- B. Butterfly valves for above grade service shall be flanged end with face to face dimensions in accordance with Table 2 of AWWA C504 for short-body valve. Valves for dead end shut off service shall be flanged type.
- C. Valve seats shall be full resilient seats retained in body or on disc edge in accordance with AWWA C504. Valve discs shall be constructed of cast iron, ASTM A 48, Class 40; Ni-resist, ASTM A 436, Type 1; or ductile iron, ASTM A 536, Grade 65-45-12.

1. When resilient seats are attached to body, discs shall have Type 316 stainless steel seating edges. When resilient seat is attached to disc, it shall be fastened with a one piece Type 316 stainless steel retaining ring, Type 316 stainless steel Nylock set screws and a mating Type 316 stainless steel ring shall be installed in valve body. Resilient seats shall be EPDM. Seats shall be fully adjustable and replaceable with valves in place using no special tools.
- D. Valve body shall be constructed of close grain cast iron per ASTM A 126, Class B with integrally cast hubs for shaft bearing housings of through boss-type. Permanently self-lubricating body bushings shall be provided and shall be sized to withstand bearing loads. Stuffing box of liberal dimensions shall be provided at operator end of vane shaft.
1. Packing shall be of self-compensating V-type. A sealing element utilizing O-rings shall also be acceptable for up to and including 24-in valves. Over 24-in, pull down seals using a square braid of graphite fiber is an acceptable alternate.
 2. Packing shall be held in place by a bolted corrosion resistant retainer plate or gland; retainer clips are not acceptable. Valves 30-in or larger shall use a stuffing box with follower gland.
 3. Replacement of seals, for all size butterfly valves, shall not require removal of valve from the line. In addition adjustment or replacement of seals on valves of 30-in or larger shall not require disturbing any part of valve or operator assembly, except any packing follower gland.
- E. Valve shaft shall be of Type 316 stainless steel and designed for both torsional and shearing stresses when valve is operated under its greatest dynamic or seating torque. No reductions of shaft diameter will be allowed except at operator connection. Any reduction shall have a full radius fillet.
- F. Butterfly valve actuator shall conform to requirements of AWWA C504, insofar as applicable and as specified herein. Gearing for actuators where required shall be totally enclosed in a gear case in accordance with AWWA C504. Actuators shall have permanent indicators with raised or engraved marks to show position of valve disc.

2.05

2.05 PLUG VALVES

- A. Plug valves shall be of offset disc type, 1/4 turn, non-lubricated, serviceable (able to be repacked) under full line pressure and capable of sealing in both directions at rated pressure. Disc shall be completely out of flow path when open. Plug valves specified herein shall be manufactured by DeZurik; M&H Valve; or approved equal. Manufacturers named or otherwise, shall comply completely with this Section.
1. Minimum port area shall be 80 percent when measured by percent cross-sectional area of equivalent size (nominal same diameter) pipe.
 2. Plug valves shall be capable of passing "pigging" cleaning equipment (using a Girard or similar cleaning pig of full nominal pipeline diameter) in either direction and manufacturer shall so certify that this may be done without use of special equipment.

- B. Valves shall be rated at minimum 175 psi WOG (Water, Oil and Gas) working pressure for sizes four-in. to 12-in. inclusive and at minimum 150 psi WOG working pressure for sizes 14-in. and larger and shall be capable of providing drop tight shut-off to full valve rating with pressure on either side of plug.
 - 1. Plug valves under this Paragraph shall be performance, leakage and hydrostatically tested in accordance with AWWA C517, except as modified herein.
 - 2. At above rated minimum working pressures, valves shall be certified by manufacturer as permitting zero leakage for a five-minute duration with full pressure applied in either direction.
 - 3. At direction of Engineer, valve manufacturer may be requested to perform a valve seat leakage test, witnessed by Engineer to prove compliance with this Section.
- C. Valve bodies shall be of cast iron, 30,000 psi tensile strength, ASTM A 126, Grade B, or of ductile iron, ASTM A 536 and of top entry, bolted bonnet design, cast with integral flanges conforming to connecting piping. Exposed bolts, nuts, and washers shall be zinc or cadmium-plated, except for submerged valves, which shall have Type 316 stainless steel hardware.
 - 1. Valve bodies shall be glass lined for plug valves installed in glass lined ductile iron pipelines. Glass lining shall be as specified in piping specification.
- D. Valve Plug:
 - 1. Shall be Buna N coated, cast iron ASTM A 126, Grade B, or ductile iron, ASTM A 536, Grade 65-45-12.
 - 2. Shall be removable without removing valve from the line.
 - 3. Shall have an integral upper and lower shaft which shall have seals on upper and lower journals to prevent entrance of solids into journals.
 - 4. Shall be one piece for all valves.
- E. Shaft bearings shall be permanently lubricated stainless steel or bronze at both upper and lower stem journals. Operator shaft shall have easily replaceable seals, which shall be externally adjustable and repackable without removing bonnet from valve, or shall have self-adjusting packing.
- F. Valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on plug mating with welded-in high nickel content overlay seating surface in body.
 - 1. Seating design shall be resilient and of continuous interface type having consistent opening and closing torques and shall be non-jamming in closed position. Screw-in seats shall not be acceptable.
 - 2. Plugs shall have a full resilient facing of neoprene or Buna-N.

- G. Valves 6 inch and larger shall be actuated via gearbox and hand wheel, unless mechanized, which shall require gearbox and actuator. A suitably sized steel actuator mounting bracket shall be provided to provide an air gap between actuator and valve stem seal. Under no circumstance shall gear box be mounted directly to top body flange such that leakage could directly enter gear box.
- H. Unless otherwise required due to location or mechanized operation, each valve four-in. and smaller shall be provided with its own securely attached lever. Provide adjustable limit stops for both opening and closing and a clearly marked position indicator.
- I. Plug valves shall be installed so that direction of flow through valve and shaft orientation is in accordance with manufacturer's recommendations. Unless otherwise noted, shaft shall be horizontal, with plug opening up.

2.06 RESILIENT WEDGE GATE VALVES

- A. Resilient wedge gate valves shall comply with AWWA C509. Body shall be ductile iron and shall have mechanical joint ends in compliance with AWWA C111. Valve body shall be rated for 250 psi. Bonnet and gland bolts and nuts shall be Type 316 stainless steel. The hot-dip process in accordance with ASTM A153 is not acceptable. Allen-wrench type bonnet and gland fastening shall not be acceptable and will be rejected. Wedges shall be ductile iron and totally encapsulated in nitrile rubber (four-inch–12-inch size) or SBR rubber (14-inch–24-inch size).
- B. Stem:
 - 1. Non-rising.
 - 2. Material: Bronze.
 - 3. Triple O-ring stem seals.
 - 4. Two upper O-ring seals shall be replaceable while valve is in service without significant leakage.
 - 5. Thrust collars and stems shall integrally cast.
- C. Operation:
 - 1. 2-inch square operating nut with direction of opening indicated.
 - 2. Open counterclockwise unless otherwise indicated.
- D. Linings and Coatings – See Paragraph 2.1.
- E. Units shall be, in addition, UL and FM approved.
- F. Manufacturers: Mueller, Clow, or equal.
- G. All gate and valves shall be provided with extension shafts, operating nuts and valve boxes as follows:

1. Extension shafts shall be Type 304 stainless steel and the operating nut shall be two-in. square. Shafts shall be designed to provide a factor of safety of not less than four. Operating nuts shall be pinned to the shafts.
2. Top of the operating nut shall be located two inches below the rim of the valve box.
3. Valve boxes shall be a heavy-pattern cast iron, three-piece, telescoping type box with dome base suitable for installation on the buried valves. Inside diameter shall be at least 4-1/2-in. Barrel length shall be adapted to the depth of cover, with a lap of at least six-in. when in the most extended position. Covers shall be cast iron with integrally-cast direction-to-open arrow, and the word ["WATER"] shall also be integrally cast. Aluminum or plastic are not acceptable. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box.
4. The upper section of each box shall have a top flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.
5. All fasteners shall be Type 316 stainless steel.

2.07 CHECK VALVES

A. Rubber Flapper Check Valves

1. Body shall be ductile iron, ASTM A 536 Gr 65 Ductile iron, 125/150 lb flanged suitable for 200 psi test pressure. Body shall be fusion bonded epoxy coated. Disc shall be Nylon reinforced EPDM encapsulated steel. Valve body and open disc shall provide full flow at least equal to nominal pipe diameter. Seating surface shall be on a 45-degree angle. Top access port shall be full size, allowing disc removal without removing valve body from pipeline. Disc shall be one piece construction, precision molded with and integral O-ring sealing surface and contain steel and nylon reinforcements in both the flex and central disc areas.
 - a. Valve shall be equipped with a field adjustable 316 stainless steel disc accelerator or spring assist/spring return to speed the closure of the disc. Screws shall be Type 316 stainless steel.
 - b. Valve shall be drilled and tapped for installation of a screw rising stem type backflow actuator for purposes of back flushing. Backflow actuator shall be 17-4 Stainless Steel, lead free bronze bushing and Buna-N seal.
 - c. A pre-wired limit switch shall be provided to indicate open/closed position at the PLC/OIT. The mechanical indicator shall activate the mechanical type limit switch. The switch shall be rated for NEMA 6P and shall have U.L. rated 5 amp, 125 VAC contacts.
2. Rubber flapper check valves shall be as manufactured by Surgebuster Series 7200 by Val-Matic, Figure SB200D by Golden Anderson, RF-ASR Series by Crispin, or equal.

2.08 SOLENOID VALVES

- A. Solenoid valves shall be packless piston type direct acting for sizes less than one-in. and internal pilot operated for sizes one-in and larger, two-way or three-way, valves and shall be ASCO

Valve; Red Hat by Automatic Switch Co., similar by Circle Seal Controls-Atkomatic Valve Co. or equal for air and water service.

- B. Valves shall be energized to open, except for valves on water seal lines to pumps which shall be energize to close.
- C. Valves shall have forged brass bodies, NPT end connections of connected piping Type 304 stainless steel internal parts, and Buna-N or Ethylene Propylene valve seats. Valves shall have a minimum 150 psig safe working pressure and zero minimum operating pressure differential. Connections shall be threaded.
- D. Solenoid valves size two-inch and larger shall be full bore bronze body, Type 430 stainless steel plunger, copper coil class A encapsulated, Type 302 stainless steel spring, wash-down safe, equal to type A as manufactured by Magnatrol Valve Corp., Hawthorne, NJ or equal. Solenoid valves shall have a manual override actuated by a handle levered plunger mounted on bottom of valve body. These valves shall be mounted in a horizontal run of piping, with solenoid up in vertical position.
- E. Note that solenoid valves may be shown on Electrical and/or Mechanical Drawings, or may only be specified, but if so specified or shown, shall be provided. Solenoid valves located in hazardous classified areas shall be provided with electrical enclosures which satisfy electrical classification as specified or shown on Electrical Drawings.

2.09 AIR RELEASE AND VACUUM RELIEF VALVES: TAG TYPE NOTED BELOW

- A. Pipeline air and vacuum valves shall be supplied with shutoff gate or ball valves with operator handle or lever removed. Valves shall be properly vented and piped to drain.
- B. Valve pressure rating shall be at least equal to attached pipe's rating and suitable for 200 psi test pressure.
- C. Valves for raw water/sewage service shall have connections for draining and flushing with isolation ball valves for connection size up to three inch, and solid wedge gate valves for size four inch and larger.
- D. Air Release Valves: Tag Type ARV.
 - 1. Small orifice assembly air release valves shall automatically release air accumulations from pipe while under positive pressure. When valve body fills with air, float mechanism shall fall to open small orifice and exhaust air to atmosphere. When air has been exhausted, float mechanism shall be buoyed up and shall tightly close small orifice. Small orifice assembly shall be furnished with Type 304 stainless steel body and cover, and shall use Type 316 stainless steel hardware. Float mechanism shall be constructed of polypropylene or Type 316 stainless steel. Wetted components shall be polypropylene, Buna-N or Type 316 stainless steel. A resilient, Buna-N seat shall provide drop-tight closure.
 - 2. Separate air release valves shall be, equal as manufactured by APCO 450; Val-Matic; GA; Crispin or equal of the special type for use with non-clean water.

E. Vacuum Breaker Valves: Tag Type VB.

1. Location and sizes of vacuum breaker valves shall be as shown on the Drawings at the pump stations after the discharge check valve and suitable for 200 psi test pressure.
2. This valve is a combination of a vacuum breaker/relief valve and a combination air valve applicable for non-clean water/raw water. The large orifice vacuum valve assembly shall be normally closed and shall automatically open to allow large amounts of air when the pressure falls below atmospheric pressure. The combination valve shall be as specified below.
3. The large orifice assembly shall be furnished with a body of cast iron ASTM A126 Grade B or cast ductile iron ASTM A536 Grade 65. The disc and seat ring material shall be suitable for the intended purpose, test pressure and working pressure rating. The disc shall be rubber faced (Buna N or better). The air inlet shall be protected by a SST 304 screen and steel hood. Opening vacuum pressure setting shall be adjustable by the amount and position of the counter weight. Valves shall have bolted inlets and threaded or plain outlets and protective hoods.
4. Valve shall be or equal by Apco model 1500T, Crispin VR, Val-Matic, Golden Anderson, or equal of the special type for use with non-clean water.

F. Combination Air Valves: Tag Type CAV.

1. Location and sizes of combination vacuum breaker valves shall be as shown on the Drawings at the pump stations between the discharge check valve and isolation valve and suitable for 200 psi test pressure. This valve is a dual body combination of a vacuum breaker/relief valve and a combination air valve applicable for non-clean water. The vacuum breaker valve shall be as specified above.
2. Valves shall be designed to release large amounts of air during pipeline filling, release small amounts of air accumulated during pipeline operation, and allow large volume of air during pipeline drainage or pipe break. The air outlet shall be throttled with a double acting throttling device. Valve shall have an intake orifice area equal to nominal size of valve. Provide back flushing accessories
3. Valves shall be rated for 200 psi service.
4. The air-vacuum valves shall be combination air valves and shall be Apco 440 SCAV with DAT (Double Acting Throttling Device) set to five percent open with a locking nut, or equal by Crispin VR, Val-Matic, Golden Anderson, of the special type for use with non-clean water.

G. Air and Vacuum Valves: Tag Type AAV

1. Location of air-vacuum/air release valves shall be as shown on the Drawings at the pump stations between the pump and discharge check valve and for non-clean water use.
2. Air-vacuum valves shall allow unrestricted venting or re-entry of air through it and be designed to allow large quantities of air to escape out the orifice to prevent vacuum.

3. The valve shall consist of a body, cover, baffle and Buna-N seat. The seat shall be fastened into the valve cover, without distortion and shall be easily removed, if necessary. The valve shall consist of a body of cast iron ASTM A126 Grade B or Ductile Iron ASTM A536 Grade 65. The AVV shall incorporate two stainless steel floats directly connected by a stainless steel stem, to maintain an air gap between the bottom concave float and the top shut-off float. The air gap shall retard waste solids from fouling or clogging the top shut off float. The baffle shall retain the Buna-N seat in place without distortion for tight shut-off. Provide back flushing accessories.
4. The float shall be ASTM A240 stainless steel, designed to withstand a minimum of 500 psi. The float shall be center guided and not free floating for positive seating.
5. The manufacturer of the valve shall confirm in writing that unit is suitable for type and size of pump, as shown on Drawings and as specified herein. Diameters reflected on the drawings are listed for reference only. Valve shall be supplied and diameter determined by pump manufacturer.
6. Units shall be by; or equal as manufactured by APCO model 401; Crispin AL, Valmatic, or Golden Anderson of the special type for use with non-clean water.

2.10 SURGE RELIEF VALVE TAG TYPE SRV

- A. Surge relief valves shall be spring-type angle surge relief valves APCO Series 3000A, or equal. Flanged connections shall be ASME 125/150 lb inlet and outlet. Body shall be ductile iron ASTM A546 Grade 65. Disc material shall be 316 stainless steel. Body seat shall be 316 stainless steel. Disc seat shall be EPDM. Bolting shall be 316 stainless steel.
- B. Relief pressure setting shall be field adjustable and set to 150 psi. Valves must have a maximum working pressure plus surge of 200 psi.

2.11 SURFACE PREPARATION AND SHOP COATINGS

- A. Notwithstanding any of these specified requirements, coatings and lubricants in contact with potable water shall be certified as acceptable for use with that fluid.
- B. If not specified herein, coatings shall comply with the requirements of Section 09901 and 09902. In case of a conflict, requirements of this Section govern.
- C. If manufacturer's requirement is not to require finished coating on interior surfaces, then manufacturer shall so state and no interior finish coating will be required, if acceptable to Engineer.
- D. Exterior surface of various parts of valves, operators, floor-stands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with instructions of paint manufacturer or other primer compatible with finish coat provided.
- E. Unless otherwise noted, interior ferrous surfaces of valves shall be given a shop finish of an asphalt varnish conforming to AWWA C509, (except mounting faces/surfaces) or epoxy conforming to AWWA C550 with a minimum thickness of 6 mils.

- F. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating. Mounting surfaces shall be especially coated with a rust preventative.
- G. Special care shall be taken to protect uncoated items and plastic items, especially from environmental damage.

2.12 FACTORY INSPECTION AND TESTING

- A. Factory inspection, testing and correction of deficiencies shall be done in accordance with the referenced standards and as noted herein.
- B. See Division 1 for additional requirements. Also refer to PART 1, especially for required submission of test data to Engineer.
- C. In addition to tests required by referenced standards, the following shall also be factory tested:
 - 1. Pressure regulating valves shall be factory tested at specified pressures and flows.
 - 2. Butterfly valves shall be factory tested to demonstrate drop tight closure at specified conditions.
 - 3. All types of air and vacuum valves.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Valves and appurtenances shall be installed per manufacturer's instructions in locations shown, true to alignment and rigidly supported. Damage to above items shall be repaired to satisfaction of Engineer before they are installed.
- B. Install brackets, extension rods, guides, various types of operators and appurtenances as shown on Drawings, or otherwise required. Before setting these items, check Drawings and figures which have a direct bearing on their location. Contractor shall be responsible for proper location of valves and appurtenances during construction of the work.
- C. Materials shall be carefully inspected for defects in construction and materials. Debris and foreign material shall be cleaned out of openings, etc. Valve flange covers shall remain in place until connected piping is in place. Operating mechanisms shall be operated to check their proper functioning and nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to District.
- D. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified, and Contractor shall certify such. Also note additional requirements in other parts of this Section.
- E. Unless otherwise noted, joints for valves and appurtenances shall be made up utilizing same procedures as specified under applicable type connecting pipe joint and valves and other items

shall be installed in proper position as recommended by manufacturer. Contractor shall be responsible for verifying manufacturers' torquing requirements for all valves.

3.02 INSTALLATION OF MANUAL OPERATIONAL DEVICES

- A. Unless otherwise noted, operational devices shall be installed with units of factory, as shown on Drawings or as acceptable to Engineer to allow accessibility to operate and maintain item and to prevent interference with other piping, valves, and appurtenances.
- B. For manually operated valves three-in. in diameter and smaller, valve operators and indicators shall be rotated to display toward normal operation locations.
- C. Floor boxes, valve boxes, extension stems and low floor stands shall be installed vertically centered over operating nut, with couplings as required and elevation of box top shall be adjusted to conform to elevation of finished floor surface or grade at completion of Contract. Boxes and stem guides shall be adequately supported during concrete placement to maintain vertical alignment.

3.03 INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

- A. See also Division 1. Take care not to over pressure valves or appurtenances during pipe testing. If unit proves to be defective, it shall be replaced or repaired to satisfaction of Engineer.
- B. Functional Test: Prior to plant startup, items shall be inspected for proper alignment, quiet operation, proper connection and satisfactory performance. After installation, manual valves shall be opened and closed in presence of Engineer to show valve operates smoothly from full open to full close and without leakage. Valves equipped with electric, pneumatic or hydraulic actuators shall be cycled five times from full open to full closed in presence of Engineer without vibration, jamming, leakage, or overheating. Pressure control and pressure relief valves shall be operated in presence of Engineer to show they perform their specified function at some time prior to placing piping system in operation and as agreed during construction coordination meetings
- C. Various pipe lines in which valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed, and replaced, or otherwise made acceptable to Engineer.
- D. Various regulating valves, strainers, or other appurtenances shall be tested to demonstrate their conformance with specified operational capabilities and deficiencies shall be corrected or device replaced or otherwise made acceptable to Engineer.

3.04 CLEANING

- A. Items including valve interiors shall be inspected before line closure, for presence of debris. At option of Engineer, internal inspection of valve and appurtenances may be required any time that likelihood of debris is a possibility. Pipes and valves shall be cleaned prior to installation, testing disinfection and final acceptance.

END OF SECTION

SECTION 15120
PIPING SPECIALTIES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete test, and make ready for operation all piping specialties required by the work of this Contract. Specific piping materials, systems and related installation and testing requirements shall be coordinated with the related sections in Divisions 2, 13 and 15. The items shall include the following:

1. Mechanical Sleeve Seals.
2. Pressure Gauges.
3. Diaphragm Seals for Gauges.
4. Color Coding and Labeling.

1.02 RELATED WORK

- A. Piping materials and systems are included in other Sections of Division 15.
- B. Specialties and apparatus furnished with equipment and systems are included in individual Sections in Divisions 11.
- C. Valves are included in Section 15100.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, general submittals for piping, piping systems and pipeline appurtenances are listed below. It is not intended that all submittals listed below be provided for all piping materials and systems. Refer to individual System or Piping Sections for specific submittals.
- B. Shop Drawings and Product Data:
1. Large scale details of wall penetrations..
 2. Catalog cuts of specialties, appurtenances, and other accessories specified herein.
 3. Brochures and technical data on coatings and linings and proposed method for application and repair.
- C. Samples.
- D. Design Data.
- E. Test Reports.

F. Manufacturers Installation (or application) instructions.

G. Warranties.

1.04 REFERENCE STANDARDS

A. ASTM International (ASTM):

1. ASTM A36 - Standard Specification for Carbon Structural Steel.
2. ASTM A126 - Standard Specification for Gray Iron Casting for Valves, Flanges and Pipe Fittings.
3. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
4. ASTM A278 - Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 Degrees F.
5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
6. ASTM A325 - Standard Specification for Strength Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
7. ASTM A536 - Standard Specification for Ductile Iron Castings.
8. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
9. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

B. American National Standards Institute (ANSI)

1. ANSI A13.1 - Scheme for the Identification of Piping Systems.
2. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
3. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.
4. ANSI B31 - Code for Pressure Piping.
5. ANSI B31.1 - Power Piping.

C. American Society of Mechanical Engineers (ASME):

1. ASME B2.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
2. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
3. ASME B16.5 - Pipe Flanges and Flange Fittings.

D. American Welding Society (AWS):

1. AWS B3.0 - Welding Procedure and Performance Qualifications.

E. American Water Works Association (AWWA):

1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in Through 48-in (75mm Through 1200mm), for Water and Other Liquids.
2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe.
4. AWWA C606 - Grooved and Shouldered Joints.
5. AWWA Manual M11 - Steel Pipe - A Guide for Design and Installation.

F. Plumbing and Drainage Institute (PDI):

1. WH 201 - Water Hammer Arrestors.

G. Underwriters Laboratories (UL).

H. Factory Mutual (FM).

I. 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 materials shall be new and unused.
- B. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified.
- C. Reject materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner and acid solder.
- D. Unless otherwise specified, pressures referred to in all piping specifications sections are expressed in pounds per square inch, gauge above atmospheric pressure, psig and all temperature are expressed in degrees Fahrenheit (F).

1.06 DELIVERY, STORAGE AND HANDLING

- A. During loading, transportation and unloading, take care to prevent damage to products furnished under this section.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Equipment shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.
- B. Equipment shall have the name of the maker, nominal size, flow directional arrows (if applicable), working pressure for which they are designed and standard referenced specifications cast in raised letters or indelibly marked upon some appropriate part of the body.
- C. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.
- D. All the piping system components shall be suitable to withstand the rated system pressure. The rated pressure shall be not less than the operating pressure and the test pressure of the piping system in which it is installed.

2.02 MECHANICAL SLEEVE SEALS

- A. Mechanical sleeve seals shall be used to secure and seal the annular space around all new sleeved and core-drilled wall penetrations.
- B. A single seal shall be provided for all sleeve and cores in walls up to 14-in thick; dual sleeves shall be provided in larger walls.
- C. Galvanized steel wall sleeves and concrete core diameter shall be sized sufficiently larger to accommodate the modular elements, per the manufacturer's recommendations.
- D. Bolts and hardware shall be carbon steel, zinc-plated. Pressure plates shall be corrosion-resistant acetal resin.
- E. Mechanical sleeve seals shall consist of modular bolted, synthetic rubber sealing elements, Link Seal by Thunderline Corp., Pipesal by Flexicraft Industries or equal.

2.03 PRESSURE GAUGES

- A. Bosses, connections, or nipples for gauges shall be provided as acceptable to the Engineer. Unbossed tappings shall not be acceptable. Where gauge tappings are not available in the suction or discharge nozzle, the necessary tapping in the adjacent piping shall be made.

- B. In addition to the locations shown on the Drawings, pressure gauges shall be furnished and installed on the upstream and downstream sides of pressure reducing stations and in the suction and discharge nozzle of all pumps, compressors and similar equipment. Additional pressure gauges shall be furnished and installed as specified with individual equipment.
- C. Gauges shall be furnished as part of a complete factory assembly, including gauge, snubber, liquid fill, bar stock ball valve isolation valve and threaded red brass connecting piping.
- D. Unless otherwise noted, gauge rating shall be from 0 to at least 2.5 percent higher than the rating of the pipe it is connected to.
- E. For Liquid Service:
 - 1. Pressure gauges shall have a 300 series stainless steel/ABS or FRP/Aluminum case and shall be 4-1/2-in nominal diameter with a full-sized Type 316 stainless steel Bourdon tube and a 300 series stainless steel movement. The gauges shall be liquid filled with glycerin and shall be provided with a filler/breather cap. The socket shall be 1/4-in NPT Type 316 stainless steel with a bottom connection and the dial shall be a white background with black markings. Gauges shall be ANSI Grade A plus or minus one percent of scale and shall have a blow-out back design.
 - 2. Gauges for the above services shall be liquid filled as manufactured by U.S. Gauge; Ashcroft; Terrice or equal.
- F. Air Service:
 - 1. Unless otherwise noted, pressure gauges for pressure air pipelines shall have a range of 0 to 200 psig.
 - 2. Pressure gauges shall have a 300 series stainless steel/aluminum case and shall be 4-1/2-in nominal diameter with a Type 316 stainless steel Bourdon tube and a 300 series stainless steel movement. The socket shall be 1/2-in NPT Type 316 stainless steel with a bottom connection. Gauges shall have an accuracy of at least plus or minus 0.25 percent of scale. Gauges shall be furnished with needle valve isolation.
 - 3. Gauges for air service shall be Model 5840 as manufactured by Marsh Instrument Co., Skokie, IL or equal.
- G. Gauges shall be furnished from standard ranges of the manufacturer, with dual range (ft and psi) scales, per the following schedule:

2.04 DIAPHRAGM SEALS FOR GAUGES

- A. Diaphragm seals shall be installed for all pressure gauges and pressure switches, to protect pressure gauges and pressure switches from contact with the fluid in the pipeline. Gauges shall be furnished as part of a complete factory assembly, including gauge, snubber, diaphragm seal, liquid fill, bar stock isolation valve and threaded red brass interconnecting piping. Furnish also a 1/4-in backflushing connection and ball valve.

- B. Diaphragm seals shall be minimum 2-1/2-in diameter, or as required for the connected pressure gauges. The diaphragm shall be "thread attached" to both piping and pressure switches or gauges. Furnish mineral oil fill between the diaphragm seal and the gauge.
1. Diaphragm seals shall have an upper housing of cadmium plated carbon steel, with the lower housing of Type 316 stainless steel with Type 304 stainless steel bolts. Diaphragms shall be Teflon.
 2. Each diaphragm seal shall be connected to its respective piping or equipment with threaded red brass pipe and fittings. Pipe size and diaphragm tap size shall match the size of the gauge tap on the equipment, but shall not be less than 3/4-in, except for connections to plant water piping which shall be minimum 1/2-in. Furnish a ball valve shut-off valve between the pipeline or equipment and the diaphragm seal.
 3. Each diaphragm seal shall have a minimum 1/4-in NPT flush connection with ball valve and gauge tap to match the size of the gauge.
 4. Furnish pulsation dampeners adequate to prevent pulsation and/or vibration of the gauge indicator under all system operating conditions.
 5. Pump gauges shall connect to the diaphragm seal by a flexible Type 304 stainless steel capillary tube. Gauges shall be mounted on a support stand independent of the pump and piping, to minimize vibration of the gauges caused by vibration of the equipment or piping. Mount both the suction and discharge gauges at the same elevation. Furnish supports as specified in Section 15140, or attach gauges to the seal water assembly support (where applicable).
 6. Diaphragm seals shall be Type SG by Mansfield and Green; Ashcroft or equal.
- C. Where installed on chlorine lines, or lines leading to chlorine ejectors, seals shall be special chlorine-resistant type. All other materials shall be certified corrosion resistant for seal location and fluid.

2.05 COLOR CODING AND LABELING

- A. General:
1. Provide a complete color coding system consisting of preprinted labels and banding by Brady; Seton or equal. Field painting shall be specified in Section 09902. Painting and coding shall comply with the requirements of the PROCESS PIPING SCHEDULE.
 2. Piping system identification shall comply with the requirements of ANSI A13.1.
 3. Colors listed are general. Actual colors will be selected based on a comparison to the existing plant color codes, except as otherwise indicated; samples shall be furnished for all pipe paint colors; with chips from existing piping where new service lines are connecting.

- 4. Banding:
 - a. Unless special spacing is listed in schedule, apply banding to pipe at connections to equipment, valves, branch fittings, at wall, floor, or ceiling boundaries and at intervals not greater than 36-ft.

- 5. Labels and Directional Arrows:
 - a. Apply labels with directional arrows at connections to equipment, valves, branch fittings, at least one wall, floor, or ceiling boundary within a room and at intervals not greater than 36-ft.
 - b. At each label, arrows indicating direction of flow shall point away from label. If flow may be in both directions, use double headed arrows.
 - c. Lettering shall bear the full pipe system name as scheduled.
 - d. Lettering height shall be as follows:

Outside Pipe Diameter	Minimum Letter Height
3/4-in to 1-1/4-in	1/2-in
1-1/2-in to 2-in	3/4-in
2-1/2-in to 6-in	1-1/4-in
8-in to 10-in	2-1/2-in
Over 10-in	3-1/2-in

- e. Two labels minimum each room, crawl space or compartment, unless otherwise approved.

PART 3 EXECUTION

3.01 GENERAL

- A. All dirt, scale, weld splatter, water and other foreign matter shall be removed from the inside and outside of all pipe and sub-assemblies prior to installing.
- B. All pipe joints and connections to equipment shall be made in such a manner as to produce a minimum of strain at the joint.
- C. Installation of Pipeline Appurtenances:
 - 1. All pipeline appurtenances shall be installed as required and in accordance with the manufacturer's recommendations, as acceptable to the Engineer.
 - 2. Gauges, meters and similar in-line items shall be isolated from testing pressures in excess of the rated pressure of the assembly.
 - 3. Use Teflon tape on all screwed fittings.

END OF SECTION

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SECTION 15140
PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals and install a complete system of pipe hangers, supports, concrete inserts and anchor bolts including all metallic hanging and supporting devices for supporting non-buried piping as shown on the Drawings and as specified herein.
- B. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility for providing them. Pipe supports indicated on the Drawings are shown only to convey the intent of the design for a particular location and are not intended to represent a complete system.

1.02 RELATED WORK

- A. Concrete is included in Division 3.
- B. Miscellaneous metal is included in Section 05500.
- C. Field painting is included in Division 9.
- D. Pipe and fittings are included in Division 15.
- E. Valves and appurtenances are included in Section 15100.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, complete sets of shop drawings of all items to be furnished under this Section. Submittals shall include complete layouts, schedules, location plans and complete total bill of materials for all pipe support systems.
- B. Submittals shall include a representative catalog cut for each different type of pipe hanger or support indicating the materials of construction, important dimensions and range of pipe sizes for which that hanger is suitable. Where standard hangers and/or supports are not suitable, submit detailed drawings showing materials and details of construction for each type of special hanger and/or support. Provide detailed information on anti-seize compound.
- C. Submittals shall include complete piping drawings as submitted for each piping submittal indicating type of hanger and/or support, location, magnitude of load transmitted to the structure and type of anchor, guide and other pipe supporting appurtenances including structural fasteners.
- D. Types and locations of pipe hangers and/or supports shall also be shown on the piping layouts for each piping submittal as specified in Division 15 pipe sections.
- E. Submit complete design data for pipe support systems to show conformance with this Section.

1.04 REFERENCE STANDARDS

- A. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS):
 - 1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
 - 2. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
- B. ASTM International:
 - 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.
- C. American National Standards Institute (ANSI):
 - 1. ANSI B31.1 - Power Piping.
- D. 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 hangers, supports and appurtenances shall conform to the latest applicable requirements of ANSI B31.1, except as supplemented or modified by the requirements of this Section.
- B. All hangers, supports and appurtenances shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for all supporting equipment, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10-ft of water-filled pipe being supported.
- C. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit certification stating that such requirements have been complied with.

1.06 DELIVERY, STORAGE AND HANDLING

- A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.
- B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.
- C. Finished metal surfaces not galvanized, that are not of stainless steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.

PART 2 PRODUCTS

2.01 GENERAL

- A. All of the equipment specified herein is intended to support the various types of pipe and piping systems shown on the Drawings. It shall be the responsibility of the Contractor to develop final details.
- B. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, fittings and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces and all probable external forces such as equipment, pipe and personnel contact. Structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Section 05500 and shall be furnished and installed under this Section.
- C. The Contractor may propose minor adjustments to the piping arrangements in order to simplify the supports, or in order to resolve minor conflicts in the work. Such an adjustment might involve minor change to a pipe centerline elevation so that a single trapeze support may be used.
- D. Where flexible couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc., shall be rigidly supported, to prevent transfer of force systems to the equipment. No fixed or restraining supports shall be installed between a flexible coupling and the piece of equipment.
- E. All pipe and appurtenances connected to the equipment shall be supported in a manner to prevent any strain from being imposed on the equipment or piping system.
- F. All rods, clamps, hangers, inserts, anchor bolts, brackets and components for interior pipe supports shall be furnished with galvanized finish, hot dipped or electro-galvanized coated, except where field welding is required, where cold-applied galvanizing may be used. Interior clamps on plastic pipe shall be plastic coated. Supports for copper pipe shall be copper plated or shall have a 1/16-in plastic coating. All rods, clamps, hangers, inserts, anchor bolts, brackets and components for exterior pipe, submerged pipe and pipe within outdoor structures shall be of Type 316 stainless steel.
- G. Supports shall be sufficiently close together such that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.
- H. All non-metallic piping such as PVC, CPVC, etc., shall be protected from local stress concentrations at each support point. Protection shall be provided by galvanized steel protection shields or other method as approved by the Engineer. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360 degree arc support is required, such as U bolts, protection shields shall be provided for the entire pipe circumference. Protection shields shall have an 18 gauge minimum thickness, not be less than 12-in in length and be securely fastened to pipe with stainless steel or galvanized metal straps not less than 1/2-in wide.

- I. Where pipe hangers and supports come in contact with copper piping provide protection from galvanic corrosion by; wrapping pipe with 1/16-in thick neoprene sheet material and galvanized protection shield; isolators similar to Elcen, Figure No. 228; or copper plated or PVC coated hangers and supports. All stainless steel piping shall be isolated from all ferrous materials, including galvanized steel by use of neoprene sheet material and protection shields, similar to above methods.
- J. Pipe supports shall be provided as follows:
 - 1. Except where otherwise shown on the Drawings, ductile iron, steel and stainless steel piping shall be supported at a maximum support spacing of 10-ft with a minimum of one support per pipe section at the joints.
 - 2. Insofar as is possible, floor supports shall be given preference. Typical concrete supports are shown on the structural drawings. Base elbow and base tees shall be used where possible.
 - 3. Support spacing for steel and stainless steel piping two-in. and smaller diameter and copper tubing shall not exceed five ft.
 - 4. For all stainless steel piping, provide neoprene isolators between the pipe and support components.
 - 5. Pipe supports shall not induce point loadings but shall distribute pipe loads evenly along the pipe circumference.
 - 6. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or as specified herein. No piping shall be supported from other piping or from metal stairs, ladders and walkways, unless specifically directed or authorized by the Engineer.
 - 7. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
 - 8. Effects of thermal expansion and contraction of the pipe shall be accounted for in the pipe support selection and installation.
- K. Unless otherwise specified herein, pipe hangers and supports shall be standard catalogued components, conforming to the requirements of MSS-SP-58 and -69; and shall be as manufactured by Grinnell Co., Inc., Providence, RI; Carpenter & Patterson, Inc., Woburn, MA; F&S Central, Brooklyn NY; Elcen Metal Products Co., Franklin Park, IL and Unistrut Northeast, Cambridge, MA or equal. Reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary.
- L. Required pipe supports for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes, concrete and anchor hardware similar to items previously specified herein and shall be subject to the approval of the Engineer.

- M. Expansion anchors shall be equal to Kwik-Bolt as manufactured by the McCulloch Industries, Minneapolis, MN or Wej-it by Wej-it Expansion Products, Inc., Bloomfield, CO. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of one-in. behind the steel reinforcement.
- N. Hanger rods shall be hot rolled steel, machine threaded and galvanized after fabrication. The strength of the rod shall be based on its root diameter. Hanger rods shall be attached to concrete structures using concrete inserts similar to F&S, Figures 180, 571 or 150; or continuous concrete inserts per F&S. Inserts shall be malleable iron, or steel with galvanized finish. Beam clamps, C clamps or welded beam attachments shall be used for attaching hanger rods to structural steel members. Where necessary and approved by the Engineer, expansion anchors shall be used for attaching to concrete structures.

2.02 SINGLE PIPE HANGERS

- A. Single pipes shall be supported by hangers suspended by hanger rods from structural steel members, concrete ceilings, bottom of trapeze hangers and wall mounted steel angle brackets.
- B. Except as otherwise specified herein, pipe hangers shall be steel, of the adjustable clevis type similar to Grinnell, Figure No. 65, 260 and 590 as required.
- C. Where pipes are near walls, beams, columns, etc., and located an excessive distance from ceilings or underside of beams, welded steel wall brackets similar to Carpenter and Patterson, Figure No. 69-68, 84 or 139 shall be used for hanging pipe. Where single pipes rest on top of bracket pipe supports, attachments shall meet requirements as specified under multiple pipe hangers.

2.03 MULTIPLE PIPE HANGERS

- A. Suspended multiple pipes, running parallel in the same horizontal plane, which are adjacent to each other shall be suspended by trapeze type hangers or wall brackets. Trapeze hangers shall consist of galvanized structural steel channel supported from galvanized threaded rod or attached to concrete walls, columns or structural steel support members as required to meet the intent of this Section. Channel shall be similar to F&S, Figure 710, rods, concrete inserts, "C" clamps, beam clamps, welded beam attachments and expansion shields shall be as specified in Paragraph 2.02 above.
- B. Except as otherwise specified herein pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs similar to F&S, Figures 158, 419, 160A, 160B as required. Material of construction shall be galvanized steel. Chair "U" bolts shall be tightened to allow freedom of movement for normal expansion and contraction except where pipe must be anchored to control direction of movement or act as a thrust anchor.

2.04 SINGLE AND MULTIPLE PIPE SUPPORTS

- A. Single pipes located in a horizontal plane close to the floor shall be supported by one of the methods as shown on the Drawings and as specified herein.
- B. Pipes three-in. in diameter and larger shall be supported by adjustable stanchions similar to F&S, Figure 427. Stanchions shall provide at least four-in adjustment and be flange mounted to floor.

- C. Pipes less than three-in in diameter shall be held in position by supports fabricated from steel "C" channel, welded post base similar to Unistrut, Figure P2072A and pipe clamps similar to Unistrut, Figures P1109 thru P1126. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected together by horizontal member of sufficient load capacity to support pipe. Wherever possible supports shall be fastened to nearby walls or other structural member to provide horizontal rigidity. More than one pipe may be supported from a common fabricated support.
- D. Where shown on the Drawings, ductile iron pipe shall be supported using cast-in-place concrete supports.

2.05 BASE ANCHOR SUPPORT

- A. Where pipes change direction from horizontal to vertical via a bend, a welded or cast base bend support shall be installed at the bend to carry the load. The base bend shall be fastened to the floor, pipe stanchion, or concrete pedestal using expansion anchors or other method as approved by the Engineer.
- B. Where shown on the Drawings, pipe bends shall be supported using concrete anchor posts. Pipes shall be securely fastened to the concrete supports with suitable metal bands as required and approved by the Engineer. A felt insert shall be used to isolate the piping from the poured concrete.

2.06 VERTICAL PIPE SUPPORTS

- A. Where vertical pipes are not supported by a Unistrut system as specified in Paragraph 2.08 below, they shall be supported in one of the following methods.
 - 1. For pipes 1/4-in to two-in in diameter, an extension hanger ring shall be provided with an extension rod and hanger flange. The rod diameter shall be as recommended by the manufacturer for the type of pipe to be supported. The hanger ring shall be steel or PVC clad depending on the supported pipe. The hanger ring shall be equal to Carpenter & Paterson, Figure No. 81 or 81CT. The anchor flange shall be galvanized malleable iron similar to Carpenter and Patterson, Figure No. 85.
 - 2. For pipes equal to or greater than two-in in diameter extended pipe clamps similar to Carpenter and Patterson, Figure No. 267 may be used. The hanger shall be attached to concrete structures using double expansion shields, or to steel support members using welding lugs similar to Carpenter and Patterson, Figure No. 220.
 - 3. Pipe riser clamps shall be used to support all vertical pipes extending through floor slabs. Riser clamps shall be steel similar to Carpenter and Patterson, Figure No. 126. Copper clad or PVC coated clamps shall be used on copper pipes. Insulation shall be removed from insulated pipes prior to installing riser clamps. Insulation shall not be damaged by clamp installation.
 - 4. Unless otherwise specified, shown, or specifically approved by the Engineer, vertical runs exceeding 12-ft shall be supported by base elbows/tees, clamps, brackets, wall rests and pipe collars, all located as required to ensure a rigid installation.

2.07 SPECIAL SUPPORTS

- A. Pipe supports shall be provided for closely spaced vertical piping systems required to provide a rigid installation. The interval of vertical support spacing shall be as specified, but in no case shall vertical interval exceed 10-ft. The support system shall consist of a framework suitably anchored to floors, ceilings or roofs.
- B. Vertical and horizontal supporting members shall be U shaped channels similar to Unistrut, Series P1000. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps. All components shall be of steel.
- C. For piping three-in and smaller, the framework shall be as manufactured by the Unistrut Corporation; Globe-Strut as manufactured by the Metal Products Division of U.S. Gypsum or equal. For piping larger than three-in, the support frame shall be fabricated from structural steel shapes and secured through the use of expansion anchors.
- D. The assemblies shall be furnished complete with all nuts, bolts and fittings required for a complete assembly including end caps for all unistruts members.
- E. The design of each individual framing system shall be the responsibility of the Contractor. Shop drawings, as specified above shall be submitted and shall show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached.
- F. Supports not otherwise described in this Section shall be fabricated or constructed from standard structural steel shapes in accordance with applicable provisions of Section 05500, or unistrut-type frame; have anchor hardware similar to items previously specified herein, shall meet the minimum requirements listed below and be subject to the approval of the Engineer.
 - 1. Pipe support systems shall meet all requirements of this Section and all related Sections.
 - 2. Complete design details of the pipe support system and system components shall be submitted for review and approval as specified in PART 1. No hanger or support shall be installed without the written approval of the Engineer.
 - 3. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.

2.08 SURFACE PREPARATION AND SHOP PRIME PAINTING

- A. All surfaces shall be prepared and shop painted as part of the work of this Section. Surface preparation and shop painting shall be as specified in Section 09901.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Proceed with the installation of piping and supports only after any building structural work has been completed and new concrete has reached its 28-day compressive strength.

- B. The installation of pipe support systems shall in no way interfere with the operation of the overhead bridge cranes, monorails, access hatches, etc.
- C. The installed systems shall not interfere with maintenance and operational access to any equipment installed under this Section, or any other related Section.
- D. All pipes horizontal and vertical, requiring rigid support shall be supported from the building structure by approved methods. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or as specified herein. No piping shall be supported from metal stairs, ladders and walkways unless specifically directed or authorized by the Engineer.
- E. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.
- F. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings (within four pipe diameters) and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
- G. Inserts for pipe hangers and supports shall be installed on forms before concrete is placed. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.
- H. Continuous metal inserts shall be embedded flush with the concrete surface.
- I. Apply anti-seize compound to all nuts and bolts. Supports installed without the approved compound shall be dismantled and correctly installed, at no additional cost to the District.

3.02 TESTING

- A. All pipe support systems shall be tested for compliance with this Section. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired or augmented under this Section to the satisfaction of the Engineer.

END OF SECTION

SECTION 15400
PLUMBING - GENERAL PROVISIONS

PART 1 GENERAL

1.01

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, services and incidentals required and install and test a complete plumbing system as specified and shown on the following:
1. Specification Sections
 - 15410 Plumbing - Piping Systems
 2. Drawings
 - P-1 Plumbing Symbols and Abbreviations
 - P-2 Pump Building Plumbing Plan
 - PD-1 Plumbing Details
- B. More specifically the work shall include, but shall not be limited to the following:
1. All items included under the Scope of Work of other Plumbing Sections.
 2. Cutting, coring and rough patching in accordance with Section 01045.
 3. All parts necessary to make a complete Plumbing System ready for continuous operation.
 4. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility for providing them.
- C. The Contractor shall be fully responsible for the proper execution and performance of the work described herein. It shall be their responsibility to inspect all installation conditions and bring to the attention of the Engineer any conditions which may affect their work adversely. They shall report to the Engineer, prior to commencing any portion of this work, any conditions unsuitable for the installation of their portion of the work.
- D. Mention herein or indication on the Drawings of equipment, materials, operation or methods shall require that each item mentioned or indicated be provided to make a complete system of plumbing ready for continuous operation.
- E. The location of all equipment, fixtures and piping shall be considered as approximate only and the right is reserved by the Engineer to change at any time, before the work is installed, the position of such equipment and piping to meet structural conditions and to provide proper headroom clearance or for other sufficient causes and such changes shall be made without additional expense to the District.
- F. Comply with all the laws, ordinances, codes, rules and regulations of the State, local or other authorities having jurisdiction over any of the work specified herein.

- G. Obtain all required permits and pay all legal fees for the same and in general take complete charge and responsibility for all legal requirements pertaining to this Section of the work.
- H. Requirements set forth in this Section and indicated on the Drawings shall be followed when in excess of the required or minimum regulations.
- I. If any work is performed and subsequent changes are necessary to conform to the regulations, such change shall be made as part of this work at no additional cost to the District.
- J. All work shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of pipes and general method of running them are shown, but it is not intended to show every offset and fitting nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings, all necessary parts to make complete working systems ready for use shall be furnished without extra charge.
- K. Refer to the Structural and Architectural Drawings which indicate the type of construction in which the work shall be installed. Locations shown on the Plumbing Drawings shall be checked against the general and detailed drawings of the construction proper. All measurements shall be taken at the building.

1.02 RELATED WORK

- A. The following work related to, but not covered under, the plumbing work is included under other related Sections.
 - 1. All piping systems in the building other than the plumbing work specified in the Plumbing Sections.
 - 2. Yard piping for sanitary and storm drains beyond five-ft-0-in outside the building unless otherwise indicated.
 - 3. Source for potable and protected water and gas services shall terminate as hereinafter specified.
 - 4. Valve tags are furnished in Section 01170, but installed on Plumbing items under this Section.
 - 5. Excavating and backfilling is included in Division 2.
 - 6. Sump pit frames and covers not specified under the plumbing work is included in Division 5.
 - 7. Manholes, catch basins, gasoline trap and buried pipe encasement is included in Division 2.
 - 8. Concrete is included in Division 3.
 - 9. Painting is included in Division 9.
 - 10. Portable fire extinguishers are included in Division 10.
 - 11. Ductwork is included elsewhere in Division 15.

12. Electrical work is included in Division 16.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data to establish compliance with this Section. Submittals shall include the following:
1. Shop drawings and technical literature covering details of all equipment, fixtures and accessories being furnished under this Section prior to fabrication, assembly or shipment.
 2. Provide a list of recommended spare parts as well as spare parts being provided.
 3. Furnish no less than 60 days before start-up, a schedule of all exposed valves installed under this Section. The schedule shall include for each valve the location, type, a number, words to identify the valve function, and the normal operating position.
 4. Detailed layout drawings of piping in mechanical rooms and other congested areas shall be provided. Drawings shall show the locations of piping appurtenances, specialties, and all valve banks. Drawings shall be at a minimum scale of 1/4" = 1'0".
 5. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.
 6. All submittals shall contain a statement that Section 15400 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.
- B. Operation and Maintenance Data
1. Operating and maintenance manuals shall be furnished to the Engineer as provided in 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 assist operation and maintenance personnel unfamiliar with such equipment. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.
 - a. Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.
 - b. Equipment shall be identified with the Engineer's Equipment Numbers and Identification as shown in the Schedules and on the Drawings.
 - c. Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings shall be bound in the manual, or contained in envelopes bound into the manual.
 2. Contents - Each volume shall contain the following minimum contents:
 - a. Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

- b. Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long-term storage shall be included.
 - c. Maintenance shall include preventive and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.
- C. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.04 MANUFACTURER'S SERVICES

- A. A representative of the manufacturer who has complete knowledge of proper operation and maintenance shall be provided for the number of eight-hour days as listed below to instruct representatives of the District and the Engineer on proper operation and maintenance. With the District's permission, this work may be conducted in conjunction with the inspection and 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 additional cost to the District.

1.05 REFERENCE STANDARDS

- A. ASTM International (ASTM)
- B. American National Standards Institute (ANSI)
- C. American Water Works Association (AWWA)
- D. National Fire Protection Association (NFPA)
- E. National Electrical Manufacturers Association (NEMA)
- F. National Sanitation Foundation (NSF)
- G. Plumbing and Drainage Institute (PDI)
- H. Cast Iron Soil Pipe Institute (CISP)
- I. Underwriters Laboratories (UL)
- J. Factory Mutual (FM)
- K. American Society of Plumbing Engineers Data Book (May be used as a design guide.)
- L. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.06 QUALITY ASSURANCE

- A. All equipment of a given type included in this Section shall be furnished by or through a single manufacturer or as specified on the schedules.
- B. Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.
- C. The piping manufacturer shall furnish an affidavit of compliance certifying that all materials used and work performed complies with the specified requirements. Provide copies of mill test confirming the type of material used in the various components.
- D. The District and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.
- E. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The District and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.
- F. All rotating parts of equipment shall be statically and dynamically balanced at the factory.

1.07 ENGINEERING SERVICES

- A. When engineering services are specified to be provided by the Contractor, the Contractor shall retain a licensed professional engineer to perform the work. The engineer shall be licensed at the time the work is done and in the state in which the project is located. If the state issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.
- B. All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.08 SERVICE AND UTILITY CONNECTIONS

- A. Sanitary
 - 1. The sanitary waste and drainage systems shall terminate at the sump pits or at points five-ft-0-in outside the building or as otherwise shown on the Drawings.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.
- B. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the District by the manufacturer.

- C. All materials shall be suitably packed for shipment and long-term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.
- D. All equipment shipped that is exposed such as on a flatbed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt, stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.
- E. Instructions for the servicing and startup of equipment in long-term or prolonged storage shall accompany each item.
- F. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.10 COORDINATION

- A. The Drawings indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.
- B. Coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.
- C. Assume full responsibility for coordination of the Plumbing systems, including scheduling and verification that all structures, piping and the mounting of equipment are compatible.

1.11 ELECTRICAL EQUIPMENT

- A. Electric motors in NEMA frame sizes shall conform to the requirements in Section 01171, unless otherwise specified herein.
- B. Electrical equipment which is furnished under this Section shall meet the requirements specified in Division 16:
 - 1. Disconnect switches, motor starters and combination motor starters (starters with disconnecting means and short circuit protection) shall be as specified in Section 16191.
 - 2. Cord-connected controls for hazardous areas shall be provided with intrinsically safe relays, which shall be as specified in Section 16191.
 - 3. Raceways, boxes, fittings and supports shall be as specified in Section 16110.
 - 4. Wires and cables shall be as specified in Section 16120.
- C. Electrical enclosures, panels and components shall be suitable for the environment and electrical classification for the space they are located in. The type of enclosure for the various spaces shall be as specified in Division 16 unless otherwise specified. Refer to the electrical drawings for the space classifications.

1.12 SUPPORTS

- A. All components shall be provided with lugs, brackets or field supplied devices to allow the components to be firmly attached to the structure. The lugs, brackets or field supplied devices shall be sized to withstand the seismic loads for the area and type of application.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

- A. All the items specified in Section 15410 and under Part 2 shall be installed according to the applicable manufacturer's recommendations, the details shown on the Drawings and as specified herein and in other related Sections.
- B. Start up each piece of equipment and system and make all adjustments so that the system is placed in proper operating condition.
- C. Do not install any equipment or materials until the District and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.
- D. All work shall be installed in accordance with the manufacturer's printed instructions and shall be rigid, plumb and true to line, with all parts in perfect working order. Maintain protective covers on all units until final cleanup time and at that time remove covers and clean and polish all surfaces.
- E. Attention is called to the necessity for elimination of transmission of vibration from mechanical equipment to building structures. All equipment, therefore, shall be carefully selected and installed to meet this condition and isolators and water hammer arrestors shall be provided where required.

3.02 PROTECTION

- A. Materials, fixtures and equipment shall be properly protected at all times and all pipe openings shall be temporarily closed so as to prevent obstruction and damage.

3.03 COORDINATION SKETCHES

- A. It shall be the responsibility of the subcontractor to have employed a competent coordinator of mechanical systems and as such to provide all coordination of drawings or sketches as may be required or deemed necessary by the Engineer to obtain the required ceiling heights and eliminate conflicts with all piping, ducts and electrical installation.

3.04 INSTRUCTION

- A. Instruct such persons as designated by the District in the care and use of all plumbing equipment and piping systems installed.

END OF SECTION

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SECTION 15410
PLUMBING - PIPING SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The areas where work is to be accomplished is described in Section 15400.
- B. This Section specifies the basic Plumbing Systems of Piping and the materials of each system, including valves and associated appurtenances.
- C. Furnish all labor, materials, equipment, services and incidentals required and install complete interior Plumbing Piping Systems as shown on the Drawings and as specified herein.
 - 1. Sanitary - Waste and Vent Systems.
 - 2. Furnish and install all piping, valves, dielectric fittings, floor drains, cleanouts, sleeves, hangers and insulation in conjunction with the above listed piping systems.
- D. All piping and equipment shown on the Drawings is intended to be approximately correct to scale; but, figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of piping is shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the Drawings, all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The Contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.02 RELATED WORK

- A. Refer to Section 15400.
- B. Materials and installation conforming to the requirements of Pipe Penetrations in Section 01172 shall be furnished in this Section.

1.03 SUBMITTALS

- A. Submit, in accordance with Sections 15400 and 01300, shop drawings and technical literature covering details of all plumbing piping systems being furnished under this Section prior to fabrication, assembly or shipment.
- B. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit
- C. All submittals shall contain a statement that Sections 15400, 15410, and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable: Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved and shall be included with every submittal and resubmittal.

- D. Detailed layout drawings of piping in mechanical rooms and other congested areas shall be provided. Drawings shall show the locations of piping appurtenances, specialties, and all valve banks. Drawings shall be at a minimum scale of $1/4" = 1'0"$.
- E. Provide manufacturer's catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials, and installation shall be in accordance with the recommendations of MSS SP-58 and MSS SP-69.
- F. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication process and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.
- G. Include in the submittal a list of any exceptions to the specifications that are taken and include any supporting documentation to justify the exception.

1.04 REFERENCE STANDARDS

- A. Refer to Section 15400.

1.05 SERVICE AND UTILITY CONNECTIONS

- A. Refer to Section 15400.

1.06 QUALITY ASSURANCE

- A. Refer to Section 15400.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 15400.

1.08 COORDINATION

- A. Refer to Section 15400.

1.09 SEISMIC RESTRAINTS

- A. Refer to Section 15400.

PART 2 PRODUCTS

2.01 PIPING SYSTEM MATERIALS

- A. Sanitary Waste Systems:
 - 1. The pipe and fittings shall be SV (Service) hub and spigot cast iron soil pipe and fittings conforming to ASTM A74 tarred inside and out at the foundry.

2. Joints for below grade piping shall be installed with compression gaskets conforming to ASTM C564 or shall be installed with lead and oakum.
3. Piping above grade shall be of the above-mentioned hub and spigot type or of the No-Hub type conforming to the Cast Iron Soil Pipe Institute Standards 301. Pipe shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.
4. The No-Hub coupling shall be Anaheim Foundry Co. Husky SD4000, Clamp-All 125 or by MG Coupling Co.
5. Copper piping may be used for sanitary waste and vent in sizes two-in. and smaller. Pipe shall be Type "K" used with either cast or wrought DWV fittings. Solder shall be Alloy 95TA (95 percent Tin, five percent Antimony), ASTM B32. No solder containing lead shall be utilized on the project. Flux shall comply with ASTM B813 and NSF 61.

B. Dielectric Fittings:

1. Provide dielectric fittings between piping and components of dissimilar metals.

2.02 DRAINS

A. For the purpose of explanation and description only, the following drain catalog numbers are taken from the catalogs of Zurn Industries, Inc. unless otherwise noted. Those drains as manufactured by J.R. Smith Mfg. Co. or Josam Mfg. Co. and determined by the Engineer to be equal in every respect to those specified shall be acceptable for installation. All drains shall be of sizes shown on the Drawings.

B. Equipment Drains (ED):

1. Floor drains shall be fitted with a deep seal cast iron "P" type or "running" type trap to suit drain outlet. Traps shall be acid resisting material where noted.
2. Floor drains shall have cast iron or acid resisting drainage flange, seepage control, 1/2-in trap primer connection where required, clamping collar and inside caulk outlet or resilient gasket pipe connection, unless noted otherwise to be IPS outlet.
3. Schedule of Floor Drains

Type	Cat. No.	Remarks
"C"	Z-415E	With Type E strainer and 4-in diameter funnel assembly.

2.03 CLEANOUTS

A. For the purpose of explanation and description only, the following cleanout catalog numbers are taken from the catalogs of Zurn Industries, Inc. unless otherwise noted. Those drains as manufactured by J.R. Smith Mfg. Co. or Josam Mfg. Co. and determined by the Engineer to be equal in every respect to those specified shall be acceptable for installation. All cleanouts shall be of size shown on the Drawings.

B. In cast iron bell and spigot pipe cleanouts shall consist of a cast iron ferrule and extra heavy brass tapered screw cleanout plug with square or hexagonal nuts.

- C. In threaded pipe (galvanized steel with recessed drainage pattern fittings) cleanouts shall consist of standard iron pipe size (IPS) brass plugs screwed into drainage fittings.
- D. In copper tubing cleanouts shall consist of copper to IPS adapters with IPS brass plugs screwed into female threaded portion of the adapter.
- E. Acid resisting pipe terminal cleanouts shall be of acid resisting material and of the type recommended by the manufacturer of the pipe and fittings.
- F. Flush Floor Cleanouts (FCO):
 - 1. Flush floor cleanouts shall be Zurn Z-1400 or equal.
- G. Wall Cleanouts (WCO):
 - 1. Wall cleanouts shall be equal to Zurn Z-1440 with stainless steel shallow cover and screw.
 - 2. Cleanout tees shall be equal to Zurn Z-1445, as suitable to the individual application.
- H. Exterior Cleanouts (ECO):
 - 1. Exterior cleanouts shall consist of cast iron threaded ferrule and brass screwed raised head plug, Zurn Z-1449, with heavy cast iron housing and gasketed cover, Zurn Z-1474, or equal. Set flush with concrete slab.

2.04 SLEEVES AND CASTINGS

- A. Sleeves:
 - 1. Sleeve all piping through walls, beams and partitions. Wall sleeves shall finish flush with the finish line.
 - 2. Sleeve all piping passing through floor slabs. Sleeves shall extend two-in. above the finish floor slab.
 - 3. Refer to Drawings for additional information.
- B. Castings:
 - 1. Provide waterproof castings on each plumbing pipe penetrating walls of wet wells, tanks or pits. Castings shall be of size and length to suit pipe and wall thickness.

2.05 HANGERS, SUPPORTS AND ANCHORS

- A. Piping support systems shall include restraints as required by the applicable building codes to withstand seismic loading. Design shall be provided by a professional engineer hired by the Contractor as specified in Section 15400.
- B. The absence of pipe supports and details on the drawings shall not relieve the Contractor of the responsibility for providing them.

- C. Hangers supporting vertical pipes shall be friction clamps similar to Anvil Figure 40 or 261 and shall be supported at each floor level.
- D. Hangers supporting horizontal piping shall be clevis hangers similar to Anvil Figure 260.
- E. Horizontal piping buried in earth under lowest floor slabs shall be supported with the hanger types shown on the Drawings except where otherwise required to be encased in concrete.
- F. All hangers shall be of a type to permit vertical adjustment after installation.
- G. Materials and installation shall be furnished under this Section. All rods, clamps, hangers, concrete inserts, anchor bolts, brackets, metal insulation shields, channel supports, pipe anchors, and components for pipe supports shall be galvanized steel furnished with a hot dipped or electro-galvanized finish. All hangers and supports for copper piping shall be plastic coated where in contact with copper.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all piping, valves, hangers and appurtenances as specified herein and in the referenced Sections above.
- B. Do not install any equipment or materials until the District and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals it shall be at the Contractor's risk.
- C. Reductions in size shall be made using reducing fittings.
- D. Welding:
 - 1. Welding of joints shall be by metal-arc welding process. Welding shall be by qualified welders meeting the requirements outlined in Section IX of the ASME Boiler and Pressure Vessel Code and certified by the Hartford Steam Boiler Inspection Company.
 - 2. Welding shall not be done when the temperature is less than 32 degrees F or when surfaces to be welded are wet.
 - 3. Surface to be welded shall be free from loose scale, slag, rust, paint, oil and other foreign material. Joint surfaces shall be smooth, uniform and free from fins, tears and other defects which might affect proper welding.
 - 4. Bevels shall be accurately cut by machining or by a mechanically guided cutting torch.
 - 5. Piping shall be carefully aligned before welding and maintained in alignment during welding. Tack welds may be used to maintain alignment. They shall be the same quality as the final welds and shall be fused thoroughly therein. Defective tack welds shall be removed before the final weld is made.
 - 6. The surface of the finished welds shall have a bright metallic luster after cleaning, a fairly smooth and uniform contour with regular ripples and be free from overlaps, undercuts and excessive convexity.

7. Welds shall be sound throughout, fused thoroughly and free from gas pockets, oxide, slag inclusions and surface porosity. The inside of the pipe shall be free from globules of weld metal, spacers or other material which would restrict the pipe area or dislodge to enter the fluid stream.
8. Defective or unsound welds shall be corrected by removing and replacing the welds. Pipe or fittings which cannot be rewelded satisfactorily shall be replaced with new pipe or fittings at the Contractor's expense.
9. All welded joints may be visually inspected by the District's Representative for defects beyond those acceptable in ANSI B31.1. Method of repair shall be in accordance with instructions as received from the District's Representative.

E. Flanged Connections:

1. All flange faces shall be in perfect alignment with the holes straddling the vertical center line of the piping.
2. All bolts shall be well lubricated over the entire thread length with a heavy graphite and oil mixture prior to the tightening operation. Bolts shall be tightened with proper wrenches, care being taken to secure uniform pressure on the bolts and gasket and to avoid overstressing of the bolts, dishing of the flanges and compression of the gasket beyond its proper limits.
 - a. Commercial grade carbon steel bolts, ASTM A307, Grade B shall be tightened to obtain approximately 15,000 psi stress based on the root area of the thread. Alloy steel bolts, ASTM A193, Grade B7 shall be tightened to obtain a stress of 45,000 psi.
3. All bolts shall be of sufficient length so that when fully tightened, a minimum of two full threads shall extend beyond the nut.

F. Screwed Connections:

1. All screwed connections shall have full thread of true taper, accurate to gauge and conform to ANSI.
2. Screwed joints shall be made with an approved joint compound applied to the male thread only. Caulking of screwed joints shall not be allowed.

G. Soldering (Copper Tubing):

1. Tubing shall be cut with square ends and reamed to prevent burrs, out-of-round or improperly sized ends.
2. After cutting, all surfaces to be soldered shall be thoroughly cleaned to a metal-bright finish, free from dirt, grease or other material before fluxing and soldering. This cleaning shall be performed by using emery cloth, sandpaper or steel wool. Clean the outside end of the tubing for a length of 1/2-in greater than the depth of the fitting. The inside of the fittings shall be cleaned in a similar manner. Apply flux and assemble the joint.

3. The surfaces to be joined shall be heated up slowly and uniformly to the melting point of the solder. The surface being soldered shall be maintained above the melting point of the solder for sufficient time to draw the solder completely into the joint. When the solder congeals to a plastic state the excess metal shall be removed with a cloth brush, leaving a fillet around the end of the fitting. Full penetration of the solder uniformly throughout the entire socket is required. The soldered joints shall be allowed to cool in still air until only warm to the hand after which the work may be quenched.
4. Any type of crack, pinhole, area of incomplete penetration, or similar defect shall not be accepted. Peening for closing up defects shall not be permitted.
5. Heating torches of sufficient size shall be used for heating of large fittings prior to soldering. Multiple tips or ring burners for use on combination torches may be used.
6. Remove all external and internal loose solder and flux after joint cools.

H. Grooved Joints:

1. Grooved piping joints shall be made in strict accordance with the joint manufacturer's recommendations. The depth, width and distance from the end of the pipe shall be within the joint manufacturer's tolerances.
2. Grooves shall be rolled in steel piping systems. Piping shall be cut to length and squared before grooving. Grooved end shall be clean and free from indentations and projections in the area from the pipe end to groove.
3. Lubricant for the gaskets shall be supplied by the joint manufacturer. Gaskets shall be checked to be sure that they are the proper gasket for the piping system. Lubricant shall be applied to the gasket prior to installing the gasket on the pipe. Gaskets shall be supplied by the grooved coupling manufacturer.
4. The gap between the ends of the pipe being joined is to be set based on the piping systems needs to expand and contract. In general pipe expansion and contraction in grooved piping systems shall be taken up by the proper gap of the individual joints.
5. The housing shall be assembled around the piping being sure that the housing does not pinch the gasket and that it also drops into the grooves on the two sections of piping. Bolts shall be tightened by hand uniformly. Only metal to metal contact is required between the segments of the housing. Do not over tighten the bolts.
6. The coupling manufacturer's factory trained field representative shall provide on-site training for Contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory trained representative shall periodically review the product installation. Remove and replace all improperly installed products.

I. Brazing:

1. Cutting and cleaning of tubing shall be as specified for soldering operations.

2. Apply flux in accordance with recommendations of manufacturer of brazing filler material being used. Apply to outside of fitting and heat affected area of tubing. Avoid getting flux inside tube. Flux may be omitted when joining copper tubes to wrought copper fittings but is required for joining to cast (bronze) fittings.
3. Assemble joint by inserting tube into socket hard against stop and turning.
4. Heat parts to be joined beginning one-in. from edge of fitting, continuously moving the flame. When flux has become transparent, begin to heat the fitting at the base of the cup, still continuously moving the flame. When flux at fitting is quiet and transparent, maintain heat along joint by moving flame along axis between fitting and tubing.
5. Apply brazing material at point where tubing enters socket of fitting. Avoid putting flame on brazing material. Heated joint should melt brazing material and capillary action will draw material into the joint. When joint is properly made, a fillet of filler metal will be visible completely around the joint. Stop adding filler metal when fillet is formed.
6. After brazing material has solidified, clean off flux residue. Fittings must cool naturally. Quenching shall not be allowed.
7. Any type of crack, pinhole, area of incomplete penetration, or similar defect will not be accepted. Penning for closing up defects will not be permitted.

J. Cleanouts:

1. Install cleanouts as directed by applicable code at end of each branch soil and waste line, where waste and soil lines change direction, and at the bottom of every riser either as a cleanout tee above floor or end cleanout in the horizontal below the floor.

3.02 INSTALLATION OF HANGERS AND SUPPORTS

- A. In certain locations, pipe supports, anchors, guides, and expansion joints may be indicated on the Drawings. The Contractor shall be responsible to provide a complete system of supports, expansion joints, and anchors. Additional supports may be required adjacent to expansion joints, couplings, and valves or based on field conditions.
- B. Supports and hangers for cast iron soil piping shall be installed in accordance with the latest addition of the cast iron soil pipe handbook unless noted otherwise.
- C. Provide a metal insulation shield at support points of insulated lines. Secure the shield with metal bands at each end of the shield and one additional band in the middle of the shield. The band material shall match the hanger material.

3.03 FIELD TESTING

- A. Provide air and water necessary for testing the piping systems as specified under this Section of the work. Provide connections for testing under this Section. Remove debris resulting from testing. Use the water in an efficient and economical manner.

- B. Provide apparatus and other supplies or materials which may be necessary for testing the systems and operating the apparatus during the period while tests of any kind are being made or for carrying out the work of the Contract.
- C. The various piping systems shall be subjected to water, smoke, or air tests as noted and shall hold tight at pressures stated without extra pumping or water addition for the time intervals stated.
- D. Additional tests, methods or materials that may be required by the local ordinances and not specifically specified herein shall be made as directed by the Engineer or the local inspection authority.
- E. Provide for repeated tests as necessary to make systems tight as required.
- F. Test metal and plastic soil, waste, drain, vent and rainwater piping as follows:
 - 1. Test the rough drainage of soil, waste, drain, vent and rainwater leader by plugging piping where it terminates in the building or where it leaves the building and by filling each system completely with water. After all the outlets in the section have been plugged or capped, test for at least one hour.
 - 2. If it becomes necessary during the construction of the building to test a part of a section for any reason or to cover permanently any pipe before piping above the part or section has been completed, apply a water test to such part or section of the piping by maintaining a ten-ft head of water on the highest section of the piping and the test shall hold tight for one hour.

3.04 CLEANING

- A. At the completion of the work, clean all piping, fixtures, equipment, apparatus and exposed trim for same included in this Section and, where required, polish ready for use.

3.05 PAINTING

- A. CPVC and PVC pipe and fittings exposed to the direct sunlight shall be field painted to provide additional UV protection. This painting shall be required whether or not marking is required and shall be in accordance with Section 09901.

END OF SECTION

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SECTION 15500
HVAC

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. These Sections and Drawings cover(s) the requirements of the HVAC Work to be performed and shall not void any of the requirements specified under the Agreement.
- B. The areas where work is to be accomplished are specified and shown in the following:
1. Specification Sections

15860	Fans
15990	Testing, Adjusting and Balancing
 2. Drawing Number

H-1	HVAC Symbols and Abbreviations
H-2	Electrical Building HVAC Plan
H-3	Pump Building HVAC Plan
HD-1	HVAC Schedules
HD-2	HVAC Details
- C. The requirements specified herein shall be modified only if specified otherwise for particular application in other divisions.
- D. This HVAC specification is incomplete without the information contained on the Drawings and in the Schedules. Schedules are located on the Drawings.
- E. Work included under the "Scope of Work" of this HVAC Section includes all labor, material, equipment, tools and services necessary to furnish, deliver, unload, install, test and place in satisfactory operation, the equipment, services and systems as called for under the HVAC Section(s) including any incidental work not shown, or not specified but which can reasonably be inferred as belonging to the various systems and necessary in good practice to provide complete and fully operational systems. Cutting and patching is included in this Section and shall be done as described in Section 01045 unless otherwise indicated.
- F. Equipment shall consist of the following:
1. Fans
 2. Split system units, condensing units and filters
 3. Heating units
- G. The following work descriptions are not intended to in any way limit the above broad statement but are intended as a more specific mention of the most important items included therein.

H. The functions of the HVAC systems are as follows:

Outdoor Design Conditions

Summer:	92°F Dry-bulb,	79°F Wet-bulb
Winter	44°F Dry-bulb,	6.7 mph wind velocity
Approximate Heating Degree Days	1303	
Approximate Cooling Degree Days	2629	
Site Elevation	13 ft. Above Sea Level	

For air-cooled condensing unit selection, the summer design dry bulb temperature plus ten degrees F shall be used.

Indoor Design Conditions

	Summer Space Temp. °F	Outdoor Air Vent.	Winter Space Temp. °F	Outdoor Air Vent.
Electrical Room	80±5°F	N/A	50±5°F	N/A
Pump Room	102±5°F	6 AC/hr	50±5°F	6 AC/hr

- I. This Section is incomplete without the information contained in the HVAC equipment schedules. Provide equipment of the type, size, capacity and arrangement as shown on the Drawings and as scheduled. Equipment shall consist of the particular components listed in the schedules in addition to those components normally required for the type of unit. The order of component assembly will be as stated in the schedule. Particular attention must be paid to the remarks and notes in the schedules and on the Drawings.
- J. All ductwork, piping, and equipment shown on the Drawings are intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. Coordinate the system installation and routing with the work of all trades.

1.02 RELATED WORK

- A. Cutting and patching is included in Division 1, except for items specified herein.
- B. Temporary heating, electric power and lighting is included in Division 1.
- C. Trenching, excavation and backfill is included in Division 2, except for items specified herein.
- D. Concrete work is included in Division 3, except for required HVAC anchor bolts, sleeves and templates which shall be furnished under this Section.

- E. Structural steel and miscellaneous metal is included in Division 5, except for supplementary steel required for HVAC hangers, equipment supports, anchors and guides, which shall be furnished under this Section.
- F. Flashing and counterflashing is included in Division 7, except for items specified herein.
- G. Painting is included in Division 9, except for factory finished HVAC equipment, HVAC shop painting and HVAC identification labeling.
- H. Exterior louvers are included in Division 10.
- I. Plumbing work is included under the Plumbing Section (Division) of this Division (Specification) except for water and drain closing in connections to HVAC equipment.
- J. Electrical field wiring is included in Division 16, except for field wiring for automatic temperature controls as specified herein or as shown on the HVAC Drawings.
- K. Line voltage thermostats for unit heaters are installed and wired under Division 16.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, shop drawings and product data for the following:
 - 1. Catalog cuts and data sheets for all equipment.
 - 2. Automatic control drawings with composite wiring diagrams, including bills of material and descriptions of operation for all systems. Panel layouts and name plate lists for all local and central panels. Data sheets for all control system components.
 - 3. Software licensing and user agreements will be submitted for approval with the shop drawings for the equipment using the software. The submittal shall be a copy of the final agreement document that is to be signed.
 - 4. Complete damper schedules for damper submittals including the following for each type or model of damper to be furnished for the project: materials of construction for blades, frames, bearings, linkages and seals; flow and leakage characteristics; typical operating torque requirements or characteristics; options to be furnished; general installation and maintenance instructions. Damper schedules shall include damper type; unit served; damper service; damper size; duct size; drive linkage location; installation arrangement (flanged or in duct) and damper operator type.
 - 5. All fans, submit in accordance with sections 01300, 15500, and 15860 all data on the fan schedules. In addition, the submittal shall include catalog data, fan data sheets with a description of the proposed fan, fan size, type, arrangement, materials of construction, weight, motor horsepower, motor type, power supply, and frame size. Provide catalog data and selections for vibration isolators, include materials of construction. For belt drive equipment; provide drive data indicating the sheave sizes, belts size, number and length. Each submittal shall include pertinent equipment dimensional data, fan performance (operating data information, and a performance curve showing the fan operating point and range. Minimum curve size shall be eight-in. by six-in. Faxed copies of curves are not acceptable. A list of accessories to be furnished shall be included on each submittal. Copies of operating and maintenance manuals shall be submitted. Significant dimensional

differences between the specified equipment and the proposed equipment shall be noted on the equipment submittal. Provide data to show the dimensionally different equipment will fit within the space and still provide suitable clearance. Where corrosion resistance is required, provide conformation of material suitability for the specified service.

6. For all air handling units, submit, in accordance with Section 01300 and 15500, the following:
 - a. Unit data sheets; to include catalog data, a description of the proposed unit, size, type, arrangement, and materials of construction.
 - b. For belt drive equipment, provide drive data indicating sheave sizes, belt size, number and length.
 - c. Each submittal shall include pertinent equipment dimensional data, heating and cooling coil operating data. Submit, in accordance with Sections 01300 and 15500, all data and the unit schedules. The submittal shall include fan data sheets with a description of the proposed fan, fan size, type, arrangement, materials of construction, weight, motor horsepower, motor type, power supply, and frame size. Provide catalog data and selections for vibration isolators, include materials of construction. For belt drive equipment; provide drive data indicating the sheave sizes, belts size, number and length. Each submittal shall include pertinent equipment dimensional data, fan performance (operating data information, and a performance curve showing the fan operating point and range. Minimum curve size shall be eight-in. by six-in. Faxed copies of curves are not acceptable. A list of accessories to be furnished shall be included on each submittal. Copies of operating and maintenance manuals shall be submitted. Significant dimensional differences between the specified equipment and the proposed equipment shall be noted on the equipment submittal. Provide data to show the dimensionally different equipment will fit within the space and still provide suitable clearance. Where corrosion resistance is required, provide conformation of material suitability for the specified service.
 - d. For heating sections, provide information on type of heating, air entering and leaving conditions, air pressure drop, heating media entering and leaving conditions and flow or consumption, and pressure drop. Provide size, type, arrangement, materials of construction, and operating weight.
 - e. For cooling sections, provide information on type of cooling, air entering and leaving conditions, air pressure drop, cooling media entering and leaving conditions, flow, and pressure drop. Provide size, type, arrangement, materials of construction, and operating weight.
 - f. For condensing sections provide information on number and type of compressors, type of refrigerant and refrigerant charge, and controls provided and operating weight. Provide electrical data for power and controls. For condensing coils, provide air entering and leaving conditions, air pressure drop, size, type, arrangement, and materials of construction.
 - g. List of accessories to be furnished shall be included on each submittal.
 - h. Provide a recommended list of spare parts to be provided.
7. Detailed equipment, ductwork and piping layout drawings; minimum scale 1/4-in = one-ft-0-in for interior systems and equipment, dimension clear service spaces for motors and drives, filter, coils and spacer section access doors, and ductwork access panels and doors. (Site layout drawings and roof plans showing HVAC equipment and systems may be prepared and submitted at scales smaller than 1/4-in = one-ft-0-in, subject to Engineer's prior approval.)

8. Standard shop and field installation details for transitions, elbows, takeoffs, discharge nozzles, turning vanes, access panels and doors, volume control and splitter dampers and extractors.
9. Piping and appurtenances, materials and joining methods. Pipe hanger materials and methods.
10. Ductwork materials, joining methods, reinforcing and material gauges. Where options are allowed by SMACNA, the proposed option shall be clearly defined. Indicate proposed materials and methods for ductwork and equipment hangers.
11. Prepare dimensional comparisons between proposed equipment and scheduled equipment when the proposed equipment is dimensionally larger than that scheduled. Do not propose dimensionally larger equipment from an alternate manufacturer for installation in confined areas, or when the installation of alternate equipment will result in reduction of service access below that recommended by the manufacturer.
12. Prepare layouts showing size, arrangement, and routing of field fabricated refrigerant piping for split-systems and air handling units with remote condensers. Include a letter from the AC system manufacturer indicating their approval of the proposed sizing and routing.
13. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.
14. When special hangers, supports, anchors, or hold downs are required that are not covered by standards provide signed and sealed calculations and details for record purposes.
15. All submittals shall contain a statement that Section 15500 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.
16. Submit air system testing, adjusting and balancing reports for review and approval.
17. Operation and Maintenance Data
 - a. Submit to the Engineer as provided in Section 01730, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.
 - 1) Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.
 - 2) Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.
 - 3) Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings shall be bound in the manual, or contained in envelopes bound into the manual.

- b. Contents - Each volume shall contain the following minimum contents:
 - 1) Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.
 - 2) Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.
 - 3) Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.
 - c. Spare Parts List
 - d. Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.
18. Submit the following for each insulation by System: manufacturer's product data showing conformance with this Section for all required insulation, jackets, covers, coatings, adhesives, fasteners, supports and appurtenances; complete manufacturer's instructions for installation of all required items.
19. All materials deliveries must have accompanying manufacturer's certifications attesting to satisfactory results of product testing showing conformance with this Section.
20. Provide a recommended list of spare parts to be provided
21. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the Contract Documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.04 REFERENCE STANDARDS

- A. These standards shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. In case of conflict between published requirements, the Engineer shall determine which is to be followed.
- B. Abbreviation and the title of Federal, State and industry standards, technical societies, associations and institutes and other organizations which may be used are as follows:
 1. Associated Air Balance Council (AABC)
 2. American Conference of Governmental Industrial Hygienists (ACGIH)
 3. Air Diffusion Council (ADC)

4. American Bearing Manufacturers Association (ABMA)
5. Air Movement and Control Association (AMCA)
6. American National Standards Institute (ANSI)
7. Air-Conditioning, Heating, and Refrigeration Institute (ARI)
8. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
9. American Society of Mechanical Engineers (ASME)
10. ASTM International
11. Factory Mutual (FM)
12. Institute of Electrical and Electronic Engineers (IEEE)
13. National Institute of Standards and Technology (NIST)
14. National Environmental Balancing Bureau (NEBB)
15. National Electrical Code (NEC)
16. National Electrical Manufacturers Association (NEMA)
17. National Fire Protection Association (NFPA)
18. Occupational Safety and Health Administration (OSHA)
19. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
20. Underwriters Laboratories (UL)

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

1.05 QUALITY ASSURANCE

- A. Provide single source supplier/installer responsibility for the following systems or services:
1. ATC Equipment
 2. Thermal Insulation
 3. Testing and Balancing
 4. Air Conditioning Equipment
 5. Fans

- B. Provide single source supplier/installer responsibility for systems where specified in other related Sections.
 - 1. Automatic Temperature Controls - Operation and maintenance instructions. One Man-day.
 - 2. Testing and Balancing - Spot check HVAC system flows and system inspection during the first year of operation at District's request exclusive of repair, malfunction, or other trouble-shooting service calls. One Man-day.
- C. The insulation materials to be furnished under this Section shall be essentially the standard products of manufactures regularly engaged in the manufacture of insulation systems.
- D. Several manufacturers are indicated as acceptable for each type of insulation in these specifications. The insulation sub-contractor shall be responsible for determining that all insulation supplied for the project is suitable for installation in the spaces indicated. The insulation sub-contractor shall also insure that all materials used are compatible and in compliance with applicable codes and standards.
- E. All equipment of a given type included in this Section shall be furnished by or through a single manufacturer or as specified on the schedules
- F. Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.
- G. The District and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.
- H. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The District and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.
- I. All rotating parts of equipment shall be statically and dynamically balanced at the factory.

1.06 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.
- B. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the District by the manufacturer.
- C. All materials shall be suitably packed for shipment and long-term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

- D. All equipment shipped that is exposed such as on a flatbed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.
- E. Instruction for the servicing and startup of equipment in long-term or prolonged storage shall accompany each item.
- F. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.07 COORDINATION

- A. The Drawings indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.
- B. Coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.
- C. Assume full responsibility for coordination of the HVAC systems, including; scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.

1.08 ENGINEERING SERVICES

- A. When engineering services are specified to be provided by the Contractor, the Contractor shall retain a licensed professional engineer to perform the services. The engineer shall be licensed at the time the work is done and in the State in which the project is located. If the State issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.
- B. All work shall be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.09 MAINTENANCE

- A. Maintain and service all equipment and systems until the particular equipment or the system has been accepted by the District.
- B. Maintenance shall include compliance with the manufacturers operating and maintenance instructions as well as periodic cleaning or replacement of air handling system filters.
- C. Compile records of all maintenance and lubrication work performed on District or Contractor furnished equipment. Maintain records at the construction or installation site and make available at all times for review by the District or Engineer. At the request of the District or Engineer submit copies of these records to the District for information and/or review.

- D. Provide all special tools required for normal maintenance. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.
- E. Provide to the District a list of all spare and replacement parts with individual prices and location where they are available. Prices shall remain in effect for a period of not less than one year after start-up and final acceptance.

1.10 WARRANTY

- A. In the event that the equipment or components fail to perform satisfactorily at any time within the Defects Liability Period, the Contractor shall replace it with one capable of operating as specified and shall comply with the requirements in Division 1. The Contractor shall be responsible for all cost incurred in furnishing and installing the replacement equipment.

1.11 DEFINITIONS

- A. Particular terminology used under this Section is defined as follows:
 - 1. Traffic Level and Personnel Level - Areas, including process areas, equipment rooms, boiler rooms and other areas where insulation may be damaged by normal activity and local personnel traffic. Area extends to eight-ft above floor, walkways, platforms and stairs, and horizontally three-ft beyond the edge of walkways, platforms, and stairs.
 - 2. Exposed Piping and Ductwork - Piping and ductwork visible from the floor level and includes all piping and ductwork in equipment rooms, boiler rooms, etc.
 - 3. Concealed Piping and Ductwork - Piping and ductwork not visible from the floor level and includes piping and ductwork above hung ceilings and in shaftways.
 - 4. Supply Air Ductwork - Ductwork carrying air from a fan or air handling unit to the space or spaces to which it will be introduced. This air may have been heated or cooled or in the case of ventilation system the air would be neither heated nor cooled. Supply air ductwork extends from the fan or air handling unit to the registers, grills or diffusers at the end of the ductwork.
 - 5. Return Air Ductwork - Ductwork carrying air from the space it was supplied to back to a fan or air handling unit. Return air ductwork extends from the registers or grills at the end of the ductwork to the air handling unit or connection with an outdoor air intake duct.
 - 6. Exhaust Air Ductwork - Ductwork carrying air from a space to a fan and then to be discharged to the outdoors. Exhaust air ductwork extends from the registers or grills at the end of the ductwork to the fan. From the fan exhaust ductwork extends to the discharge point, exhaust air damper, or exhaust air plenum, whichever comes first.
 - 7. Relief Air Ductwork - Ductwork carrying air from a space without a fan to be discharged to the outdoors. Relief air ductwork extends from the registers or grills at the end of the ductwork, to the discharge point, relief air damper, or relief air plenum, whichever comes first.

8. Outdoor Air Ductwork - Ductwork carrying untreated air from the outside to a fan or air handling unit. Outdoor air ductwork starts at the intake point, outdoor air damper, or outdoor air plenum, whichever comes last. The outdoor air ductwork extends to the fan, air handling unit, or connection with a return air duct, whichever comes first.
9. Mixed Air Ductwork - Ductwork that can carry either return air or outdoor air or a combination of both. Mixed air ductwork starts at the connection of the return air and outdoor air ducts and extends to the fan or air handling unit.
10. Outdoor Air Plenum - A plenum that extends from the opening in the skin of the structure to the outdoor air duct. If the outdoor air damper is directly at the intake or there is no outdoor air damper, the plenum will extend to the first size reduction. If the outdoor air damper is not at the intake, the plenum will extend to the outdoor air damper.
11. Exhaust Air Plenum - A plenum that extends from the opening in the skin of the structure to the exhaust air duct. If the exhaust air damper is directly at the discharge or there is no exhaust air damper, the plenum will extend from the last size reduction. If the exhaust air damper is not at the discharge, the plenum will extend to the exhaust air damper.
12. Relief Air Plenum - A plenum that extends from the opening in the skin of the structure to the relief air duct. If the relief air damper is directly at the discharge or there is no relief air damper, the plenum will extend from the last size reduction. If the relief air damper is not at the discharge, the plenum will extend to the relief air damper.
13. Ventilated Spaces - Areas supplied with outdoor air on a continuous or intermittent basis. The outdoor air may be heated and/or cooled or untreated.
14. Heated Spaces - Areas where heat is supplied to maintain a minimum temperature during the heating season.
15. Unheated Spaces - Areas where heat is not applied and there is no minimum temperature during the heating season.
16. Conditioned Spaces - Areas that are provided with heating and mechanical cooling.
17. Non-Conditioned Spaces - Areas that are not provided with mechanical cooling.
18. Indoor Piping - Piping within a building that is not exposed to the weather.
19. Outdoor Piping - Piping that is not within a building and which is exposed to the weather.
20. Indoor Ductwork - Ductwork within a building that is not exposed to the weather.
21. Outdoor Ductwork - Ductwork that is not within a building and is exposed to the weather.
22. Hot Ductwork - Ductwork carrying air with a temperature above the surrounding space temperature.
23. Cold Ductwork - Ductwork carrying air with a temperature below the surrounding space temperature.

24. Hot/Cold Ductwork - Ductwork carrying air with a temperature that can be either above or below the surrounding space temperature.
25. Thermal Conductivity - The rate of heat flow through unit area of a homogeneous substance under the influence of unit temperature gradient in the direction perpendicular to the area. Units-BTU per (hour)(sq ft)(degrees F temp. difference)(per inch thickness).
26. Flues/Stacks/Breeching - Ductwork carrying products of combustion to atmosphere.

PART 2 PRODUCTS

2.01 ELECTRICAL EQUIPMENT

A. Electric Motors

1. Electric motors in NEMA frame sizes shall conform to the requirements in Section 01171, unless otherwise specified herein.
2. The motor manufacturer shall confirm that motors used to power equipment are provided with bearings that will provide a bearing life equal to the driven equipment or better. Confirmation shall be included with shop drawing submittal.
3. Motors will be selected to be non-overloading over the entire operating range of the equipment. A safety factor of 25 percent will be added to all motors up to and including 50 horsepower. A safety factor of 15 percent will be added to all motors over 50 horsepower. Motors indicated on the schedules are to be considered a minimum. This sizing is not to limit compliance with the above requirements

B. Electrical Equipment

1. Electrical equipment which is furnished under this Section shall meet the requirements specified in Division 16:
 - a. Disconnect switches, motor starters and combination motor starters (starters with disconnecting means and short circuit protection) shall be as specified in Section 16191.
 - b. Cord-connected controls for hazardous areas shall be provided with intrinsically safe relays, which shall be as specified in Section 16191.
 - c. Raceways, boxes, fittings and supports shall be as specified in Section 16110.
 - d. Wires and cables shall be as specified in Section 16120.

C. Electrical enclosures and panels to include automatic temperature control panels and components shall be suitable for the environment and electrical classification for the space they are located in. The type of enclosure for the various spaces shall be as specified in Division 16. Refer to the electrical drawings for the space classifications.

D. Where noted in the HVAC equipment schedules, or when shown on the Drawings, provide fan speed control switches and integral unit thermostats.

2.02 EQUIPMENT VIBRATION ISOLATOR AND MOUNTINGS

A. General

1. Unless otherwise specified in this Division all machinery or vibrating mechanical equipment shall be isolated from the building structure by vibration isolators with a minimum deflection as specified. Operating equipment that can transmit objectionable vibration and noise must be installed with special types of vibration isolators such as flexible connectors to ductwork, piping and wiring. In more critical areas and under particular conditions, additional vibration isolators shall be installed as specified in other related Sections in this Division, or in specific equipment schedules.
2. All equipment shall be provided with attachment points for floor or suspended mounting that will safely transmit all loads including seismic to the supports.
3. The vibration isolator manufacturer shall be responsible for the proper selection of vibration isolators suitable for the particular application. Selection of the vibration isolator shall include the following factors.
 - a. Equipment Weight
 - b. Equipment operating frequencies
 - c. Type of building support structure
 - d. Seismic forces as required by the applicable building codes to include shear, tension and compression due to the code specified loads.
4. All floor mounted vibration isolators shall be bolted to the floor or framing on which they rest. Bolts shall be arranged to prevent transmission of vibration through the bolts.
5. All isolation devices for a single piece of equipment shall be selected for a uniform static deflection according to distribution of weight in the equipment.
6. All pieces of equipment that have a variation in weight during operation or maintenance such as, but not limited to, cooling towers and hoppers, shall have built-in vertical limit restraints to limit motion to a maximum of 1/4-in.
7. Isolators exposed to the weather, in rooms classified on electrical drawings as damp, wet, or corrosive or where called for on the Drawings shall be provided with corrosion protection. Steel parts other than springs shall be galvanized. Parts subject to wear, rubbing, shall be non-corrosive material such as rubber or stainless steel. Springs and hardware shall be cadmium plated or otherwise provided with an approved coating.
8. After installation of equipment, isolators shall be adjusted for proper loading and distribution of weight.

B. Types - The following types of vibration isolators may be used.

1. Isolation Types for Floor Mounting
 - a. Single elastomer-in-shear isolators, molded mound shaped element designed for 1/4-in deflection under the imposed static load. Double elastomer-in-shear isolators shall be two such elements assembled in series or a molded element designed to provide 1/2-in deflection under the imposed static load. Elastomer-in-shear isolators shall be properly

housed to prevent bulging and shall be provided with adequate facilities for bolting to equipment and floor slab.

- b. Spring isolators shall be free standing and laterally stable and shall be equipped with acoustical-friction pads, leveling bolts and bolt holes for anchoring to floor slab. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection. Where housed springs are specified or required, provide units with telescoping cast iron or steel housing, containing one or more springs, complete with resilient alignment insert and a minimum of 1/4-in thick rubber or neoprene sound deadening pad bonded to the base of housing.
- c. Heavy load pads shall be 1-1/4-in thick and shall consist of a high load capacity elastomer pad and sandwiched between two 1/8-in thick steel load distribution plates capable of supporting loads up to 250 psi. For large pad area, steel plates of suitable thickness shall be provided to distribute the load.
- d. Light load pads shall be neoprene corrugated single, laminated double or laminated with 1/2-in thick fine granular composition cork sandwiched between two 1/4-in layers of corrugated, oil resistant neoprene. Pads shall be capable of loading to 50 psi.

2. Isolation for Suspension

- a. Isolation hangers for suspension of equipment and piping shall have a single element of elastomer for 1/4-in deflection, a double or a single molded element of 1/2-in deflection, a single spring element with an elastomer grommet for up to 3/4-in deflection and a combination of an elastomer and spring elements in series for one-in. deflection and up contained within a structural rigid one piece steel hanger box. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection.
- b. The neoprene element shall have a bushing to prevent hanger rod contact with the housing box. The lower rod shall be free to swing in a 30 degree arc without touching the spring or the housing.

3. Rails and Bases - Rails and bases shall be of the following types based on the equipment and deflection required.

- a. Rubber in shear type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall incorporate single or double deflection elastomer-in-shear fastened in place and a continuous steel floor bearing plate running the full length of each rail. The rails shall be drilled and tapped to accept the supported equipment and shall serve as a template.
- b. Steel spring type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall consist of structural members supported by individual free standing springs. The rails shall be drilled to accept the supported equipment and shall serve as a template.
- c. Fans and their driving motors shall be mounted on structural steel channel members forming a rigid base. A common member parallel to the V-belt drive shall run the full length of the fan and motor and shall be of sufficient rigidity to resist the bending stress of belt pull. The structural steel base shall incorporate single or double deflection elastomer-in-shear elements or free standing springs located for proper weight distribution. The base shall be drilled and tapped to accept the fan and motor and shall serve as a template. Integral motor slide rails shall be provided and welded in place.

- d. Unless specifically noted in other sections of the specification or on specific equipment schedules, all equipment will be provided with vibration isolation as defined by the following table:

Type of Equipment	Vibration Isolation Type	Minimum Deflection for Slab on Grade Inches	Minimum Deflection for up to 20-ft floor span inches	Minimum Deflection for 20-ft to 30-ft Floor Span Inches	Minimum Deflection for 30-ft to 40-ft Floor Span Inches
Condensing Units	Rubber	0.25	--	--	--
Air Handling Units	Rubber	0.25	--	--	--

C.

C. Rigidly Mounted Equipment

1. When equipment does not require vibration isolation, it shall be firmly attached to the building structure. Bolts and support structure shall include allowances for seismic loads as required by the applicable building codes to include shear and moment loads.

2.03 FLAME AND SMOKE RATINGS

- A. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive), and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with the ASTM E84, NFPA 255, and UL 723..
- B. These requirements apply to all circumstances whether the materials are field applied or applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project.

2.04 V-BELT DRIVES

- A. V-belt drives shall consist of the driver and driven sheaves and one or multiple matched V-belts. Select V-belt drives with belt horsepower ratings equal to or greater than 1.5 times the driving motor nameplate horsepower. Provide sheaves with steel, cast iron, or malleable iron split taper bushings and keyways on driven shafts of 3/4-in and larger diameter.

2.05 NOISE CRITERIA

- A. The selection of pumps, fans, air handling equipment, air conditioners, heating ventilating and air conditioning machinery and mechanical equipment and the installation of the system components such as duct work and piping shall be such as not to exceed to maximum permissible noise for non-equipment spaces as defined in Table 2, Design Guidelines for HVAC System Noise in Unoccupied Spaces contained in the 1995 edition of the ASHRAE Application Handbook. Under no conditions shall the noise created by equipment exceed the levels of permissible noise exposures of occupational areas as established by the OSHA and other Federal, State and local safety and health standards, codes and ordinances.

- B. The following sound criteria shall be met for all of the following listed equipment. Data shall be the sound pressure level (reference 20 micro pascals per octave band) and to include the dBA at 5 feet.

Equipment Identification	63	125	250	500	1000	2000	4000	8000	dBA
EF-1,2	84	82	81	79	74	69	65	62	68

- 1. The equipment supplier shall provide actual data for the equipment submitted. If the space does not meet the required criteria, and the noise level of the equipment is found to be the cause, the equipment supplier shall be responsible for the modifications required to correct the condition.

2.06 BEARINGS

- A. General - Furnish equipment bearings suitable for the intended equipment service. Furnish bearings designed to carry both thrust and radial loads for equipment designed for all angle operation.
- B. Provide extended lube lines with pressure relief equipped grease fittings for all bearings which are not readily accessible from outside the equipment.
- C. Bearings for all equipment in the schedule below shall have heavy-duty grease lubricated self-aligning ball or roller bearings. Bearings shall have ample thrust provision to prevent end play during the normal life of the bearing. Unless specifically noted otherwise, all fans shall have bearings for both the equipment and motors with the following ABMA L-50 life.
 - 1. Fans over 3000 cfm - 100,000 hours.
 - 2. Fan impellers greater than 10-in diameter
 - 3. Continuous duty fans with motors over 25 horse power 200,000 hours.
 - 4. All fans with motors over 50 horse power 200,000 hours.
- D. Belt driven fans, including air handling unit fans shall be equipped with self-aligning single row ball bearings, double row tapered or spherical roller bearings.
- E. For systems with bearings requiring L-50 lives of 200,000 hours or greater, the equipment supplier shall provide calculations for both the equipment bearings and the motor bearings to confirm the bearing selections. For belt drives, the calculations shall include the effect of the sheave size, number of belts, the sheave location on the shaft, and the location of the motor to the driven sheave.
- F. Provide seals for bearings installed in airstreams, exposed outdoors, and for applications in corrosive or dusty atmosphere.
- G. Provide bearings suitable for high temperature service where heat fan construction is required.

2.07 HANGERS, SUPPORTS AND ANCHORS

A. General

1. Furnish supports, hangers and other devices necessary to support and anchor firmly and substantially the piping, equipment and ductwork described in this Section. Piping and duct support systems shall include restraints as required by the applicable building codes to withstand seismic and wind loading. Design shall be provided by a professional engineer hired by the Contractor as specified in other sections. Signed and sealed calculations shall be submitted for record purposes.
2. All equipment, ductwork, piping, and supports that are installed outdoors shall be designed and installed to meet wind loadings as required by the Florida Mechanical Code, the Florida Building Code, all other applicable codes, and the requirements of this specification. All equipment shall be furnished with factory supports and/or tie downs to properly secure the equipment to applicable structure, equipment pad, etc. For all outdoor equipment, each equipment manufacturer shall provide a signed and sealed letter certifying that their equipment's unit integrity and anchoring system meet the requirements of the Florida Mechanical Code and the Florida Building Code.
3. All equipment shall be provided with lugs or brackets to allow the equipment to be firmly fastened to the structure. The lugs and brackets shall be sized to withstand the expected seismic and wind loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.
4. Design of hangers, supports, anchors and hold downs shall include the effect of all loads applied to the equipment, pipe or duct as well as the load of the component. These loads include, but are not limited to wind, seismic and internal dirt or liquid buildup.
5. Provide stainless steel hanger rods, hangers, supplementary steel, anchors and guides in areas classified as corrosive, wet, and in outdoor exposed applications.

B. Hangers and Suspension

1. Furnish and install all miscellaneous metalwork in accordance with Division 5 requirements.
2. Where C-clamp type hangers are used, furnish with a retainer strap.
3. Hangers shall not be supported from roof decking or bulb tees. Where required, provide supplemental steel to span between the building structures.
4. All piping supported at a maximum of 10-ft-0-in intervals. Hangers or rings, sized to fit outside the insulation.
5. All piping two-in diameter and smaller supported by pipe rings or bands with one 3/8-in adjustable steel rod hanger and one concrete insert.
6. Anchor piping mains where indicated or wherever necessary to limit pipe expansion and to prevent vibration. Furnish anchors constructed of steel securely bolted to masonry and welded to pipes.

7. Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as called for in the SMACNA standards, except as detailed below:
 - a. Rectangular ductwork 48-in wide and larger shall be supported by adjustable threaded rod.
 - b. Round ductwork 37-in and larger shall be supported by two adjustable threaded rods.
 - c. The following methods of hanger attachment to the building structure are NOT allowed. The numbers and letters refer to hanger methods shown in Figure 4-1, 4-2 and 4-3 of the 1985 edition of the HVAC Duct Construction Standards Metal and Flexible as published by SMACNA.
 - 1) "T" wrap around straps of open web joist.
 - 2) "W" bent over band on open web joist.
 - 3) "14" Friction clamps
 - 4) "17" Bent wire in metal deck.
8. All hanger and fastener material shall be of same finish as ductwork which they serve, e.g., galvanized, aluminum, black steel, etc. When a material other than the duct construction material must be used, the material used must be as corrosion resistant or greater than the duct material.
9. Perforated band iron or wire for supporting ducts shall not be permitted.
10. Duct supports at flexible connections shall be adjustable.

2.08 PAINTING AND COATINGS

- A. Unless otherwise specified, all machinery and factory finished equipment such as pumps, fans, air handling units, air conditioning units, and other items of manufacture shall be hot dipped galvanized or will have a factory applied finish, color as standard with the manufacturer. Components fabricated from stainless steel do not require a coating finish unless otherwise specified. All tanks, supporting steel, hangers, rods and all other uncoated or non-galvanized steel other than standard piping and fittings shall have a shop coat consisting of a suitable primer and finish coat. If not factory-applied, the prime coat shall be as specified in Division 9. All items not factory or shop primed prior to installation shall be suitably cleaned of rust and mill scale by wire brushing, sanding, or other means and prime painted, immediately after installation.
- B. The Contractor shall be responsible for the repair of all defects, blemishes, holidays and the like apparent in manufactures coatings and shall ensure that the materials used for such repair shall match and be compatible with the manufacturer's standard color, coatings and practices. Surfaces to be repaired or recoated are to be prepared as recommended by the paint or coating supplier. Care shall be taken not to paint over nameplates.
- C. Furnish touch up paint for the various types of equipment furnished and deliver unopened paint to the District at completion of the project. The amount of touch-up paint supplied shall be sufficient to cover 15 percent of the applicable painted surfaces or one pint, whichever is greater.

- D. Where specified, or called for on the following schedule, special corrosion resistant/protective coatings shall be provided. Whenever a protective coating is specified, the equipment shall be coated both inside and out. Whenever necessary to provide full coverage of the equipment, the equipment shall be completely disassembled to allow proper preparation and coating application. Any component that would block the coating process shall be removed. Equipment provided with gaskets or liners shall be coated before the application of the gasketing or liner. The equipment Vendor shall test rotating equipment after coating to confirm dynamic balance. If work needs to be done to correct the equipment balance, the integrity of the coating must be corrected after such work.
- E. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating are not acceptable.
- F. All items to be provided with a protective coating shall have the following data on the coating included with the unit submittal. Submittal shall include vendor data sheets on the specific coating being used, corrosion resistance data sheets, detailed application data sheets to include surface preparation procedures. For baked coatings submit a letter from the coating manufacturer, that the company doing the actual coating operation is an approved coating company. When an equipment supplier provides the coating, the information shall be supplied by the coating manufacturers.
- G. Inspection and Preparation of Coil prior to Cleaning and Coating
1. Coil shall be inspected for fin damage. Bent fins shall be straightened using the proper fitting fin comb. Tubes and tube "U" bends shall be inspected for dents, punctures or pinched areas. Where possible, and with equipment manufacturer's approval bent, punctured, pinched tube or "U" bend areas shall be repaired and leak tested by coating vendor's A/C technician prior to coating. Vendor shall securely seal all open tubes to prevent the infiltration of dirt, water, cleaning and coating solutions into the tube. The header tube shall be fitted with a Schrader valve and the coil placed under no less than five and no greater than 50 psi nitrogen blanket throughout the cleaning and coating process. The charge shall be recorded and verified following coating to ensure the coil was not damaged allowing cleaning or coating solutions to infiltrate the tube side.
- H. Cleaning and Conditioning of the Coil Fin and Tube Surfaces Prior to Coating
1. Following initial preparation of the coil, the coil shall be thoroughly cleaned using a non-etching and non-oxidizing detergent solution having less than 10-ppm chlorides, and formulated for use on ferrous and non-ferrous metals to remove shop soils, dirt, grease and oils from the surface of the coil fins, tubes and casings. Following the detergent cleaning the coil shall be thoroughly rinsed using clean filtered water to flush off soils removed by the detergent. The surface to be water break free when rinsed ensuring a clean surface. A non-oxidizing chemical solution sealer shall then be applied to enhance adhesion and provide secondary corrosion protection. The coil shall then be dried at temperatures up to 220 degrees F until thoroughly dry prior to applying the coating.

I. Coatings shall be of the following types:

1. MANUFACTURER STANDARD COATINGS

- a. Coating material shall be manufacturer's standard as specified in the schedule below. Surfaces shall be prepared, primed and coated as required by the coating supplier. Heat curing shall be provided where required by the coating supplier.

2. BAKED PHENOLIC (for heat transfer coils, dipped) TYPE 1A and TYPE 1B

- a. Type 1A- Coating Material Heresite P-413C baking phenolic with a plastizer or approved equal. The surface shall be degreased and etched or phosphatizing by immersion. The coating shall be applied in multiple coats by immersion, with a baking (partial cure) in an oven following each immersion. After the final immersion and the application of one (1) spray coat, the coating shall be completely cured with a baking at 400 degrees F. The coating shall provide a final dry film thickness of approximately two mils.
- b. Type 1B – Coating material Husky Coil Coat and Husky E-Vap Coat from Bronz-Glow. Coil shall receive corrosion protection treatment from a qualified coating vendor through application of vendor's in-house dip coating process. The coating material applied by this process shall have passed a minimum 3,500 hours salt spray test in accordance with ASTM B-117.85. Coating solution shall provide effective corrosion protection throughout the entire pH range of 1.0 to 14.0. Coating material shall consist of a synthetic polyelastomer material having properties of a minimum 5,000 psi tensile strength, 400% or greater flexibility, 250% or greater elasticity to prevent chipping, cracking or flaking, have negligible (less than ½ of one percent) effect on heat transfer coefficients, coating shall contain a UV inhibitor rating at 10 year Florida sun protection and coating shall be of a type that can be repaired in the field in the event of damage to the coating. The protective coating shall be applied by dip application (complete immersion) of the coil into the coating solution. Following curing of the coating the dry mill thickness of the coating shall be not less than 1 or greater than 1½ dry mills. Following dip coating the coil fin edges shall be sprayed to enhance fin edge coverage then the coating shall be cured at temperature of not greater than 200°F until fully cured.
- c. Equivalent complete immersion coating products by ElectroFin or equal will be considered upon Engineer's review and approval of product data, application data, and corrosion resistance data.

3. BAKED PHENOLIC (equipment) TYPE 2A and TYPE 2B

- a. Coating Material Heresite baked phenolic coating. The surface shall be prepared by degreasing with an appropriate solvent. Steel surfaces for immersion shall be sand blasted in accordance with NACE No.1 or SSPC-SP5. Steel surfaces for non-emersion shall be sand blasted in accordance with NACE No. 3 or SSPC-SP6. Surface profile shall be 20 to 25 percent of dry film thickness in accordance with the supplier's recommendations. Thinner where required shall be of the same manufacturer as the coating. Coating shall be applied by spraying in multiple passes. The piece shall be baked in accordance to the manufacture's time and temperature schedules with the final baking at 400 degrees F.
- b. Type 2A - Heresite P-403 baked phenolic coatings. Dry film thickness shall be five to seven mils applied in three to four coats.

- c. Type 2B - Heresite P-413 baked pheniloc coating. If surface cannot be adequately cleaned use Heresite P-700A primer in accordance with the manufacturer's recommendations. Dry film thickness shall be four to six mils applied in four to five coats.
 - d. Equivalent complete immersion coating products will be considered upon Engineer's review and approval of product data, application data, and corrosion resistance data.
 4. AIR DRIED PHENOLIC (equipment) TYPE 3A and TYPE 3B
 - a. Type 3A - Coating Material Heresite VR-507 air dried phenolic coating. The surface shall be prepared by degreasing with an appropriate solvent. Steel surfaces for non-immersion shall be sand blasted in accordance with NACE No. 3 or SSPC-SP6. Surface profile shall be 20 to 25 percent of dry film thickness. If blasting is not possible, the surface shall be primed with Heresite P-750 in accordance with the supplier's recommendations. Dry film thickness shall be 0.5 to 0.75 mills. Thinner where required shall be of the same manufacturer as the coating. Coating shall be applied by spraying in multiple passes. The piece shall be dried in accordance to the manufactures time schedule. The equipment shall be given a minimum of three coats resulting in a dry film thickness of four to six mils. All equipment coated with VR-500 shall be given a topcoat of Heresite UC-5500. The UC-5500 series shall be applied by spraying and shall have a dry film thickness of 4 to 5 mils.
 - b. Type 3B - Coating material Husky SPC or Husky Pat Coat and Lin Coat from Bronz-Glow. When spray coating interior or exterior metal surfaces for corrosion protection vendor shall prepare the coated or uncoated metal surface in accordance with coating manufacture's specification. Coating shall have passed 3,000 hours salt spray test in accordance with ASTM B-117.85 Coating shall be a synthetic resin elastomer having a minimum 300% flexibility, 200% elongation, and effectively provide protection throughout the entire a pH range of 1.0-14.0. The coating shall be applied to a dry thickness of four to six mils. Coating to be field repairable in the event of damage to the coating. Following coating application coating shall be fully cured in accordance with manufacture's specifications prior to being placed in service or packaged for shipment.
 - c. Equivalent spray-on or roll-on cabinet coating products will be considered upon Engineer's review and approval of product data, application data, and corrosion resistance data.
 5. AIR DRY SPRAY ON COATING (Equipment, coils, fins, etc.) TYPE 4A and TYPE 4B
 - a. Type 4A - Coating Material Adsil Micro Guard HVAC/R Coil and Fin Clear Protective Treatment AD35. Surface preparation, mixing and catalyzing, application, and clean-up shall be in strict accordance with the manufacturer's instructions. All recommended cleaning agents (Micro Kleen products) shall be utilized and applied per the manufacturer's instructions. Drying times and curing times shall be in accordance with the manufacturer's time schedule.
 - b. Type 4B- Coating Material Husky Coil Coat from Bronz-Glow. Prior to spray coat application the coil shall be cleaned and in accordance with the coating manufacturer's specifications. Coil shall be allowed to dry thoroughly after cleaning prior to applying the coating. Coil shall receive corrosion protection treatment from a qualified coating vendor through application of vendor's in-house or field applied spray coating process. The coating material applied by this process shall have passed a minimum 3,000 hours salt spray test in accordance with ASTM B-117.85. Coating solution shall

provide effective corrosion protection throughout the entire pH range of 1.0 to 14.0. Coating material shall consist of a synthetic polyelastomer material having properties of a minimum 5,000 psi tensile strength, 400% or greater flexibility, 250% or greater elasticity to prevent chipping, cracking or flaking, have negligible (less than 1/2 of 1%) effect on heat transfer coefficients, coating shall contain a UV inhibitor rated at 10 year Florida sun protection. The unit to be disassembled to the point to where the face of the coil from both sides are exposed and can be coated. The vendor shall further ensure the “U” bend and header areas shall also be exposed to allow maximum coating coverage on both the inner and outer radius of the “U” bend and header surfaces. The protective coating shall be applied by spray application on both sides of the coil and using a method that ensures maximum coating penetration into the fin area. Following curing of the coating the dry mill thickness shall not greater than 1½-2 dry mills. Following coating the coil shall be cured in accordance with coating manufacturer’s specification prior to restoring power to the unit. It is not recommended a coil of more than two rows be spray coated. Cabinet coating shall be Type 3B as described above.

- c. Special care must be taken to follow coating manufacturer’s instructions for coating coils to be sure that the entire surface of the fins and the tubes in the coil are coated. It is imperative that as much of the internal coil surfaces be coated as possible to prevent failure of the coil.
 - d. Equivalent spray-on coil coating products by Heresite (PC-2000 with PC-2000-C cabinet coating), Blygold (PoluAl coil coating with Type 3A or equal cabinet coating), Thermoguard (Total Coat), or equal will be considered upon Engineer’s review and approval of product data, application data, and corrosion resistance data.
- J. Coatings shall be factory applied by the equipment manufacturer/supplier. If this is not possible, coating shall be applied by a specialty shop under contract to the equipment manufacturer/supplier.
1. Corrosion protection shall be provided, by an authorized coating vendor for each applicable unit component as specified herein. A “Certificate of Coating Compliance” shall be issued by the coating vendor verifying use of the specified products and processes. Coating vendor shall supply District a written “Owner’s Coated Coil Cleaning Service and Maintenance Manual”. Aforementioned certificate and manual shall be submitted upon completion of the project with all other closing documents.
 2. Prior to shipment or installation of a coil into a cabinet coil shall be pressure tested to 110% of operating pressure and held for 45 minutes to ensure no leaks have occurred. Coil shall then be evacuated and placed under nitrogen blanket or installed in the cabinet.
 3. When coil is being shipped as a single unit, vendor shall protect coil tubes from soil or moisture infiltration by shipping coil under a nitrogen blanket of not less than 5 psi on the fluid side. Coil shall be tagged advising coil is under nitrogen blanket and psi rating of the nitrogen blanket.
 4. Following installation of coil into the cabinet coating vendor’s a/c technician shall place coil under a 200-400 micron vacuum to ensure integrity of coil and absence of moisture within the coil.

5. Coil shall be issued a registration number and number shall be affixed to the coil by means of a non-removable polymer seal. Coating vendor shall maintain a job warranty file for each coil coated for the period of the warranty.
 6. After coating application is completed, the equipment manufacturer/supplier shall test the equipment and certify system operation prior to releasing the equipment to the job site.
- K. Any holidays, runs, sags, blisters, or inclusions in the coating are unacceptable and will be corrected. With the approval of the engineer, small areas no more than four-in. by four-in. may be corrected in the field. Larger faults shall be returned to the coater to be repaired. The faulty material shall be removed by sanding and in the case of blisters, the edges feathered. The material used for recoating shall be manufactured by the same manufacturer as the original coating and shall be suitable for field repairs. The touch up material shall have the same corrosion resistance as the original coating, and if the original coating required an ultraviolet protection, the same protection will be provided as part of the repair. The final mil thickness of the repaired coating shall be equal to the originally specified thickness. Where baked coatings have been damaged, the repair shall be made with heat applied to the repaired surface to cure the coating. After curing a solvent test as recommended by the manufacturer shall be used to confirm that the coating is cured.
- L. The coating manufacturer shall supply direct to the engineer, a set of coupons showing the final appearance of the cured coatings. Any coating that does not match the supplied coupons will be rejected.

2.09 TESTING, ADJUSTING AND BALANCING

- A. Furnish the services of an AABC or NEBB certified agency for the testing, adjusting and balancing of all HVAC air systems installed under this Section.
- B. The testing, adjusting and balancing agency shall be independent of all suppliers, installers and contractors on the project.
- C. Refer to Section 15990 Testing, Adjusting and Balancing for additional requirements.

2.10 INSULATION

- A. Provide insulation adhesives, coatings and vapor barrier materials, which are compatible and recommended, for use by the insulation manufacturer. Submit a certified statement from the insulation manufacturer attesting to their approval of the adhesives, coatings, and vapor barrier materials. The following adhesives and coatings, as manufactured by Foster Div.; H.B. Fuller Co. or Childers Products Co. are representative of approved products that meet the above requirements. (Other manufacturers who demonstrate to the Engineer that their products are equivalent are acceptable.)

1. Lagging adhesive: 30-36, CP50, AMV-1.
2. Vapor barrier coating: 30-35, CP30.
3. Vaporseal adhesive: 85-75, CP82.
4. Duct adhesive: 85-20, CP82.

5. Sealing compound adhesive: 30-45, CP70.
 6. Weatherproof mastic: 35-01, CP10-1.
- B. Closed cell foam type insulation applications include, but are not limited to:
1. Refrigerant Piping - Suction Lines
 - a. Insulation Material - Preformed flexible closed cell foam sheet, minimum density 5.5 lbs/cu ft, maximum "K" factor of 0.27 at 75 degrees F mean temperature.
 2. Condensate Drain Piping - Air Conditioners
 - a. Insulation Material - Preformed flexible closed cell foam sheet, minimum density 5.5 lbs/cu ft, maximum "K" factor of 0.27 at 75 degrees F mean temperature.
- C. Fiberglass board type insulation shall include but not be limited to the following:
1. Exposed rectangular hot, cold and hot/cold ductwork.
 - a. Insulation Material - Fibrous glass insulation, minimum density three lbs/cu ft and a maximum "K" factor of 0.24 at 75 degrees F mean temperature.
 - b. Facing - Factory applied vapor barrier 0.02 perm, consisting of glass fiber scrim reinforced laminated facing of two mil aluminum foil and kraft paper.
- D. Acceptable manufacturers shall be Armstrong Cork; Certain-Teed; Owens Corning; Manville or equal.

2.11 PIPE AND FITTINGS

- A. Condensate Drains
1. Pipe - Copper tube ANSI H23.1 Type K or ANSI H23.6 Type DWV hard drawn. Fittings - Soldered cast brass or wrought copper drainage fittings ANSI B16.29.
 2. Solder - 95 percent tin and five percent antimony per ASTM B32, Alloy 95TA.
- B. Refrigerant Piping
1. Pipe - Type K hard drawn copper, pre-cleaned, inert gas filled, and capped. Fittings - Soldered wrought copper.
 2. Solder - Hard silver solder with a minimum melting point of 1,300 degrees F. Fit up and solder joints while using an inert gas purge.

2.12 PACKAGED HEATERS

- A. Unit Heaters
1. Unit heaters shall be substantially constructed, self-contained factory-assembled unit consisting of heating element, fan, motor, housing, outlet diffuser or vanes. They shall be the suspended or wall-mounted type arranged for horizontal or vertical air flow, as shown

on the Drawings and Schedules. Casings shall be painted with a primer and finished with baked-on enamel at the factory. Heavily brace and stiffen all parts to prevent vibration and hold all working parts rigidly in line. Casing sides shall be readily removable for access to interior parts. Casings of suspended-type units shall be designed for direct attachment of the hangers. Provide adjustable, horizontal and vertical vanes, nozzles or diffusers, arranged to give uniform air distribution without objectionable drafts for each heater. Furnish hanger brackets and other accessories as scheduled.

2. Heaters designated on the schedules as being corrosion resistant shall be constructed with Monel fin tube elements; have all fan, casing and sheet metal parts epoxy coated; have epoxy painted totally enclosed permanently lubricated ball bearing motors.

2.13 AIR HANDLING UNITS

A. In general, all air handling units, package, thru the wall type and split systems shall be factory assembled with cabinet fan, heating and/or cooling section, filters, dampers, access sections with hinged access doors, motor, motor base, drive, drive guard and vibration isolators.

1. Units shall be designed to provide an integrated assembly when all of the components are assembled. All transition sections and filler pieces required between sections are to be provided as part of the unit.
2. Support brackets or rails are to be provided with the unit. Type of support is to be as required by the schedules and as shown on the Drawings, e.g., hung, floor mounted, etc. All air handling units shall be provided with lugs, brackets or field supplied devices to allow the unit to be firmly bolted to the structure or fastened to specified vibration isolators. The lugs, brackets or field supplied devices shall be sized to withstand the expected seismic loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.

B. Casings

1. Casings shall be galvanized sheet steel construction with structural framing members as required. Pressure class rating shall be for the total fan static pressure. All sections of the unit shall be of the same pressure class.
2. Units for outdoor installation shall comply with the following:
 - a. Materials of construction shall be corrosion resistant, or provided with a corrosion resistant coating system for weather protection.
 - b. The casing shall enclose all components for weather protection, with gasketed access doors provided for all sections to facilitate maintenance. Doors shall have provision for key locking to prevent unauthorized tampering.
 - c. Top of housing shall be constructed to prevent buckling and ponding of water.

C. Fan Section

1. Fans shall be centrifugal cabinet fans with belt or direct drive as scheduled. Extended external lubrication fittings shall be provided.
2. On belt driven fans, mount motor on an adjustable slide base, equipped with jack screws.

3. Where scheduled, backwardly curved wheels shall be air foil type.
4. All fans shall be statically and dynamically balanced before shipment.
5. Whenever possible, fans shall be AMCA certified for sound and air performance, per AMCA 210-85 and AMCA 330-86.
6. Where called for on the schedules, fans shall be of spark resistant construction. On spark resistant fans, bearings shall not be placed in the air stream. Construction shall conform to AMCA 99-0401-82 Classification.
7. Fan bearings shall be furnished as specified elsewhere in this Section.

D. Cooling Section

1. Cooling coil section shall be insulated with drain pan, coil support slide rails and coil closure plate. Coil mounting shall minimize air by-pass around the coil. Provide insulated drain pan with a corrosion resistant lining and drain connections on both ends of the drain pan.
2. Refrigerant cooling coils shall be cartridge type with copper tubes, aluminum fins, galvanized steel frame, copper suction header and distribution tubes. Fins shall be mechanically attached to the tubes. Coils shall be pressure and leak tested at 300 psig with air under water. Coils shall be certified per AHRI Standard 410.

E. Heating Sections

1. Heating section shall be insulated. Where heating is provided by coils, coil support slide rails and closure plates shall be provided.
2. Location of heating sections, preheat and reheat, shall be as shown on the schedules or Drawings.
3. Electric Heating Coils
 - a. Electric heating coils shall be open resistance heating type with coil and unit UL listed. Coils and coil controls shall meet NEC requirements. Coil frame shall be galvanized steel with vertical element supports. Elements shall be insulated from the supports with ceramic bushings.
 - b. Factory wired controls shall be provided in the unit control panel. Panels shall include all safety controls and interlocks, step control relays and devices and terminal strip for remote wired devices. Step control sensors and step controller will be provided under the temperature control portion of the specification. Control voltage shall not exceed 120V.
 - c. Electric heaters must comply with the latest NEC and UL requirements and shall include the following:
 - 1) Primary over-temperature, thermal cut-out (automatic reset).
 - 2) Secondary thermal protection (manual reset).
 - 3) Zero clearance construction. Maximum current of 48 Amps per circuit.
 - 4) Interlock between fan and heater control circuit.
 - 5) A disconnect switch at or within sight of magnetic contactors.

- 6) Factory dielectric test of electrical insulation.
- 7) Fusible links (heat limiters) for thermal protection will not be accepted.
- 8) All three phase duct heaters shall have balanced three phase circuits. Where duct heaters draw more than 48 Amps, each circuit must have fused or circuit breaker protection.
- 9) Pressure type minimum airflow switch.
- 10) The following built-in accessories and controls, in addition to the NEC and UL required safety controls, shall be housed in the terminal box, magnetic contactors for automatic temperature control, control circuit transformers and a fusible disconnect switch with visible break and external operating handle with direct linkage to disconnect switch.

F. Filters

1. See air handling unit schedules for filter types by unit.
2. Filter Box shall have tracks for the specified filter types, except roll filters, to allow filter replacement from either side. Sealing material shall be provided at tracks and ends to prevent air by-passing the filters.
3. Disposable Filters shall be framed filters, two-in. thickness (as scheduled). Filter pressure drop for clean filters at 300 fpm face velocity shall be 0.15-in wg for two-in. thick filters. Filter shall have 30 to 35 percent efficiency on ASHRAE test standard 52-76. Manufacturers and type shall be American Air Filter Co., Am Air 300X; Farr Co., 30/30 Disposable or equal.
4. A total of three complete sets of filter media shall be provided for each unit.

G. Condensing Unit

1. Condensing unit shall consist of casing, compressor(s), refrigerant piping system, condenser, condenser fans and drives and factory wired controls and panel.
2. All rotating components shall be internally isolated with vibration isolators from the main unit.
3. Condensing unit for split systems shall be designed and constructed for mounting remote from its associated air handler with field fabricated interconnecting refrigerant piping, including associated specialties.
4. Refrigerant compressors shall be of the type, number, and capacity specified on the schedules. Compressors shall be provided with unloading or hot gas by-pass as required by the schedule. Compressor shall include suction strainer, crank case oil sight glass, oil strainer and oil heater and forced feed lubrication. Compressor controls shall include three-phase manual reset overload protection, hi-low refrigerant pressure cutout, manual reset low oil pressure cutout, non-cycle pump down relay. In addition, multiple compressor units shall have a compressor sequence switch.
5. Air cooled condenser shall have propeller or centrifugal fans as shown on the schedules. Exposed fans shall be provided with fan guards. Coils shall have copper tubes, aluminum fins, galvanized steel frame and copper headers. Fins shall be mechanically attached to the tubes. Coils shall be pressure and leak tested at 425 psig with air under water.

- H. A complete refrigerant piping system shall be factory fabricated and installed in the unit. Each compressor shall be provided with a complete and independent refrigerant piping system.
1. Piping shall be Type K copper tubing with joints silver brazed. Brazing shall be done with an inert gas purge. Suction lines shall be insulated with closed cell foam insulation. Hot gas piping shall be insulated to protect personnel as required.
 2. Valves shall be bronze body brazed connection and shall include compressor and condenser relief valves, condenser liquid line service valve, refrigerant charging valve, compressor discharge, suction service valves, liquid line solenoid and thermal expansion valve.
 3. Complete refrigerant system shall be cleaned, leak tested and charged with refrigerant.
 4. Size of field fabricated piping for split systems shall be determined by the equipment manufacturer.
- I. Unit Control Panel
1. For split systems, factory wired control panel shall be furnished and mounted on the unit. Panels shall include all controls required in other sections and all safety controls and interlocks, heavy duty fused visible break disconnect, control devices, motor starters and terminal strip for remote wired devices. Control type and sequence shall be as specified in other related Sections or on the Drawings. Control voltage shall not exceed 120 Volts. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door. Step control sensors and step controller will be provided under the temperature control portion of the specification unless specified with unit on the equipment schedule.
 2. Furnish electric heater section controls as scheduled and in accordance with the controls specified under Electric Duct Heaters, elsewhere in this Section.
 3. Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification.
 4. The type of enclosure shall be as specified in Division 16.
- J. Accessory Sections
1. Accessory sections shall be as shown on the Drawings and Schedules, and as required for the unit type.
 2. Furnish aluminum or steel dampers in accordance with requirements specified under ATC Equipment elsewhere in this Section. Mixing box dampers shall be parallel blade type and where dampers are used for outdoor air shutoff service, they shall be low leakage type. Manual dampers shall be provided with an external position indicating handle with a positive locking device.
 3. Dampers shall be opposed blade type with blades mounted on 1/2-in minimum steel rods. Dampers shall be provided with low friction bushings and edge gaskets to reduce air leakage. Blades shall be sectionalized to limit unsupported blade length and warping at full system fan static pressures. Maximum damper blade width shall not exceed six-in. Manual

dampers shall be provided with an external position indicating handle with a positive locking device.

4. Mixing boxes shall be of the configuration shown on the Drawings. Deflection plates shall be provided if required to maintain even air flow over coils and prevent stratification.
5. The dampers for all units that require corrosion resistant coatings shall be supplied under this section. Materials and construction shall be as required for the ductwork materials to which the unit is connected.
6. Spacer and access sections will be provided where specified or required. Access sections shall have hinged doors on each end except for filters.
7. Inlet and discharge louvers for outdoor mounted units shall be weatherproof design.
8. Factory fabricated insulated curbs shall be provided where shown on the schedule and/or Drawings. Curbs shall be galvanized steel construction with corrosion resistant coating. Unless otherwise specified, curbs shall include provisions for supply and return air duct and piping connections to the area below. Where the roof is pitched the curb shall be constructed to match the pitch and provide a level surface at the top of the curb for the unit to mount on.

2.14 DUCTWORK

- A. Sheet metal ductwork shall be constructed of the materials specified using the gauges or thicknesses and reinforcing called for by SMACNA for the material specified. Unless otherwise specified, all components of duct systems shall be constructed of the same material as the ductwork. This is to include braces and turning vanes.
 1. Galvanized steel ductwork shall be constructed of hot-dip galvanized sheet steel, per ASTM, A525 and A527.
 2. Aluminum ductwork shall be constructed of 3003H-14 alloy B&S Gauges.
- B. Ductwork shall be constructed of the following materials and to the following standards:

<u>System</u>	<u>Location</u>	<u>Static Pressure</u>	<u>Construction Material</u>	<u>SMACNA Standard</u>
Supply & Exhaust	Pump Room	±2-inch WG	AL	M&F
Supply & Exhaust	Electrical Room	±2-inch WG	GS	M&F

Abbreviations

M&F	-	SMACNA HVAC Duct Construction Standards - 1st Ed. - Metal & Flexible
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* except where listed otherwise in this table

AL = Aluminum
GS = Galvanized Steel

- C. Design of ductwork shall include all loads applied to the ductwork, in addition to the load of the duct. These loads include but are not limited to wind, snow and internal dirt or liquid buildup.

2.15 DUCTWORK CONSTRUCTION

- A. All ductwork shall be substantially built with joints and seams smooth on the inside and given a neat appearance on the outside. Inside surfaces and joints shall be smooth and free from pockets, burrs and projections. All joints shall be substantially air tight with laps made in the direction of air flow and no flanges projecting into the air stream. All changes in direction and duct transitions shall be shaped to permit the easiest possible air flow.
- B. Pressure Classes
1. Pressure classes for determination of sheet metal gauge and reinforcing shall be as defined by the latest issue of the SMACNA standards for duct construction.
 2. For ductwork with a static pressure higher than two-in. water gauge, pressure class shall be as shown on the Drawings. For ductwork with a static pressure two-in. water gauge or less pressure class shall be equal to the maximum pressure indicated for the fans or air handling units on the Schedules and the pressure class shall be the same for the entire length, including branches, of the specific duct system.
- C. Rectangular Ductwork
1. Ductwork shall be constructed as shown on the Drawings in accordance with the specified SMACNA Construction Standard, latest edition.
 2. Cross-breaking shall conform to SMACNA Standard. Cross-breaking shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure rigidity for each panel.
 3. All square elbows for rectangular ductwork shall be provided with turning vanes unless otherwise noted on the Drawings. Turning vanes shall be as detailed in the SMACNA Manual and or as shown on the Drawings.
 4. Alternate Construction (Rectangular Only) - Factory-fabricated joint systems may be offered as an alternate form of construction. The system offered shall meet all requirements of SMACNA. Alternate joint systems shall be "Ductmate System" as manufactured by Ductmate Industries, Inc., installed in accordance with the manufacturer's recommendations. The system shall be sealed for zero leakage and angle attachment to the main duct section shall be by tack welding. The use of screws is not allowed.
- D. For duct lining, see Ductwork Installation; PART 3.

E. Volume Dampers

1. Dampers shall be standard opposed or parallel multi-blade type on two-in. channel frame, flanged connection with external damper position indicator, manual adjustment, and position locking arrangement. Damper blades shall not exceed six-in. in width. Dampers shall be constructed of the same material as the ductwork, or of a material of equal corrosion resistance. Balancing and balancing/shutoff dampers shall be opposed blades and shutoff dampers shall be parallel blade.
2. Locking quadrants shall have a positive method of holding the damper in its selected position such as a bolt through both the quadrant and the lever arm. Systems using springs or other devices that can vibrate loose are not acceptable.
3. Where manual dampers are used for shut off service, dampers shall have a replaceable butyl rubber or bulb vinyl seals provided with the damper. Install seals along the top, bottom and sides of the frame and along each blade edge.

F. Access Doors

1. Access doors shall be 24-in by 24-in minimum, except where the duct size is less than 26-in, where the largest door that will fit the duct will be used. Unhinged access panels are not acceptable, except where shown on the Drawings. Access doors shall be of the same material as the duct, pan type construction for metal ductwork, with smooth edges and fitted seals, constructed and installed for air-tight fit with ease of opening and closing. Doors shall be substantially butt hinged, with heavy sash locks and substantial door pulls. Door openings and door frames shall be reinforced with bar stock or angle. Where ductwork is installed with duct liner or exterior duct insulation, the access door shall be of the insulated type. Access doors may be factory fabricated. Where ductwork is constructed of aluminum or stainless steel, access door hardware shall be of similar material.

G. Fasteners

1. Sheet metal screws, drive cleats, cinch bands and other fasteners shall be fabricated from materials with an equal or greater corrosion resistance than the ductwork in which they are installed. Where a material other than the duct material is used, it shall be approved by the Engineer before installation.

2.16 DIFFUSERS, REGISTERS AND GRILLES

A. General

1. All diffusers, registers and grilles shall be of the shape, sizes, capacity and type as shown on the Drawings.
2. On all duct openings that do not have a specific diffuser, register, grill or mesh covers, provided a wire mesh cover.
3. Finish - Unless, otherwise specified, diffusers, registers and grilles shall have the following finish. All diffusers, registers and grilles located in ceilings shall have a baked white enamel finish except where the ceiling system has an exposed aluminum support grid. Where the ceiling has an exposed aluminum support grid the diffusers, registers and grilles

shall have a baked aluminum enamel finish. All diffusers, registers and grilles not located in ceilings shall have baked aluminum enamel finish.

B. Wire Mesh Covers

1. Where wire mesh covers are called for on the Drawings, the wire mesh and support frame shall be the same material as the duct where the cover is installed. Unless otherwise noted the wire mesh shall be 0.5-in mesh.
2. The wire mesh shall be contained in a metal frame. The mesh shall be firmly attached to the frame to prevent it being pulled out of the frame by casual contact. The frame shall be a minimum of 16 gauge sheet metal or the minimum gauge for a flange based on SMACNA, whichever is greater. The frame shall be on both sides of the mesh creating a sandwich with the mesh in the middle. Fastenings shall go through the frame on both sides of the cover.

2.17 ATC EQUIPMENT

A. Area Classification

1. Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification as specified in Division 16. Special attention shall be given to hazardous areas specifically "Class I Div. 1 Group D" and "Class I Div. 2 Group D" to comply with code requirements for equipment selection and installation procedures.

B. Room Thermostats

1. Electric room thermostat shall be of the heavy duty all metal type, provided with concealed adjustment and exposed thermometer.
2. Temperature sensors shall be of the wire-wound resistive element type (RTD) using either nickel or platinum alloy as the resistive element. All temperature sensors shall have an end to end (element to readout display) accuracy of plus or minus 0.5 degree F.
3. Room thermostat and temperature sensors mounted on exterior walls shall be provided with insulated mounting plates.
4. All room thermostats and sensors shall be mounted five-ft-six-in. above finish floor except where otherwise indicated on the Drawings or specified herein.
5. Electric thermostats in corrosive areas shall be installed in electric boxes with remote stainless steel bulbs.

C. Ionization Type Smoke Detectors (Four Wire Type)

1. Furnish and install ionization type smoke duct detectors in the supply air duct and return air duct or plenum of each air handling unit and in the exhaust air duct of systems which exhaust greater than 50 percent of the supply air. This applies to all air systems of 2000 cfm or greater or where shown on the Drawings.

2. The detector housing shall be listed per UL 268A specifically for use in air handling systems. The detector shall operate at air velocities of 500–4000 feet per minute. The detector housing shall be equipped with an integral mounting base capable of accommodating either photo electronic or ionization detector heads. It shall be capable of local testing via remote testing station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL 268A, Standard for Smoke Detectors for Duct Applications. The housing shall be capable of mounting to either rectangular or round ducts without brackets. An integral filter system shall be included to reduce dust and residue effects on detector and housing, thereby reducing maintenance and service.
3. Detectors shall be provided with two sets of contacts to provide smoke alarm signals. One is to be used by the ATC systems, and the second is for use in Division 16 for interface to fire alarm system.
4. Remote test switch and alarm indicator stations shall be furnished for all duct smoke detectors as specified above. The installation and wiring of the remote stations will be provided under this Section. The remote test stations shall be wall mounted within the visible location of the smoke detector and easily accessible from the floor.

D. Dampers

1. Automatic dampers shall be parallel or opposed blade as specified under "Sequence of Operation."
2. All damper frames are to be constructed of the same material as the duct or a material with greater corrosion resistance sheet metal and shall have flanges for duct mounting. Damper blades shall not exceed -in in width. All blades are to be of corrugated type construction, fabricated from two sheets metal, spot welded together. Blades are to be suitable for high velocity performance. Maximum blade length in any section shall be 48-in. Additional stiffening or bracing shall be provided for sections exceeding 48-in in height. Multi-section dampers shall be provided with sufficient interconnecting hardware to provide unison operation of blades in the entire assembly.
3. All damper bearings shall be made of nylon.
4. Replaceable butyl rubber or bulb vinyl seals are to be provided with the damper. Seals are to be installed along the top, bottom and sides of the frame and along each blade edge. Seals shall provide a tight closing, low (one percent) maximum leakage damper.
5. Dampers shall be selected for the velocity and pressure differential required without excessive deflections.
6. Modulating dampers shall be of opposed blade construction. Dampers for two position operation may be single direction multiple-leaf type.
7. Dampers may be furnished for in duct mounting and with face linkages if the following conditions are met.
 - a. Service is for supply or makeup air in either process or non-process areas or service is for return or exhaust of non-corrosive air.
 - b. Space is available to install a 24 by 24 (minimum) access door in the duct on the linkage side of the damper.

8. Dampers shall be furnished for flange mounting with exposed jamb mounted blade linkages for any of the following applications:
 - a. Where installation clearances do not allow the installation of full size access doors to allow inspection and adjustment of face linkages.
 - b. For corrosive, dirty or particle laden air service.
 - c. Where called out on the Drawings.

E. Electronic Damper Actuators

1. Electronic actuators, less than 600 in-lb of rated torque, shall have ISO 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification. Electronic actuators used on dampers shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable.
2. Actuators shall be fully modulating/proportional, pulse width, floating/tri-state, or two position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required. Proportional actuators shall be capable of digital communication, as built.
3. Two sets of DPDT switches with fully adjustable set points shall be provided to activate panel indicators and provide signals for equipment operation.
4. Actuator shall have an operating range of minus 22 to 122 degrees F.
5. Proportional actuators shall accept a 0 to 10 VDC or 0-20 mA input signal and provide a two to 10 VDC or 4-20 mA (with a load resistor) operating range.
6. Actuators shall be capable of operating on 24, 120 or 230 VAC or 24 VDC and Class 2 wiring as directed by the application. Power consumption shall not exceed 10 VA for AC, including 120 VAC actuators and eight watts per actuator for applications
7. NEMA 2 rated actuators shall be provided with a three-ft (minimum), prewired, electrical cable. Actuators requiring removal of the actuator cover for access to wiring terminals, exposing electronics, printed circuit boards to damage, are unacceptable.
8. Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end of rotation or magnetic clutches are not acceptable.
9. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return models >60 in-lb will be capable of mounting on shafts up to 1.05-in diameter. Spring return actuators with more than 60 in-lb of torque shall have a manual override metal crank. Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.

10. Actuators using "on-board" chemical storage systems, capacitors or other "on-board" non-mechanical forms of fail-safe operation are unacceptable.
11. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators. Dual mounted actuators using additional anti-rotation strap mechanical linkages or special factory wiring to function are not acceptable. Actuators in a tandem pair must be "off the shelf" standard actuators ready for field wiring.
12. Dampers actuators will not produce more than 62 dbA when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dbA with power on or in the running or driving mode.
13. Proportional actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload, mechanical travel and mechanical load limit. The actuators shall also provide actuator service data, at a minimum, number of hours powered and number of hours in motion.
14. Actuators shall not be manufactured by a control manufacturer.
15. Where special classifications are shown on the electrical drawings damper actuators shall be provided with suitable enclosures.
16. NEMA 4X enclosures shall be Type 304 stainless steel and shall have a shaft seal and all electrical connections shall be suitable for the space classification. Enclosure shall be UL listed.
17. Explosion-proof enclosure shall be suitable for Class I, II and III. A suitable shaft seal must be provided. Housing shall be cast copper fill aluminum with stainless steel fasteners and shall be UL listed. Housing shall be suitable for NEMA 4, 7 and 9.

F. Local ATC Panels

1. Where shown on the Drawings or required by the control sequence, provide local ATC panels.
2. All controllers, relays, switches, etc., for equipment shall be mounted within ATC cabinets with hinge lock type doors where shown on the Drawings. All temperature settings, adjustments and calibrations shall be made at the system control panel.
3. Submit details of each ATC panel for approval prior to fabrication. Locations of each panel are to be convenient for adjustment and service. Provide engraved nameplates beneath each panel mounted control device clearly describing the function of said device and range of operation. All manual switches and dial thermometers shall be flush mounted on the hinged door, with permanent labels showing the function of each item. All other devices shall be located within the cabinet mounted to a sub panel.
4. All electrical devices within the panels shall be factory pre-wired to a numbered terminal strip. All wiring within the panel shall be in accordance with NEMA and UL standards and shall meet all local codes.

5. Unless otherwise specified herein or shown on the Drawings, control panels shall meet the requirements for Electrical Products specified elsewhere in this Section.
 6. Electrical power supplied to automatic temperature control panels shall be 120V, single phase, 60Hz. Where 24V power is required, a 120/24 transformer shall be provided. The transformers shall be sized for their control system electrical loads. Transformers shall be mounted in the local control panel.
 7. Provide a 110V power receptacle in each panel.
 8. Provide a copy of the wiring and control diagram for all work in each panel. The diagram is to be stored in a pocket on the door.
- G. Miscellaneous Devices - Provide all the necessary relays, limit switches, positioners, clocks, transformers, etc., to make a complete and operable system. Locate these devices on local ATC panel unless specified otherwise.
- H. Name Tags - All sensing devices, transmitters, controllers, not mounted in a clearly labeled panel, or which are not an obvious part of a clearly labeled device, shall be provided with an engraved plastic plate containing the name, function and system or system number for the device.
- I. Set points on thermostats and temperature controllers, shown on the Drawings are indicative only and devices shall be adjustable above and below such set points. If a set point is not stated, the control range of devices shall be suitable for the intended service. Range of devices shall be approximately 50 percent greater in both directions than span of variable, with a minimum of 25 degrees and a maximum of 100 degrees F for air systems.
- J. Thermometers - Thermometers shall be flush mounted on local panels. These thermometers shall be of the dial type, minimum three-in diameter.
- K. Short Cycle Timers - Timers shall be electric operated with two sets of normally open, normally closed contacts with manual time adjustment from one to 15 minutes.
- L. Electronic Sensors
1. All mixed air and coil discharge sensors shall utilize industry standard 4-20 mA sensors with averaging elements. Sensing elements shall be a minimum of 25-ft and temperature sensed shall be averaged over the entire length of the element. Thermistor type sensors will not be acceptable for this application.
 2. Space type sensors shall have an accuracy of plus/minus .5 degrees over sensed temperature range (20 to 120 degrees F).
- M. Field Wiring
1. All field wiring, other than power wiring, between control devices, unitary control panels and control terminals in motor control centers shall be furnished under this Section and shall conform to the requirements of Division 16.

2. 120V line voltage wiring to suspended and cabinet unit heaters and their thermostats shall be considered power wiring. All interlocking wiring within MCC shall be installed under Division 16.
 3. Refer to the electrical drawings for NEMA enclosure types, other than NEMA 1, by room or location designation such as "Damp", "Wet", "Corrosive", "Class - Div. - Group -".
 4. Installation of all conduit, wire, sleeves, outlet boxes, insulating bushings, system cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, system devices, etc, shall be in accordance with the appropriate requirements of Division 16 and in accordance with the requirements of the current edition of the local codes for signal systems and electrical systems.
 5. Run wiring in rigid steel conduit except in dry locations above ceilings and wood or metal stud framed partition walls, where EMT may be used. Conduit, boxes and fittings and their installation and testing shall be as specified in Section 16110.
 6. Wire, with the exception of DDC cable and thermostat wire, shall be copper type THHN/THWN insulated for 600 Volts. Wire and its installation and testing shall be as specified in Section 16120.
 7. In the event of any conflict among referenced codes, current editions of the applicable local codes shall take precedence for interpretation of "Signal System" installation requirements.
 8. Installation of sensor wiring in finished areas shall be concealed whenever possible. Where concealed wiring is not possible, written approval for exposed work shall be obtained from the Engineer prior to installation.
 9. Coordination Issues
 - a. Line voltage thermostats shall be furnished under this Section and installed and wired under Division 16.
 - b. The electrical contractor shall provide a 120V circuit to all control panels shown on the Drawings. Power for the control systems shall be taken from the panels and no other source.
 - c. Alarms from the HVAC systems that provide a signal to the central control system shall be furnished and installed under this Section. The alarms shall be provided with two sets of contacts. One set shall be wired by the electrical contractor for the instrumentation system. The second contact shall be used to provide an HVAC signal which will be wired under the Section.
 - d. Wiring from smoke detectors provided under this Section to the building fire alarm systems shall be provided under Division 16.
 - e. Refer to electrical drawings for details of wiring at motor control panels. Provide all interconnecting wiring to start and stop motors.
- N. Software licensing and user agreements shall be based on a one-time fee. Agreements that remove all responsibility for the software and its performance are not acceptable.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Start up each piece of equipment and system and make all adjustments so that the system is placed in proper operating condition.
- B. Do not install any equipment or materials until the District and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.
- C. Equipment
 - 1. Install equipment in accordance with manufacturer's recommendation. Provide piping and ductwork connections in accordance with the requirements as specified elsewhere in this Section.
 - 2. When units are shipped disassembled, field connect all sections together as shown on the Drawings to form single air handling unit. Seal all joints with gaskets and/or sealants.
 - 3. Do not operate equipment without filters. Do not run equipment with dirty filter pressure drop more than twice clean filter pressure drop. A total of three complete sets of filters shall be provided. The first set shall be installed for start-up, testing and balancing. The second set shall be installed after final cleanup and acceptance by the District. The third set shall be turned over to the District as a spare.
 - 4. Start up each piece of equipment and system and make all adjustments so that the system is placed in proper operating condition.
- D. Insulation - General
 - 1. Do not apply insulation prior to testing and acceptance of piping, ductwork and/or equipment. Insulation shall not be applied to damp or frosty surfaces. Clean dust, dirt, grease and moisture from surfaces of pipe and ducts before applying insulation or insulation adhesives. Install all insulation in a neat and workmanlike manner. Nameplates and equipment certification and data tags affixed to any piece of apparatus must remain exposed to view. Where two layers of insulation are used, stagger all joints both ways. Secure each layer independently. Continue insulation through walls, partitions, floors and pipe sleeves.
 - 2. The recommendations and instructions of the manufacturers of products used in the work are hereby made part of this Section except as they may be superseded by other requirements of this Section.
 - 3. Adhesives, coatings and vapor barrier materials shall be applied as specified by the manufacturer. Do not apply these materials when ambient temperature is above or below the maximum and minimum ambient temperature respectively, specified as limits by the manufacturer. In general, these limits are 90 degrees F and 40 degrees F, however, the limitations are to be checked for each product.

4. All penetrations through a vapor barrier for hangers, instruments, etc, shall be sealed to provide a complete vapor barrier. The use of staples or other fasteners that penetrate the vapor barrier will not be permitted.
5. Insulation systems that require a vapor barrier shall be installed with an intact vapor barrier that covers the entire pipe, duct, or piece of equipment to be insulated. All edges of insulation that do not abut another piece of insulation shall have the vapor barrier extended, and sealed to the item being insulated. All penetrations through the insulation such as for thermowells, test ports, dampers, nameplates, or other items shall have the vapor barrier extend over the edges of the insulation and sealed to the item being insulated. Where items are mounted on ductwork a standoff shall be provided to protect the vapor barrier. The vapor barrier shall be sealed to the standoff.
6. For insulated items exceeding 100 square feet, or 20 feet in length, extend the vapor barrier to the item being insulated to reduce the area or length within a single enclosed area to the dimensions listed above.

E. Piping Insulation Cold Piping Closed Cell Foam

1. Apply insulation in thicknesses indicated. Joints shall be sealed using self-sealing seams or adhesive.
2. Fittings shall be covered with the same insulation, mitered to fit.
3. Installation - Apply insulation in the thickness indicated. Attach insulation to sheet metal duct. Joints shall be made to have compression fit with the joints sealed with adhesive. Manufacturer's installation instructions shall be followed. Adhesives and coatings shall be provided by the insulation manufacturer and shall be compatible with the insulation. Insulation shall be provided with a protective finish for outdoor use in accordance with manufacturer's recommendations.

Service	Pipe Size	Insulation Thickness
Refrigerant Piping	All sizes	1 – in.
Condensate Drain Piping Air Conditioners	All sizes	1 – in.

F. Ductwork Insulation

1. Provide all cold ductwork with a vapor barrier. Where the method of attachment causes penetrations of the vapor barrier, seal such penetrations with vaporseal adhesive and vapor barrier tape.
2. Clips, pins, washers, staples, and other metal components shall be of the same material as the duct to be insulated. Where items of the same material are not available, a material of equal corrosion resistance may be used. If a different material of equal corrosion resistance is to be used, it must be approved by the Engineer.
3. All outside corners of ductwork in the traffic level shall be protected by sheet metal angles. Angles shall be 22 gauge galvanized steel with two-in. legs. When the duct is constructed of materials other than galvanized steel, the protective angle shall be fabricated of the same material as the duct, or of equal corrosion resistance. If a different material of equal

corrosion resistance is to be used, it shall be approved by the Engineer. Angles shall be attached to the outside of the vapor barrier with adhesive. The entire inside surface of the corner angle shall be coated with adhesive before being installed.

4. All joints in insulation shall be compressed 0.25-in. Corner insulation shall be lapped with the overlap extending over the full thickness of the insulation layers. Open spaces in joints are not acceptable. A minimum of two layers of insulation shall be used when the required insulation thickness is greater than two-in. Joints in adjacent layers shall be staggered a minimum of three-in.
5. All ductwork, except as specifically noted below, shall be insulated.
 - a. Exposed ventilation and relief ductwork located in areas that are neither heated nor cooled.

G. Ductwork Insulation - Fiberglass Board Type

1. Exposed Rectangular Single Wall Ductwork and Plenums
 - a. Installation - Apply insulation in the thickness listed below. Impale the insulation over suitable mechanical fasteners, such as welded pins or approved adhered pins, applied to duct surface on 12-in to 18-in centers. Use a minimum of two rows of fasteners on each side of duct. Secure insulation in place with suitable self-locking caps pushed onto the pins. Seal all joints and breaks in insulation and pin heads with tape. Seal all insulation raw edges and butt joints with either pressure sensitive duct tape or lagging adhesive. Groove insulation to cover standing seams or stiffeners or butt to the standing seams or stiffeners. Extend facing continuously over standing seams or stiffeners to provide a continuous finish.
 - b. Insulation Thickness - Exposed rectangular hot ductwork.

All ducts	two-in.
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H. Installation of Ductwork

1. Fabricate and erect all ductwork where shown on the Drawings, as specified herein and in accordance with SMACNA requirements. Rigidly support and secure ductwork in an approved manner. Install hangers plumb and securely suspended from supplementary steel or inserts in concrete slabs. Sufficiently thread lower ends of hanger rods to allow for adequate vertical adjustment. Do not use building siding and metal decking to hang ductwork.
2. Wherever ducts are divided, maintain the cross-sectional area. All such changes shall be approved and installed as directed by the Engineer or as approved on shop or erection drawings.
3. During installation, close the open ends of ducts to prevent debris and dirt from entering. Install work in accordance with the overall approved progress schedule and in cooperation with all other trades so there will be no delay to other trades.

4. Provide the unused portion of external louvers (where it is not used as a fresh air intake or exhaust) with a blank-off constructed of 0.0625-in aluminum. Provide blank-off panels with aluminum reinforcing angles to prevent buckling and secured to the exterior wall with aluminum angles and rustproof fasteners on not more than 12-in centers. Provide caulking completely around the outside edge of the angle and the aluminum.
 5. Install automatic dampers when supplied by other trades.
 6. Cross-break sheet metal in accordance with SMACNA duct construction standard. Apply cross-breaking to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure each panel section being rigid.
 7. Cross-break steamlined ducts on top only and adequately brace internally.
 8. Beading as specified in SMACNA will be acceptable in lieu of cross-breaking.
 9. The Drawings of the air ducts and air risers show the general location for installation of the ducts and risers. Should additional offsets or changes in direction be made, these changes shall be considered in the original bid and shall be installed at no additional cost to the District.
 10. All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building. Ducts shall be transformed or divided as may be required. Wherever this is necessary, maintain the cross-sectional area. All of these changes, however, shall be approved and ducts installed as directed by the Engineer or as approved on shop or erection drawings.
 11. The taper of all transformations shall be not more than 15 degrees.
 12. Secure casing to curbs according to SMACNA Duct Construction Standards.
 13. Provide baffle plates as required to prevent stratification and to provide proper operation of controls.
 14. Where ducts are constructed of materials other than galvanized steel the reinforcing members shall be of the same material as the ductwork.
 15. The use of button punching or snap locks on ductwork constructed of aluminum will not be permitted.
- I. Hangers
1. Ductwork shall not come in contact with any of the ceiling construction or any other equipment in the ceiling cavity.
- J. Sealing of Ductwork
1. General – Unless, otherwise indicated, seal all ductwork joints and seams using sealant in accordance with the instructions of the sealant manufacturer and this Section. All transverse seams, joints and fitting connections, both shop and field assembled, shall be

sealed in accordance with this Section. Not more than one longitudinal seam shall be unsealed in each section of duct.

2. Application of Sealant - Thoroughly clean all seams, joints, etc., of dirt, oil, grease, or other coatings which might interfere with the adhesion of the duct sealant before the sealant is applied.
3. Uncured sealant may be forced into the slotted side of the seam or joint before shop or field assembly, and the joint or seam completed while the sealant is still uncured. Excess sealant shall be removed from both the inside and outside of the duct before it sets.
4. Duct Tape - Use of duct tape alone for sealing ductwork is prohibited. Duct tape may be used primarily for the purpose of retaining the uncured duct sealant in seams and joints until it has cured. Duct tape shall not be applied to the inside of any duct nor shall it be applied to standing type joints at any time. All duct tape used shall be compatible with the sealant.
5. Sealant shall be either in liquid form or a mastic with a maximum flame spread of 25 and a maximum rate of fuel contributed and smoke developed of 50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.
6. Sealing systems shall be suitable for the environment. The following schedule is to be used to select the sealant.
 - a. Indoor, dry galvanized round and rectangular duct is to be sealed with Iron Grip 601 or equal.
 - b. Indoor, dry, stainless steel, aluminum and PVC coated is to be sealed with FTA 20 adhesive and DT-Tape gypsum or equal.
 - c. All other areas unless otherwise noted are to be sealed with FTA 50 adhesive and DT-Tape gypsum or equal.
 - d. All sealers listed or manufactured by Hardcast Inc. and are to define the type of sealer. Other equal sealants are acceptable.

K. Ductwork Fittings and Accessory Items

1. Duct Elbows - Rectangular ductwork where full radius elbows cannot be installed, provide abrupt elbows equipped with shop-installed hollow, air foil turning vanes.
2. Flexible Connectors
 - a. Install flexible connectors at all duct connections to fans, fan units or blowers, air handling units and air conditioning units. Make connections substantially air tight at all seams and joints.
 - b. Where the construction of the flexible connection or vibration isolator results in a cross sectional area of the connection which is less than 90 percent of the adjacent ductwork, the size of the connection shall be increased to provide a cross sectional area equal to or greater than 90 percent of the adjacent duct.
 - c. Provide flexible duct connections at both the intake and discharge connections for all fans and air handling units except as noted below:
 - 1) Wall and roof fans that have integral motor/fan wheel isolation.

- 2) Air handling units where the fan is isolated from the intake and discharge connections by internal flexible connections or separations, and the unit is mounted without vibration isolators between the unit and the support structure.

3. Dampers

- a. Install manual volume control dampers wherever it may be necessary to regulate air volume for system air balancing and where shown on the Drawings.
- b. Install splitter dampers, where shown on the Drawings, to regulate air volume for system air balancing. Splitter dampers shall be single blade, end pivoted type, manual adjustment and position locking arrangement.
- c. Factory-fabricated volume extractors shall be used at all supply air diffusers.
- d. An access door, of ample size to permit maintenance and resetting of damper blades, shall be installed at each opposed blade damper, splitter damper and volume extractor so located for easy access to the damper blades.

4. Access Doors

- a. Provide access doors at the following locations (minimum requirements):
 - 1) Automatic dampers - linkage side.
 - 2) Duct mounted temperature controllers.
 - 3) Freeze-stats.
 - 4) Fire dampers.
 - 5) Smoke dampers.
 - 6) Filter banks.
- b. Where access doors are required in ductwork located above ceilings, coordinate the location of the access doors to clear the ceiling support system and to be accessible through the ceiling grid.

L. Grilles, Registers and Diffusers

1. The location of diffusers, registers and grilles shall be as shown on the Reflected Ceiling Plans. Where diffusers, registers and grilles are not located in the ceiling, there are no Reflected Ceiling Plans provided, the location shall be as shown on the ductwork drawings. The exact location of these devices shall be determined in the field in cooperation with the other trades.
2. Install all devices in an approved manner in accordance with the manufacturer's recommendation.

M. Filling in Space Around Ductwork

1. To prevent sound passing through the area between the duct and the framed or cut opening in the floors, walls or partitions, pack mineral wool to completely fill the space the full depth of the opening. Whenever a fire-rated wall or floor is penetrated, fill the space around the duct with a locally approved type of fireproof rope.
2. At firewalls, apply galvanized sheet metal escutcheon plates on both faces of the wall to close the gap between the structure and the sides of the insulated or bare duct.

N. Ductwork at Masonry

1. Where ducts connect to, or terminate at masonry openings, or along the edges of floors where concrete curbs are not being provided, place a continuous 2-1/2-in by 2-1/2-in by 3/16-in galvanized angle of the same material as the duct around the ductwork. Then bolt the angle to the construction and make airtight to same by applying caulking compound on the angle before it is drawn down tight to construction.
2. Fasten plenums to concrete curbs with three-in by three-in by 1/4-in thick continuous angle. Concrete curbs will be provided under another Division. This angle shall sit on a continuous bead of caulking compound and be anchored to the curb at 16-in centers. Terminate the sheet metal at the curb and bolt to the angle. Seal the sheet metal to the curb with a continuous bead of caulking compound.
3. When exposed ducts pass through finished floors, walls or ceilings, provide angle collars completely covering space around duct.

O. Quality of Ductwork Installation

1. All ductwork shall be free from pulsation, chatter, vibration or objectionable noise. After system is in operation, should these defects appear, correct by removing, replacing or reinforcing the work. Sound levels shall not exceed the minimum requirement as specified in ASHRAE 1980 Systems Volume, page 35.16, Table 23. No discreet tones will be allowed.
2. The maximum allowable leakage of low pressure system shall be five percent of air volume.

P. Plenums

1. Seal fresh air inlet and exhaust air plenums at louvers or otherwise subject to weather entrainment watertight at all bottom joints and seams and up all vertical seams for a minimum of 12-in. After application, remove excess sealant before it sets hard. Where possible, pitch fresh air inlet and exhaust air plenums down towards the louver. Where it is not possible to pitch the plenum, provide a one-in capped drain connection at the low point of the plenum.

Q. Test Ports

1. Where shown on the Drawings and where required for testing and balancing, provide instrument insertion ports. Size and location of ports shall be coordinated with the Contractor performing air balancing. Seal ports with plastic snap lock plugs. When the ductwork will be insulated, extend the port to the face of the insulation and seal the vapor barrier to the port. When the ductwork is lined, extend the port into the duct to the inner surface of the duct liner.
2. In round ductwork provide two ports 90 degrees on centers. In rectangular ductwork provide ports are required by AABC or NEBB for a full traverse measurement.
3. As a minimum, ports shall be provided in the following connections:
 - a. All duct mains.

- b. All duct branches unless all connections are diffusers, registers, or grilles and the total can be calculated by summing the readings for all of the connections.
 - c. All connections to tanks or hoods where there is no other access for taking a measurement.
4. A main duct is defined as one of the following:
- a. A duct serving five or more outlets.
 - b. A duct serving two or more branch ducts.
 - c. A duct emanating from a fan or plenum.
 - d. All remaining ducts are considered branch ducts.

R. Piping

1. Pipe and Fittings

- a. Install piping in a neat manner with lines straight and parallel or at right angles to walls or column lines and with risers plumb. Run piping so as to avoid passing through ductwork or directly under electric light outlets and/or interference with other lines or extending beyond furring lines as determined by Architectural Drawings. Accomplish all work using the best methods and procedures of recognized pipe fabrication in a good and workmanlike manner in accordance with the latest revision of applicable ANSI Standards, ASME Codes and PFI Standards.
- b. Cut pipe square, not upset, undersize or out of round. Carefully ream ends and clean before installing.
- c. Bending of pipe shall not be permitted. Use fittings for all changes in direction.
- d. Do not remove end caps on pre-cleaned pipe until immediately before assembly. Cap all open ends immediately after completion of installation.
- e. Thoroughly clean all piping interiors after installation and keep them clean by approved temporary closures on all openings until the system is put in service. Closures shall be suitable to withstand the hydrostatic test.

2. Soldering (Copper Tubing)

- a. After cutting, thoroughly clean all surfaces to be soldered to a metal-bright finish, free from dirt, grease or other material before fluxing and soldering. Perform this cleaning by using emery cloth, sandpaper or steel wool. Clean the outside end of the tubing for a length of 1/2-in greater than the depth of the fitting. Clean the inside of the fittings in a similar manner. Apply non-corrosive flux and assemble the joint. Acid solder or acid flux will not be accepted.
- b. Heat the surfaces to be joined slowly and uniformly to the melting point of the solder. Maintain the surface being soldered above the melting point of the solder for sufficient time to draw the solder completely into the joint. When the solder congeals to a plastic state, remove the excess metal with a cloth brush, leaving a fillet around the end of the fitting. Full penetration of the solder uniformly throughout the entire socket is required. Allow the soldered joints to cool in still air until only warm to the hand, after which the work may be quenched.
- c. Any type of crack, pinhole, area of incomplete penetration, or similar defect will not be accepted. Peening for closing up defects shall not be permitted.
- d. Use heating torches of sufficient size for heating of large fittings prior to soldering. Multiple tips or ring burners for use on combination torches may be used.

- e. Remove all external and internal loose solder and flux after joint cools.

3. Refrigerant Piping

- a. Before and during silver soldering refrigerant piping, purge the assembly of pipe and fittings with dry nitrogen, to avoid formation of oxidation scale on inside of pipe during soldering.
- b. Where specially prepared, Type R, cleaned or charged refrigerant piping is not available for equipment interconnection, with the Engineer's or District's Representative approval, the following procedure shall be completed. Clean the interior of field assembled refrigerant piping after joining in four steps as follows:
 - 1) Draw a clean lintless cloth through the piping to remove coarse dirt and dust.
 - 2) Draw clean lintless trichlorethylene saturated cloth through the piping until cloth is not discolored with dirt.
 - 3) Draw a clean cloth saturated with compressor oil through the piping.
 - 4) Complete cleaning by drawing a clean, dry, lintless cloth through the piping.
- c. Pressure test and charge immediately after cleaning.

3.02 FIELD TESTING

A. Testing

1. General - If required by the Engineer, tests shall be made during the progress of the work to demonstrate the strength, durability and fitness of the installation. Furnish all instruments, ladders, lubricants, test equipment and personnel required for the tests; including manufacturer's representatives for testing and start-up of all Contractor supplied equipment. Before testing, all systems shall be cleaned as specified. Submit four printed copies and one electronic copy of records of all tests, measurements, settings of throttling devices and nameplate data to the Engineer. Information shall be in Excel spread sheet format.
2. Final Tests - Perform tests of all systems as required by the Engineer prior to final acceptance of the systems for the purpose of demonstrating satisfactory functional and operating efficiency as well as adjustment. During this period, check the setting of all automatic controls and take sufficient measurements to ensure that conditions are correct and that capacities are adequate to meet the specified requirements. Systems will not be considered complete until all tests have been concluded to the satisfaction of the Engineer and all other parties having jurisdiction. In event of leakage or defects, repeat tests until all faults are corrected. Perform the general operating tests under as near design conditions as possible.
3. Coordination of the test shall be the responsibility of the balancing sub-contractor. Access to the site, availability of service representatives, and tenant acquiescence will be considered in the determination of both the testing schedule and the witnessed recheck of the balancing.

B. Piping Pressure Testing

1. Pipe Testing Procedure

- a. The equipment to which any piping system is attached shall not be subject to any line tests. Either remove or blank off items which may be damaged by the test pressure. The test pressures apply to the piping materials as specified, but shall not be assumed to apply to piping specialties, accessories, or equipment including safety heads, rupture discs, relief valves, expansion joints, instruments or filters.
- b. Prior to pressure testing, take the following precautions:
 - 1) Do not apply insulation over piping prior to completion of testing.
 - 2) Lines containing check valves shall have the source of test pressure located on the upstream side. Set the control valves in the open position for the duration of the test.
 - 3) Block up all piping supported by springs temporarily to a degree sufficient to sustain the test liquid load.
- c. Test the piping system at the pressure indicated in the individual pipe material specification section or 1-1/2 times normal working pressure, whichever is greater for the respective systems. Leakage or loss of head will not be acceptable.

2. Condensate Drains Testing

Test Press.	Medium	Duration	Allowable Loss
10 Feet Column	Water	2 hrs	None
10 Inch Mercury	Air	15 min.	None

3. Refrigerant Piping Testing

Test Press.	Medium	Method
To suit	Inert gas	Electronic
Refrigerant used	and refrigerant	leak detector

- 4. Following the completion of acceptable leak testing, evacuate and charge the completed refrigeration system in accordance with the manufacturer's recommendations.

3.03 START-UP AND TEMPORARY OPERATION

- A. Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the District.

3.04 BALANCING OF ROTATING EQUIPMENT

- A. All machines shall be balanced both statically and dynamically by the manufacturer within the limits of best commercial practices. The term machine, as used above, is to be considered as any piece of equipment, which contains rotating components. All machines furnished shall have operating speed not exceeding 80 percent of the first critical speed.

3.05 PAINTING

- A. The Contractor shall be responsible for the repair of all defects, blemishes, holidays and the like apparent in manufacturer's coatings and shall ensure that materials used for such repair shall match or be compatible with the manufacturer's standard color, coatings and practices. Do not paint over nameplates.

- B. Paint black the louver side of all louver blank off panels and the interiors of unlined plenums and ductwork where connected to louvers.

3.06 ACCEPTANCE OF AUTOMATIC CONTROL SYSTEM

- A. During the acceptance inspections, the manufacturer shall provide the required personnel to operate the system and show complete functionality. The manufacturer shall also provide the required communication devices to allow simultaneous observations at multiple points. In general, each system will be run through its complete operating sequence.
- B. Systems that are found to be operating incorrectly shall be bypassed and not corrected during the inspection. If multiple systems are found to not be operating, the inspection will be canceled and rescheduled at the manufacturer's expense.

3.07 CLEANING

- A. Leave all ductwork and equipment in a thoroughly cleaned condition.
- B. Maintain all ductwork, fans, coils, air filters, outlets and other parts of the ductwork systems in a clean condition during installation.
- C. Clean complete ductwork systems prior to testing and air balancing. Secure cheese cloth over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

END OF SECTION

SECTION 15860
FANS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install all fans and fan accessories as shown on the Drawings, the schedules on the Drawings, and as specified herein.
- B. This HVAC specification is incomplete without the information contained on the Drawings and in the Schedules on the Drawings.
- C. Refer to Section 15500 for additional requirements.

1.02 RELATED WORK

- A. HVAC is included in Section 15500.
- B. Ductwork and accessories are included in Section 15500.
- C. Remote disconnects are included in Division 16.

1.03 SUBMITTALS

- A. Submit, in accordance with sections 01300 and 15500, all data and the fan schedules. The submittal shall include fan data sheets with a description of the proposed fan, fan size, type, arrangement, materials of construction, weight, motor horsepower, motor type, power supply, and frame size. Provide catalog data and selections for vibration isolators, include materials of construction. For belt drive equipment; provide drive data indicating the sheave sizes, belts size, number and length. Each submittal shall include pertinent equipment dimensional data, fan performance (operating data 0 information, and a performance curve showing the fan operating point and range. Minimum curve size shall be eight-in. by six-in. Faxed copies of curves are not acceptable. A list of accessories to be furnished shall be included on each submittal. Copies of operating and maintenance manuals shall be submitted. Significant dimensional differences between the specified equipment and the proposed equipment shall be noted on the equipment submittal. The Contractor shall provide data to show the dimensionally different equipment will fit within the space and still provide suitable clearance. Where corrosion resistance is required, provide conformation of material suitability for the specified service.
- B. Where called for on the schedules, provide certified test data for the fan.
- C. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.
- D. All submittals shall contain a statement that Sections 15500, 15860 and 15990 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved and shall be included with every submittal and resubmittal.

- E. Submit, in accordance with Section 01730, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.
1. Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.
 2. Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.
 3. Contents - Each volume shall contain the following minimum contents:
 - a. Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.
 - b. Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long-term storage shall be included.
 - c. Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.
 4. Spare Parts List
 5. Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.
- F. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.
- G. Provide a recommended list of spare parts to be provided.

1.04 REFERENCE STANDARDS

- A. These standards shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. The Engineer shall resolve conflicts between published requirements.
- B. Titles and abbreviation of Federal, State and industry standards, technical societies, associations and institutes and other organizations, which may be used, are as follows:
1. Air Diffusion Council (ADC)
 2. American Bearing Manufacturers Association (ABMA)

3. Air Movement and Control Association (AMCA)
 4. American National Standards Institute (ANSI)
 5. Air Conditioning and Refrigeration Institute (ARI)
 6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 7. American Society of Mechanical Engineers (ASME)
 8. American Society for Testing and Materials (ASTM)
 9. Factory Mutual (FM)
 10. Institute of Electrical and Electronic Engineers (IEEE)
 11. National Institute of Standards and Technology (NIST)
 12. National Electrical Code (NEC)
 13. National Electrical Manufacturers Association (NEMA)
 14. National Fire Protection Association (NFPA)
 15. Occupational Safety and Health Administration (OSHA)
 16. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
 17. Underwriters Laboratories (UL)
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. All equipment of a given type included in this section shall be furnished by or through a single manufacturer or as specified on the schedules
- B. Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.
- C. The District and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.
- D. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The District and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.
- E. All rotating parts of equipment shall be statically and dynamically balanced at the factory.

1.06 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.
- B. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed-on shipping date shall be stored without cost to the District by the manufacturer.
- C. All materials shall be suitably packed for shipment and long-term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.
- D. All equipment shipped that is exposed such as on a flat bed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.
- E. Instruction for the servicing and startup of equipment in long-term or prolonged storage shall accompany each item.
- F. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.07 SPARE PARTS

- A. Spare parts shall include all special items on the manufacturer's standard list of spare parts
- B. In addition to special items, the following spare parts shall be provided:
 - 1. Furnish all special tools required for normal operation and proper servicing of the equipment.
 - 2. Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:
 - a. One complete set of drive belts for each piece of belt driven equipment.
 - b. One complete set of gaskets for each unit.
 - 3. Provide a minimum of one or five percent of the total units rounded to the next full unit whichever is greater for each size and rating of the following components.
 - a. Thermostats
 - b. Damper operators
- C. Pack spare parts in containers suitable for extended storage without deterioration of the parts. Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers.

1.08 SCHEDULES

- A. Fans shall be belt or direct drive, of the type, materials of construction, capacity and arrangement as described herein and on the schedules. Particular attention must be paid to the remarks and notes in these schedules. This Section is incomplete without the schedules on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard quality, grade, type, size, physical arrangement, performance characteristics and availability.
- B. Fans shall be factory assembled, complete with fan wheel, fan housing or cabinet, bearings, drives, drive guard, motor, motor base, unit base and vibration isolators, dampers and bird screens unless otherwise specified. All fans shall be provided with lugs, brackets or field supplied devices to allow the fan to be firmly bolted to the structure or fastened to specified vibration isolators. The lugs, brackets or field supplied devices shall be sized to withstand the expected seismic loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.
- C. All fans shall be statically and dynamically balanced prior to shipment from factory.
- D. Where belt drives are used, motors shall be provided with adjustable slide bases. Adjustable sheaves and slide bases shall be selected so that the midpoint of the adjustable range matches the fan schedule data. Drives selected shall have a safety factor of 1.5 times motor horsepower.
- E. All fans shall be AMCA certified for air performance and sound ratings tested in accordance with AMCA 300.
- F. Motor shall be selected to be non-overloading for the entire fan curve range and for the reasonable expected temperature and humidity. Schedule motor sizes are minimum. If a larger motor is required for the fan proposed, the larger motor shall be provided at no additional cost.
- G. All bearings for the fan and motor shall be as defined in Section 15500.
- H. Fans shall be assembled with OSHA shaft and motor guards. Provide access for greasing bearings, tachometer readings of fan and motor speed without removing the cover. Cover shall be properly ventilated to prevent motor overheating.
- I. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self tapping screws or other fastening methods that will damage the coating are not acceptable.
- J. The noise level of the equipment operating in the field shall not exceed 85 dBA overall sound pressure level (referenced to 20 micro pascals) at a distance of three-ft from equipment surfaces.

Provide octave band sound data if another noise level is specified in the schedule or if sound data submission is specified in the schedules.

- K. Additional requirements are contained in Paragraph 2.02 for specific fan types and in the schedules.
- L. Section 15500 contains general requirements for vibration isolators, bearings and motor drives. Adhere to those requirements and the specific requirements in this Section.
- M. When bearings are not accessible, extended supply and relief fittings shall be supplied. Both supply and relief fittings shall terminate in the same location.
- N. Provide inlet and outlet screens for fans that are not directly duct connected.

2.02 TUBEAXIAL AND VANEAXIAL FANS

- A. Axial fans shall have flanged inlet and discharge, access door in fan tube. Belt drive fans shall have shroud over the belt drive in the air stream. Mounting brackets shall be provided based on fan mounting orientation. Unless spark-resistant construction or other materials of construction are specified on the schedule, fans shall be of welded steel construction with cast aluminum wheels.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The fans shall be installed in accordance with the instructions of the manufacturer and as shown on the Drawings.
- B. The Contractor shall not install any equipment or materials until the District and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.
- C. Ensure that lubricating fluids and greases have been applied according to manufacturer's recommendations. Contractor shall be responsible for all start-up checks and adjustments and shall perform them unless they are done by the manufacturer's representative.
- D. Provide manufacturer's representative to inspect fans and supervise start-up of all fans.
- E. Field Testing
 - 1. Refer to Section 15990.

END OF SECTION

SECTION 15990
TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A.
- A. Furnish the necessary labor, materials, instruments, transportation and devices required to test, adjust and balance the total heating-ventilating-cooling system, as specified and detailed herein, or as required, to cause the system to perform in accordance with the intent of the Drawings and this Section. Systems to be tested, adjusted and balanced include air systems installed by the HVAC Contractor.
- B. Testing, balancing and operation of the systems shall be performed by competent and experienced personnel having formerly done similar work and whose qualifications and performance shall be subject to the approval of the Engineer. Test and balance air and water systems and submit testing and balancing reports to the Engineer for review and approval. Re-balance when required by the Engineer, incorporate all changes and certify the systems have been tested and balanced to meet specified requirements.
- C. The tests shall demonstrate the specified capacities and operation of equipment and materials comprising the systems. Such tests other than as described herein, which are deemed necessary by the Engineer to indicate the fulfillment of the Contract, shall be made.
- D. When the work includes modifications to existing systems, the entire system including existing portions shall be rebalanced. Where capacities of existing components are not shown as changed, the original capacities shall be used for balancing.
- E. Data required by this Section shall receive complete approval before final payment is made.
- F. If, in the opinion of the Engineer, the Contractor has not, will not, or cannot comply with the testing, balancing and adjusting requirements of this Section, he may advise the District to employ a qualified firm to perform such work at Contractor's sole expense.

1.02 RELATED WORK

- A. Refer to section 15500.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, the following:
1. Qualifications and experience information and data as described in the Quality Assurance section.
 2. Proposed testing schedules and procedures.
 3. Preliminary draft "system" balancing reports as systems are completed and tested.
 4. Final systems and Project balancing reports as final system adjustments are made as systems are accepted by the District.

5. All submittals shall contain a statement that Section 15500 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable: Contractor, subcontractor, and the vendor. The statement shall be an individual statement for each party involved and shall be included with every submittal and resubmittal.
- B. In general, corrections or comments or lack thereof made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.04 QUALITY ASSURANCE

- A. Qualifications standards for this work - Affiliation with manufacturers, installing contractors or engineering firms will not preclude acceptability. Submit qualifications within 60 days after Contract award. Membership in the AABC or NEBB for air and water testing is required. The testing and balancing contractor shall not be affiliated with the on-site contractors.
- B. The balancing contractor shall be prepared to submit credentials and other evidence of qualifications and work experience following receipt of, but prior to, award of filed sub-bids.
- C. To perform required professional services, the balancing agency shall have a minimum of two test-and-balance engineers certified by the AABC or NEBB. This certified test-and-balance engineer shall be responsible for supervision and certification for the total work specified herein.
- D. The balancing agency shall submit records of experience in the field of air and hydronic system balancing or any other data as requested by the Engineer. The supervisory personnel for the firm shall have at least five years' experience, and all the employees used in this project shall be qualified technicians in this specific field.
- E. The balancing agency shall furnish all necessary calibrated instrumentation to adequately perform the specified services. An inventory of all instruments and devices in possession of the balancing agency may be required by the Engineer to determine the balancing agency's performance capability.

1.05 ENGINEERING SERVICES

- A. When engineering services are specified to be provided by the Contractor, retain a licensed professional engineer to perform the services. The engineer shall be licensed at the time the work is done and in the State in which the project is located. If the State issues discipline-specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.
- B. All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.06 SCHEDULE AND PROCEDURES

- A. A complete schedule of balancing procedures for each of the buildings or systems shall be submitted in sufficient time in advance so that the Engineer might arrange to observe these procedures as they progress. Before commencing with the balancing of the systems submit the methods and instruments proposed to be used to adjust and balance the air and water systems.
- B. Submit proposed testing programs at least two weeks prior to the scheduled test to assure agreement as to personnel and instrumentation required and scope of each testing program.

1.07 DRAWING REVIEW

- A. The balancing organization shall thoroughly review the location of all fresh air dampers, return dampers, relief air dampers, spill dampers, quadrant dampers, splitter dampers, bypass dampers, face dampers, fire dampers, registers, grilles, diffusers, VAV boxes, troffers, etc. The purpose of the review is to finalize the optimum locations for dampers and test ports shown on the Drawings.
- B. The balancing organization shall thoroughly review the location of all balancing valves, test ports, gauge cocks, thermometer wells, and flow control devices. The purpose of the review is to finalize the optimum locations for these components.

1.08 EQUIPMENT CURVES

- A. Fan Characteristics Charts: The HVAC and General Contractors shall provide to the Balancing Organization any required characteristic curve charts for all fans including air conditioning units and air handling units. Characteristic curve charts shall be not less than 8-1/2-in by 11-in and shall show the static pressure, capacity horsepower and overall efficiency for operating conditions from no load to 130 percent of specified load. The minimum size of the actual fan curve shall be no less than six-in. by eight-in. The use of faxed copies of curves is not acceptable.

1.09 GUARANTEE

- A. The balancing work shall be guaranteed to be accurate and factual data based on readings in the field. All typewritten data shall be submitted within 14 working days of the performance of the test. Test data shall not be held until final completion but shall be submitted on an interim basis as soon as the test or appropriate groups of tests are finished.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Furnish gaskets, lubricants and other expendable materials required to be replaced during the execution of this work.
- B. Fixed-pitched pulleys required for fan adjustments shall be furnished on an exchange basis by the party responsible for the fan installation.

- C. Where test results indicate that air quantities at any system fan are below or in excess of the specified amount, the HVAC and General Contractors, at their own expense, shall change driving pulley ratio or shall make approved changes to obtain the specified or scheduled air quantities.
- D. Testing apparatus: Furnish plugs, caps, stops, valves, pumps, compressors, blowers and similar devices required to perform this work.
 - 1. Furnish anemometers, thermometers, gauges, voltmeters, ammeters, tachometers and similar instruments, not part of the permanent installation, but required to record the performance of the equipment and systems.
 - 2. Testing apparatus, not part of the permanent installation, shall remain the property of the Contractor, but made available to the Engineer.
 - 3. Instruments used for testing shall be certified accurate to within plus or minus 0.10 degrees F for temperature or plus or minus 0.10-in wc for pressure. Calibration of the instruments shall be done within seven days of testing for this project and henceforth every 30 days thereafter for the duration of the testing period. Certification of calibration shall be submitted to the engineer prior to starting the work.

2.02 TESTING REPORTS

- A. Forms: Furnish test report data on 8-1/2-in by 11-in bond AABC or NEBB form paper in accordance with Section 01300. Submit format for recording data and receive approval prior to use.
- B. Reports shall be Excel spreadsheet format and shall be submitted in both hard copy and as a data file.
- C. The report shall contain the following general data in a format selected by the balancing agency:
 - 1. Project number.
 - 2. Contract number.
 - 3. Project title.
 - 4. Project location.
 - 5. Project architect.
 - 6. Project mechanical engineer.
 - 7. Test and balance agency.
 - 8. Test and balance engineer.
 - 9. General contractor.
 - 10. Mechanical subcontractor.

11. Dates tests were performed.
 12. Certification.
- D. At a minimum, the report shall include:
1. Preface. A general discussion of the systems and any abnormalities or problems encountered.
 2. Instrumentation list. The list of instruments including type, model, manufacturer, serial number and calibration dates.
 3. System Identification. In each report, the VAV boxes, zones, supply, return and exhaust openings and traverse points shall be numbered and/or lettered to correspond to the numbers and letters used on the report data sheets and on the report diagrams.
- E. Prepare 11-in by 17-in single line diagrams or 12-in by 18-in half size drawings showing all duct systems indicating all terminal air outlets including diffusers, grilles and registers, perforated plates, nozzles and other types of air supply, exhaust or return outlets. The minimum scale for diagrams showing the measurement points shall be 1/8-in=1-ft-0-in in the final form as submitted. The use of faxed copies of diagrams is not acceptable. The location of test points shown on the diagrams shall be clear and easy to locate on the diagram. The identification mark of the test points shall be the same as is shown on the test report showing the test data. The identification for test points shall include indication of the units served and shall not have a duplicate in the project. Each test sheet shall include the following data:
1. Job name and address.
 2. Name of HVAC Contractor.
 3. Name of balancing organization.
 4. Instruments used to perform the test.
 5. Name of test technician or test engineer.
 6. Fan system and/or zone number.
 7. Room number or area name.
 8. Size of outlet.
 9. Type outlet.
 10. Manufacturer of outlet.
 11. The cfm at each outlet on system and corresponding cfm at each outlet as noted on the plans.
 12. Percent deviation of the measured flow versus the design flow.

13. Indication of the branch and terminal that are the open/low that are the basis for balancing the remainder of the system

PART 3 EXECUTION

3.01 START OF BALANCING

- A. Notify the Balancing Organization and Engineer when systems become operational and ready for preliminary and final testing, adjusting and balancing.
- B. Final balancing shall not begin until system has been installed complete and is capable of normal operation. Provide personnel to assist in rough balance and calibration.
- C. All grilles, dampers, fans, coils, pumps, valves and linkages shall be verified to be installed and operating.
- D. System shall be capable of operating under control as specified on Drawings and/or contained herein.
- E. Visually inspect all fire dampers, smoke dampers, or fire/smoke dampers on branch take-offs to each floor to ensure that they are fully open.
- F. Verify with straight edge that fan and motor shafts are parallel and that sheaves are in proper alignment.
- G. Verify that belts are properly tensioned when unit is operating with no excessive squeal at startup. If not correct, adjust sheaves or motor base accordingly.
- H. Start fans and pumps and verify that rotation is correct. If rotation is incorrect coordinate with electrical contractor to switch power leads such that the motor rotates correctly.
- I. Check nameplate voltage on motor compared to scheduled voltage. Notify the Engineer immediately of any discrepancies. Measure and record actual voltage across all power leads. Notify the Engineer of discrepancies immediately.
- J. Check motor nameplate full load amps and measure and record amperage across all power leads. If there are marked discrepancies in amperage draws between legs, notify the Engineer immediately.
- K. Measure and record fan and motor rpm. Check that motor rpm agrees with nameplate and scheduled rpm.
- L. If, upon commencing the work, the balancing contractor finds that the systems are not ready, or if a dispute occurs as to the readiness of the systems, the balancing agency shall request an inspection to be made by the Engineer. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for testing and balancing. Should the inspection reveal the notification to have been premature, all costs for the inspection and work previously accomplished by the balancing agency shall be paid for by the General Contractor. Furthermore, such items that are not ready for testing and balancing shall be completed and placed in operational readiness before testing and balancing services shall be recommenced.

- M. Leaks, damage, and defects discovered or resulting from startup, testing and balancing shall be repaired or replaced to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.

3.02 REQUIRED ACCURACY

- A. Systems shall be balanced to be within the following limits of the capacity shown on the Drawings. Limits shall be applied to both individual components and to the system totals.

- 1. General Systems (plus/minus 10 percent).

3.03 TESTING

- A. HVAC Air Systems (Air Handling Units and Fans)

- 1. Balance the supply, return and exhaust air systems in accordance with AABC or NEBB Standards by the use of direct reading instruments such as an anemotherm or velometer which has been properly calibrated.
- 2. Temporarily add static pressure to the system to simulate the effect of dirty filters by blanking off portions of the filter section and covering the filter section with cheesecloth or other suitable means. Confirm static has been added with new static pressure reading across fan. Remove cheesecloth, etc., after traverses are complete.
- 3. If so instructed by the Engineer, further balancing of temperature shall be made either by thermometer or by temperature recorder.
- 4. The sequence of air balancing shall be as follows:
 - a. First, establish air flow quantity at supply fan by main duct traverse.
 - b. Next, establish air flow quantities in main ducts and branches.
 - c. Finally, establish air flow quantities at outlets using proportional balancing among branch outlets. All multiple opening systems shall be left with at least one "open low" inlet or outlet to which all other system openings shall be proportionally balanced. The "open low(s)" on each system shall be indicated in the report.
 - d. Grille and register readings may be made by a vane anemometer but diffuser readings shall be made by a flow hood or a velometer using the tip recommended by the diffuser manufacturer. All supply outlets (vertical deflection blades, horizontal spread blades, linear diffuser pattern controllers, etc.) shall be adjusted so that there are no drafts.
 - e. After all outlets are adjusted to within the tolerances specified elsewhere in this Section, remeasure all system outlets and retrace all branch and main ducts to establish final "as balanced" flows.
 - f. All main air ducts shall be traversed using a Pitot tube and manometer. The manometer shall be calibrated to read two significant figures in all velocity pressure ranges. The static pressure reading at the traverse point shall be recorded for each successive traverse.
 - 1) A main duct is defined as either of the following:
 - a) A duct serving five or more outlets.

- b) A duct serving two or more branch ducts.
 - c) A duct emanating from a fan or plenum.
- 2) All other ducts are branch ducts.
 - 3) The intent of this operation is to measure by traverse the total air quantity handled by the fan and to verify the distribution of air to zones and to adjust system pressure to minimum level required to satisfy the farthest air outlet.
- g. Adjust fan speeds if results of system capacity tests are not within tolerances specified and repeat the steps above.
 - h. Mark all final balancing damper positions with a permanent marker.
5. Furnish data in Excel spreadsheet format tabulating the following:
- a. Dry bulb temperature in each room.
 - b. Dry bulb temperature of the supply air.
 - c. Outdoor dry and wet bulb temperature at the time the above tests are conducted. (Wet bulb temperature only required for AC systems)
 - d. Total, sensible, and latent capacity in BTUH.
6. Adjust belts, sheaves and the alignment of air handling equipment.
7. Where various combinations of sheaves must be installed on fan systems to achieve the correct air delivery, change the sheaves and continue to take successive readings until the correct combinations are installed.
8. Furnish data in Excel spreadsheet format taken at each air moving device.
- a. Manufacturer, model number and serial number of units.
 - b. All design and manufacturer's rated data.
 - c. Total quantity of supply air in cfm.
 - d. Total quantity of return air in cfm.
 - e. Total quantity of exhaust or relief air in cfm.
 - f. Total quantity of outside air in cfm.
 - g. Outlet velocity - fpm.
 - h. The rpm of each fan or blower.
 - i. Maximum tip speed - fpm.
 - j. The rpm of each motor.
 - k. Voltage and ampere input of each motor (one reading for each phase leg on 3 phase motors).
 - l. Pressure in inches w.g. at inlet of each fan or blower.
 - m. Pressure in inches w.g. at discharge of each fan or blower.
 - n. Pressure drops across system components such as louvers, filters, coils and mixing boxes.
 - o. Submit the actual fan operating point on a copy of the fan shop drawing showing operating curve.
 - p. List the following data from all fan motors installed.
 - 1) Manufacturer model and size.
 - 2) Motor horsepower, service factor and rpm.
 - 3) Volts, phases, cycles and full load amps.

- 4) Equipment locations.
 - q. Pressure in inches w.g. at inlet to unit cabinet.
 - r. Pressure in inches w.g. at discharge from unit cabinet.
- B. Electric Heating Coils (Unit Heaters and Air Handling Units):
 1. Furnish data in Excel spreadsheet format tabulating the following:
 - a. Manufacturer and model number.
 - b. All design and manufacturer's rated data.
 - c. Actual operating current and voltage for all legs.
 - d. Coil location and identification.
 - e. Number of stages.
 - f. Air flow in CFM.
 - g. Face area in square feet.
 - h. Entering air dry bulb temperature in degrees F.
 - i. Leaving air dry bulb temperature in degrees F.
- C. Condensing Units:
 1. Furnish data in Excel spreadsheet format tabulating the following:
 - a. Manufacturer, model number, size and serial number of all units.
 - b. All design and manufacturer's rated data.
 - c. Suction and condensing temperatures, and pressures.
 - d. Outside air dry bulb temperature in degrees F.
 - e. Voltage and ampere input of motors under full load (one for each phase leg).
 - f. Capacity of machine in Btuh.

3.04 STANDBY EQUIPMENT

- A. Where systems are provided with standby equipment, the system shall be balanced for operation in standby as well as normal operation.

3.05 FINAL ACCEPTANCE

- A. At the time of final inspection, the balancing agency shall recheck, in the presence of the Engineer, specific and random selections of data recorded in the certified test-and-balance report.
- B. Points and areas for recheck shall be selected by the Engineer.
- C. Measurements and test procedures shall be the same as the original test and balance.
- D. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

- E. If the specific rechecks are more than five percent deviation from the report or specified flows, all of the systems, that require specific recheck, shall be rebalanced. If five percent or five of the random checks, whichever is less, exceeds a ten percent deviation from the specified flows, the report shall be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test-and-balance report submitted, and a new inspection test made, all at no additional cost to the District.

3.06 OPPOSITE SEASON TEST

- A. The balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

END OF SECTION

SECTION 16000
ELECTRICAL - GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install complete and make operational, electrical and process instrumentation systems at the Black Creek Intake and Pump Station as shown on the Drawings and as specified herein.
- B. 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.
- C. The work shall include furnishing and installing the following:
 - 1. Electrical service from the Power Company.
 - 2. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions of these specifications.
 - 3. 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.
 - 4. 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.
 - 5. Conduit, wiring and terminations for variable frequency drives, harmonic filters, transformers and power factor correction capacitors furnished under other Divisions of these specifications.
 - 6. 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.
 - 7. Furnish and install precast manholes, precast handholes and light pole bases.
 - 8. Furnish and install manhole and handhole frames and covers.

9. 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.

10. Provide Power System Study.

- D. 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, 1.03, H for additional requirements.
- E. 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.
- F. A single manufacturer shall provide switchboard, transformers, disconnect switches, panel boards, etc. This manufacturer shall also provide a short circuit/coordination study as specified herein.
- G. 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.
- H. Complete coordination with other contractors. Contractor shall coordinate with all other contractors' equipment submittals and obtain all relevant submittals.
- I. Mount control panels, transmitters, process instruments, operator stations, etc. furnished under other Divisions of these specifications.
- J. Concrete electrical duct encasement, including but not limited to excavation, concrete, conduit, reinforcement, backfilling, grading and seeding is included in Division 16. All work shall be done in accordance with Divisions 2 and 3 of these specifications.
- K. 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.

1.02 RELATED WORK

- A. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in Division 2.

- B. 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.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings for equipment, materials and other items furnished under Division 16.
- B. Shop drawings shall be submitted for the following equipment:
 - 1. Raceways, Boxes, Fittings and Hangers
 - 2. Wires and Cables
 - 3. Miscellaneous Equipment (as specified in Section 16191)
 - 4. Switchboards
 - 5. Panelboards
 - 6. Lighting Fixtures and Lamps
 - 7. Switches, Receptacles and Covers
 - 8. Precast Manholes and Handholes, Frames and Covers
 - 9. Grounding Hardware and Connections
 - 10. Variable Frequency Drives
 - 11. Surge Protection Devices
 - 12. Lightning Protection System
- C. Submittals shall be required for the following items:
 - 1. Concealed and Buried Conduit Layouts
 - 2. Preliminary Short Circuit and Coordination Study Report
 - 3. Final Power System Study
- D. The manufacturers name and product designation or catalog numbers shall be submitted for the following material utilized:
 - 1. Testing Equipment
 - 2. Ground System Resistance Test Equipment

- E. 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.
- F. 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.
- G. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- H. 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".
- I. In addition to manufacturer's equipment shop drawings, submit electrical installation working drawings containing the following:
 - 1. Concealed and buried conduit layouts, shown on floor plans drawn at not less than 1/4-in = 1-ft-0-in scale. The layouts shall include locations of process equipment, switchboards, variable frequency drives, 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.
 - 2. Plans shall be drawn on high quality reproducible, paper size 36-inch by 24-inch and shall be presented in a neat, professional manner or electronic PDF file.
 - 3. Concrete floors and/or walls containing concealed conduits shall not be poured until conduit layouts are approved.
- J. Operation and Maintenance Data
 - 1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists, etc, to instruct operating and maintenance personnel unfamiliar with such equipment.
 - 2. Manuals shall include the following as a minimum:
 - a. A comprehensive index.
 - b. A complete "As-Built" set of approved shop drawings.
 - c. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.

- d. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints.
- e. System schematic drawings "As-Built", illustrating all components, piping and electric 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 list with stock numbers, including spare parts.

1.04 REFERENCE STANDARDS

- A. 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:
 - 1. National Electrical Safety Code (NESC)
 - 2. Occupational Safety and Health Administration (OSHA)
 - 3. National Fire Protection Association (NFPA)
 - 4. National Electrical Manufacturers Association (NEMA)
 - 5. American National Standards Institute (ANSI)
 - 6. Insulated Cable Engineers Association (ICEA)
 - 7. Instrument Society of America (ISA)
 - 8. Underwriters Laboratories (UL)
 - 9. Factory Mutual (FM)
 - 10. International Electrical Testing Association (NETA)
 - 11. Institute of Electrical and Electronic Engineers (IEEE)
- B. 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.

- 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 PRIORITY OF THE CONTRACT DOCUMENTS

- A. 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.
- B. 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.
- C. 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.
- D. 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.
- E. 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.

1.06 ENCLOSURE TYPES

- A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:
 - 1. NEMA 1 for dry, non-process indoor locations.
 - 2. NEMA 12 for "DUST" locations.
 - 3. NEMA 4X for outdoor locations, rooms below grade (including basements and buried vaults), "DAMP" and "WET" locations. Enclosures shall be Type 316 stainless steel.
 - 4. NEMA 4X for "CORROSIVE" locations. Enclosures shall be Type 316 stainless steel.

1.07 SERVICE AND METERING

- A. The power company serving this project is Florida Power & Light (FPL). Service will be obtained at 480 Volts, Three Phase, Four Wire, 60 Hz wye grounded to the service entrance equipment as shown on the drawings. Pay all fees and charges as required to obtain temporary and permanent service. Coordinate with Florida Power & Light to provide and meet requirements for these services.
- B. The power company will be responsible for the following work:
1. Furnishing and installing primary conduits and cables.
 2. Furnishing and installing transformer.
 3. Furnishing and installing the transformer pad and grounding.
 4. Termination of underground primary cables at the transformer.
 5. Termination of underground secondary cables at the transformer.
 6. Furnishing metering current transformers (C.T.s), meter and meter wiring.
 7. Furnishing meter base and enclosure.
- C. The Contractor shall be responsible for the following work:
1. Obtain an estimate from the power company for the work described in Paragraph 1.07B above and include the cost of the power company work in the Bid Price.
 2. Make all arrangements with the power company for obtaining electrical service, pay all power company charges and furnish all labor and material required for the electrical service.
 3. Furnishing and installing secondary conduits and cables from transformer to service entrance equipment.
 4. Furnishing and installing a power company approved metering current transformer enclosure.
 5. Installing meter base and enclosure.
 6. Furnishing and installing an empty conduit with pull line from the metering C.T. enclosure to the meter enclosure. Conduit size and type shall be approved by the power company.
 7. Steel bollards.

1.08 CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.09 TESTS AND SETTINGS

- A. 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.
- B. Make adjustments to the systems and instruct the District's personnel in the proper operation of the systems.
- C. In addition to the specific testing requirements listed in the individual Sections, the following minimum tests and settings shall be performed. Submit test reports upon completion of testing in accordance with Section 01300.
 - 1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.
 - 2. 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.
 - 3. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.
 - 4. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.
 - 5. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.
 - 6. 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.
 - 7. 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.
 - 8. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed.

9. Verify all terminations at transformers, equipment, panels and enclosures by producing a one, two, three clockwise rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.
 10. Verify correct wire termination positions across tie circuits, transfer switches, or other devices that normally have two sources of three-phase power present 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.
 11. Check all wire and cable terminations. Verify to the Engineer connections meet the equipments torque requirements.
 12. Field set all transformer taps as required to obtain the proper secondary voltage.
 13. Infra-red hot spot inspection shall be made of all electrical equipment including but not limited to switchboard, variable frequency drives, transformers, switches, power and control panels, etc. This shall be done under representative load conditions before the equipment is used by the District and again three months before expiration of the one-year warranty period.
- D. Testing shall be scheduled and coordinated in writing with the Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment. 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.

1.10 POWER SYSTEM STUDY

A. General:

1. The major electrical equipment manufacturer 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 equipment as well as new additions being implemented under these Specifications.
2. The study shall also include the utility company's protective devices, the main switchboard, all feeders, and distribution and all associated equipment. 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.
3. 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.

4. 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.
5. The Contractor/Manufacturer shall provide data necessary to perform the study. This includes feeder cable sizes, approximate feeder length, motor data, switchboard data, existing protective relay settings and any other information relevant to the study.
6. 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.
7. The Contractor shall provide and install equipment specific arc flash warning labels per the arc flash study performed herein.
8. Acceptable Software:
 - a. SKM System Analysis, Inc.: Power*Tools
 - b. Operation Technology, Inc.: ETAP (Electrical Transient Analyzer Program)
 - c. EasyPower, Inc.: EasyPower
 - d. Or equal
9. Except for one-line diagrams, standard 8 ½-in by 11-in pages, with total pages numbered.
10. Electronic PDF format copy with electronic bookmarks for each section.
11. Signed and sealed by a professional engineer registered in the state in which the project is located.
12. Organized in the following order:
 - a. Executive Summary
 - b. Short Circuit Analysis
 - c. Short Circuit Computer Printout
 - d. Protective Device Coordination
 - e. Motor Starting
 - f. Arc Flash Hazard Analysis
 - g. Harmonic Analysis
 - h. Utility Data
 - i. Modeled One Line Diagrams
13. Information on one-line diagrams, legible when printed at 11-in x 17-in. Show the following:
 - a. Protective device designations and ampere ratings.
 - b. Conductor types, sizes, and lengths.
 - c. Transformer kilovolt ampere (kVA), impedance, and voltage ratings.
 - d. Motor and generator designations and kVA ratings.
 - e. Switchgear, switchboard, motor-control center, and panelboard designations and

- ratings.
 - f. Derating factors and environmental conditions.
 - g. Any revisions to electrical equipment required by the study.
14. Identifiers between the one-line diagram, short circuit study, coordination study, and arc flash study to be the same.
 15. Include copies of correspondence with electric utility under utility data section of report. Correspondence to include names and contact information.

B. Scope:

1. 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 equipment is being applied with design ratings. Shop drawings for new equipment will not be reviewed until the preliminary short circuit study is approved by the Engineer.
2. 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.
3. 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.
4. 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.
5. 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.

C. Contents:

1. 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, variable frequency drives, 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.

2. 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.
3. 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.
4. 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.
5. Transformer damage curves in accordance with ANSI C57.109.
6. Feeder cable damage curves.
7. 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.
8. Tabulations indicating recommended set points for all protective devices shall be provided. This shall include the normal as well as the emergency source.
9. 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.
10. Tabulation of arc flash information.

D. Motor Current-Time Characteristic Curves:

1. A complete independent set of current-time characteristic curves for all medium voltage motor drives indicating coordination between the protective relays and the thermal characteristics of the motor shall be provided.
2. The Contractor shall obtain from the motor supplier, the necessary information to perform the study. Certified curves for "safe time versus current at 100 percent voltage" and "accelerating time versus current at 100 percent voltage" shall become part of the final report.

E. Motor Starting Study:

1. 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.

F. General Information for Time-Current Curves Presentations:

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.

G. Arc Flash Study:

1. 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.
2. Study shall be in accordance with IEEE Standard 1584 and NFPA 70E, latest versions.
3. Study shall calculate the incident energy and flash protection boundary at all significant locations in the electrical distribution 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.
4. Incident energy calculations shall include maximum and minimum fault contribution scenarios, since protective device clearing times can vary greatly depending upon the fault current.
5. 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.

- H. 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 and coordination 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 District.
- I. 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.
- J. The coordination study shall be stamped and signed by a professional engineer registered in the state in which the equipment is to be installed.
- K. Arc Flash Warning Labels:
 - 1. Provide a machine printed thermal transfer type label of high adhesion polyester for each location identified in the arc flash study.
 - 2. 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, PPE (personal protective equipment) and date.
 - 3. All equipment 50 volts and higher shall have arc flash labels. The switchboard shall include both LINE and LOAD side labels on applicable sections.
- L. Harmonic Analysis:
 - 1. Comply with IEEE 519 and IEEE 3002.8.
 - 2. Provide a harmonic analysis for all major harmonic producing equipment to determine the harmonic currents and voltages of the electrical distribution system. Include utility and alternate power sources, if applicable.
 - 3. Provide a harmonic current and voltage profile for the complete electrical distribution system. At a minimum, the voltage profile shall include voltage values at the utility service point, and at each switchgear/switchboard and motor control center bus.
 - 4. Provide calculations for all operating modes and the following conditions:
 - a. One profile for all duty equipment running with variable frequency controllers at full speed.
 - b. One profile for all duty equipment running with variable frequency controllers at 60% speed.
 - 5. Include in the analysis:
 - a. Explanation of analysis method.

- b. Explanation of analysis and recommendations to meet the specified limits.
- c. Calculations and/or computer printouts.
- d. Harmonic current and voltage profiles up to the fiftieth harmonic.

1.11 INTERPRETATION OF DRAWINGS

- A. The Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
- B. Install each three-phase circuit in a separate conduit unless otherwise shown on the Drawings.
- C. Unless otherwise approved by the Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed.
- D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.
- E. 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 District and coordinated and approved by the Engineer.
- F. 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.
- G. 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 District.
- H. 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.
- I. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by ½-inch spacers to provide a clearance between wall and equipment.
- J. All floor mounted electrical equipment shall be placed on four-inch thick (¾-inch, 45 degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.

- K. 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 District. In case interference develops, the Engineer is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.
- L. Raceways and conductors for the lightning protection system is 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.
- M. Raceways and conductors for all electrical equipment, 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.

1.12 PHASE BALANCING

- A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on switchboards and panelboards shall be field connected to result in evenly balanced loads across all phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements as specified in Section 16120.

1.13 SIZE OF EQUIPMENT

- A. 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.
- B. 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.

1.14 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings".

- B. Record Drawings shall accurately show the installed condition of the following items:
 - 1. One-line Power Diagram(s).
 - 2. Equipment elevations (front views).
 - 3. Raceways and pullboxes.
 - 4. Conductor sizes and conduit fills.
 - 5. Panel Schedule(s).
 - 6. Control Wiring Diagram(s).
 - 7. Lighting Fixture Schedule(s).
 - 8. Lighting fixture, receptacle and switch outlet locations.
 - 9. Underground raceway and duct bank routing.
 - 10. Plan view, sizes and locations of switchboard, distribution transformers, variable frequency drives, and panelboards.
- C. Submit a schedule of control wiring raceways and wire numbers, including the following information:
 - 1. Circuit origin, destination and wire numbers.
 - 2. Field wiring terminal strip names and numbers.
- D. 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.
- E. 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).

1.15 EQUIPMENT INTERCONNECTIONS

- A. 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.
- B. Furnish and install all equipment interconnections.

1.16 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.
- B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.
- C. Warrant all equipment furnished under Division 16 in accordance with Section 01740. Refer to individual equipment sections for additional warranty items.

1.17 EQUIPMENT IDENTIFICATION

- A. Identify equipment (disconnect switches, separately mounted motor starters, control stations, etc) furnished under Division 16 with the name of the equipment it serves. Control panels, panelboards, switchboards, variable frequency drives, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.
- B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.
- C. 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.
- D. All voltages (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.
- E. All receptacles, wall switches, lighting fixtures, photocells, emergency lights, exit lights, etc. shall be identified with the panel and circuit to which it is connected. Identification shall be with machine generated labels with 1/4" high letters.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SLEEVES AND FORMS FOR OPENINGS

- A. 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.
- B. 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.

- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.
- D. Seal all openings, sleeves, penetration and slots as specified in Section 16110.

3.02 CUTTING AND PATCHING

- A. 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 01045. Sawcut concrete and masonry prior to breaking out sections.
- B. Core drill holes in existing concrete floors and walls as required.
- C. Install work at such time as to require the minimum amount of cutting and patching.
- D. Do not cut joists, beams, girders, columns or any other structural members.
- E. Cut opening only large enough to allow easy installation of the conduit.
- F. Patching to be of the same kind and quality of material as was removed.
- G. The completed patching work shall restore the surface to its original appearance or better.
- H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- I. Remove rubble and excess patching materials from the premises.
- J. When existing conduits are cut at the floor line or wall line, they shall be filled with grout of suitable patching material.

3.03 INSTALLATION

- A. 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.
- B. 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 District, 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.

- C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion.
- D. 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 Section 09902, at no additional cost to the District.

3.04 MANUFACTURERS SERVICE

- A. Provide manufacturer's services for testing and start-up of the following equipment:
 - 1. 480 Volt Switchboard (one day one trip minimum)
 - 2. Variable Frequency Drives (one day one trip minimum)
- B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturers warranty repairs.
- C. The manufacturers of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:
 - 1. 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.
 - 2. 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.
 - 3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.
 - 4. 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.

3.05 TRAINING

- A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment specified under Division 16.
 - 1. Variable Frequency Drives (one day one trip minimum)

- B. The cost of training programs to be conducted with District'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.
- C. 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.
- D. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance including trouble-shooting of each system.
- E. All training schedules shall be coordinated with and at the convenience of the District. Shift training may be required to correspond to the District's working schedule. The training shall be conducted with record "as-built" drawings sufficient for a class of eight personnel.
- F. 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:
 - 1. An overview of the training plan.
 - 2. Course title and objectives.
 - 3. Prerequisite training and experience of attendees.
 - 4. Recommended types of attendees.
 - 5. Course Content - A topical outline.
 - 6. Course Duration.
 - 7. Course Location - Training center or jobsite.
 - 8. Course Format - Lecture, laboratory demonstration, etc.
 - 9. Schedule of training courses including dates, duration and locations of each class.
 - 10. Resumes of the instructors who will actually implement the plan.
- G. The Engineer will review the training plan submittal with the District.

3.06 POWER SYSTEM STUDY

- A. Provide a complete system Power System Study including preliminary short circuit, final short circuit, protective device coordination and arc flash study as specified herein.
- B. Provide and install arc flash warning labels at equipment identified with the arc flash study.

END OF SECTION

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SECTION 16110
RACEWAYS, BOXES, FITTINGS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Refer to Section 16600 for additional requirements.

1.03 SUBMITTALS

- A. 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.

PART 2 PRODUCTS

2.01 MATERIALS

A. Rigid Aluminum Conduit

1. 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.
2. Rigid aluminum conduit shall be for use under the provisions of NEC Article 344.

B. Electrical Metallic Tubing

1. 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.
2. Electrical metallic tubing shall be for use under the provisions of NEC Article 358.

C. Rigid Nonmetallic Conduit

1. PVC conduit shall be rigid polyvinyl chloride Schedule 80 as manufactured by Carlon; An Indian Head Co.; Cantex; Queen City Plastics or equal.
2. 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.

3. PVC conduit shall be for use under the provisions of NEC Article 352.

D. Liquidtight Flexible Metal Conduit, Couplings and Fittings

1. 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.
2. Fittings used with liquidtight flexible metal conduit shall be of the three-piece screw-in type malleable iron as manufactured by the O.Z. Gedney Co. or equal.
3. Liquidtight flexible metal conduit shall be for use under the provisions of NEC Article 350.

E. Flexible Metallic Tubing

1. Flexible metallic tubing shall be for use under the provisions of NEC Article 360.
2. 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.
3. Flexible metallic tubing shall be used only indoors for connection to lighting fixtures in NEMA 1 administration and office areas.
4. Furnish and install insulated bushings at terminations for conductor protection.

F. Flexible Couplings

1. Flexible couplings shall be type ECGJH as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Killark Electric Manufacturing Co. or equal.

G. Boxes and Fittings

1. 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.
2. 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 and covers shall not be less than 12 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.

3. 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 and covers shall not be less than 12 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.
4. 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.
5. 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.
6. 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.
7. Cast aluminum fittings (Cs, Ts, LBs, etc.) shall be of the mogul design (with rollers) as manufactured by Appleton Electric Co.
8. Floor boxes shall be of the adjustable single gang, concrete tight type for installation in concrete fill, Walker 800 Series, similar by Hubbell; Thomas & Betts Co. or equal.
9. Conduit hubs shall be of the grounding type as manufactured by Myers Electric Products, Inc. or equal.
10. 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.
11. Conduit wall seals for cored holes shall be Type CSML as manufactured by the O.Z./Gedney Co. or equal.
12. Conduit wall and floor seals for sleeved openings shall be Type CSMI as manufactured by the O.Z./Gedney Co. or equal.
13. 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.
14. 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.

15. Explosion proof fittings shall be as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; O.Z./Gedney Co. or equal.
16. Conduit sealing bushings shall be O.Z./Gedney, Type CSB or equal.
17. Elbows and couplings shall be aluminum.
18. 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.

H. Conduit Mounting Equipment

1. In dry indoor non-process areas, hangers, rods, backplates, beam clamps, channel, fasteners, anchors, nuts, washers, etc., shall be hot-dipped galvanized steel.
2. 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 "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.
3. Expansion anchors (minimum 3/8" diameter) shall be equal to Kwik-Bolt as manufactured by the McCulloch 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 one 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 District.

I. 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.; Pro Set Systems; Neer Mfg. Co.; Specified Technologies, Inc. or equal.

J. Cold Galvanizing Compound

1. Cold galvanizing compound shall be 95% zinc rich paint as manufactured by ZRC Products Company, a Division of Norfolk Corp. or equal.

PART 3 EXECUTION

3.01 RACEWAY APPLICATIONS

- A. Except where otherwise shown on the Drawings, or specified, all wiring shall be in rigid aluminum conduit.

- B. Rigid aluminum conduit shall be used at all locations (underground and within structures) as raceways for shielded process instrumentation wiring, shielded control wiring, data highway wiring and I/O wiring.
- C. 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.
- D. Rigid aluminum conduit or Schedule 80 PVC shall be used underground where concrete encasement is not called for or as specified in Paragraph 3.01B above. Where schedule 80 PVC is used all elbows shall be rigid aluminum.
- E. PVC conduit shall be used for concrete encased underground duct banks except as specified in Paragraph 3.01B above and except as specified in Section 16600.
- F. 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.
- G. All conduit of a given type shall be the product of one manufacturer.

3.02 BOX APPLICATIONS

- A. Unless otherwise specified herein or shown on the Drawings, all boxes shall be metal.
- B. Exposed switch, receptacle and lighting outlet boxes and conduit fittings shall be cast aluminum.
- C. Concealed switch, receptacle and lighting outlet boxes shall be pressed steel. Welded seamed boxes will not be permitted.
- D. 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.

3.03 FITTINGS APPLICATIONS

- A. 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.
- B. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Drawings.
- C. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

3.04 INSTALLATION

- A. 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.
- B. 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.
- C. The ends of all conduits shall be tightly plugged to exclude dust and moisture during construction.
- D. Conduit supports, other than for underground raceways, shall be spaced at intervals of eight ft or less, as required to obtain rigid construction.
- E. 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.
- F. 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.
- G. 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.
- H. Conduit terminating in pressed steel boxes shall have double locknuts (aluminum) and insulated grounding bushings.
- I. Conduit terminating in gasketed enclosures shall be terminated with Meyers grounding type conduit hubs.
- J. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings with lay-in type lugs.
- K. Conduits shall be installed using threaded fittings unless otherwise specified herein.
- L. 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.
- M. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

- N. 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.
- O. All threads on aluminum conduit and fittings shall be cleaned and coated with "No-Oxide" compound before installing.
- P. Aluminum conduit installed in concrete or below grade shall be completely covered with two coats of bitumastic paint or with heat shrink tubing (Raychem or equal).
- Q. Where conduits pass through openings in walls or floor slabs, the remaining openings shall be sealed against the passage of flame and smoke.
- R. 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.
- S. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.
- T. 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.
- U. 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.
- V. Conduit sealing and drain fittings shall be installed in areas designated as NEMA 7.
- W. Spare conduits and conduit stubouts for future construction shall be provided with threaded PVC end caps at each end.
- X. No unbroken run shall exceed 300 feet in length. This length shall be reduced by 75 feet for each 90 degree elbow.
- Y. Aluminum conduit entering manholes and below grade pull boxes shall be terminated with grounding type bushings and connected to a 3/4" x 10' rod with a #6 bare copper wire.
- Z. 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.
- AA. 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.

- BB. All risers from underground, concrete pads, floors, etc. shall be provided with heat shrink tubing (Raychem Co. or equal) from a point one foot-0-inch below bottom of slab or grade to a point not less than six inches above grade or surface of slab.
- CC. 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 two-in. in diameter and larger prior to installing conductors.
- DD. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment.
- EE. 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.
- FF. 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.
- GG. The use of running threads is prohibited. Where such threads are necessary, a three-piece cast aluminum union shall be used.
- HH. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc, shall be sealed with "Duxseal" as manufactured by Manville or seal fitting to prevent the accumulation of condensation.
- II. All field cut ends of hot dipped galvanized mounting channel shall be cleaned and painted with cold galvanizing compound before installation.
- JJ. 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

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.
- B. Install data highway, fiberoptic, coaxial and I/O cables furnished under Division 13.

1.02 SUBMITTALS

- A. 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.
- B. Approved samples will be sent to the project location for comparison by the Resident Engineer with the wire actually installed.
- C. Installed unapproved wire shall be removed and replaced at no additional cost to the District.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Carefully handle all conductors to avoid kinks and damage to insulation.

PART 2 PRODUCTS

2.01 GENERAL

- A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.
- B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.
- C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.
- D. All wire of a given type shall be the product of a single manufacturer.

2.02 MATERIALS

- A. 600 Volt or Less Wire and Cable
 - 1. 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.
 - 2. 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.
 - 3. Wire for control circuits shall be #14 AWG minimum NEC type XHHW-2 stranded.

4. 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 uninsulated unless shown otherwise on the Drawings.
5. Types XHHW-2 and RHW-2 wire shall be as manufactured by the Southwire Co., Pirelli Cable Corp., Okonite Co., or equal.
6. 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.
7. 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.

2.03 INSTRUMENTATION WIRE

- A. 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.
- B. Cable for 4-20 mA instrumentation, potentiometer, RTD and similar analog circuits shall be multi-conductor twisted and shielded.
 1. Single pair cable:
 - a. Conductors: Two No. 16 AWG stranded and twisted
 - b. Insulation: XLP
 - c. Shield: 100 percent tape with drain wire
 - d. Jacket: PVC with UL and manufacturers identification
 2. Three conductor (triad) cable:
 - a. Conductors: Three No. 16 AWG stranded and twisted
 - b. Insulation: XLP
 - c. Shield: 100 percent tape with drain wire
 - d. Jacket: PVC with UL and manufacturers identification
 3. Multiple pair cables (where shown on the Drawings):
 - a. Conductor: Multiple Two No. 16 AWG stranded and twisted
 - b. Insulation: XLP
 - c. Shield: Individual pairs and overall shielded with 100 percent tape and drain wire
 - d. Jacket: PVC with UL manufacturers identification

2.04 COMMUNICATION CABLE

- A. 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 one Mhz and a maximum attenuation of 10 dB per 1000 feet at one Mhz. The

twisted pair cable shall be plenum rated and shall have a minimum of four 24 AWG solid copper conductor pairs. All RJ-45 terminations on the twisted pair cable shall be done as specified by the manufacturer. Terminations shall provide strain relief on the cable jacket. Strain relief on the wire and/or wire insulation shall not be acceptable. Cable and connections shall meet or exceed Category 6 ratings and upon completion of the network installation, the system shall be tested to Category 6 standards. Category 6 cable shall be as manufactured by Belden, or equal.

2.05 TERMINATIONS AND SPLICES (POWER CONDUCTORS)

- A. 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.
- B. 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.

2.06 TERMINATION AND SPLICES (CONTROL CONDUCTORS)

- A. 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.
- B. 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.

2.07 TERMINATIONS (INSTRUMENTATION CABLES)

- A. 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.

2.08 MOTOR CONNECTIONS

- A. 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).

2.09 WIRE AND CABLE MARKERS

- A. 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.
- B. 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.

2.10 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. or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. 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.
- B. 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.
- C. 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.
- D. Seal openings in slabs and walls through which wires and cables pass.
- E. Steel fish tapes and/or steel pulling cables shall not be used in PVC conduit runs.
- F. Pull cable from direction that requires the least tension.
- G. Feed cable into raceway with zero tension and without cable crossover at raceway entrance.
- 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. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where medium voltage cables 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.

- L. Uniquely identify all cable at supply and receiving ends and in all manholes, handholes or pullboxes. Use embossed brass tags and tywrap fasteners.
- M. Hydraulically or manually operated cable benders shall not be used unless approved in writing by the Engineer.
- N. Instrumentation cables shall be installed in rigid steel 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.
- O. 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.
- P. Terminal blocks shall be provided at all instrument cable junctions, and all circuits shall be identified at such junctions.
- Q. 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.
- R. 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.
- S. 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 one-in. minimum over the jacket end and extend ½" minimum from the jacket end over the exposed conductors.

3.02 WIRE COLOR CODE

- A. 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.
- B. The following coding shall be used:

<u>System</u>	<u>Wire</u>	<u>Color</u>
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	Neutral	White
3 Phase, 4 Wire	Phase A	Black
delta, center tap	Phase B (High)	Orange
ground on phase	Phase C	Blue
coil A-C		
480Y/277 Volts	Neutral	White
3 Phase, 4 Wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
Control (Individual Conductors)	AC	Red
	DC	Blue

3.03 FIELD TESTING

- A. 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.
- B. 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. Minimum wire insulation resistance shall not be less than 250 Megohms.
- C. All service conductors shall be tested as in paragraph A above with the Engineer present.

END OF SECTION

SECTION 16150
MOTORS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. 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.

1.02 QUALIFICATIONS

- A. 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.

1.03 SUBMITTALS

- A. 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:
 - 1. Efficiency at $\frac{1}{2}$, $\frac{3}{4}$ and full load
 - 2. Power factor at $\frac{1}{2}$, $\frac{3}{4}$ and full load
 - 3. Motor outline, dimensions and weight
 - 4. Descriptive bulletins, including full description of insulation system
 - 5. Bearing design data
 - 6. Special features (i.e., space heaters, temperature detectors, etc.)
- B. 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.
- C. Guarantee: All equipment furnished and installed under this Section shall be guaranteed against defects of workmanship, materials and proper installation for a period of one year from date of acceptance. All such equipment or parts proven defective, due to the above noted causes, shall be replaced in the machines by the Contractor at no expense to the District.
- D. Provide equipment warranty in accordance with Section 01740.

1.04 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers (IEEE)
- B. National Electrical Manufacturers Association (NEMA)
- C. 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. 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.
- B. All motors used with variable frequency drives shall be rated for inverter duty and shall be in accordance with NEMA MG1, Part 31.
- C. 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.

2.02 RATINGS

- A. 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).
- B. 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.
- C. All motors shall be continuous time rated suitable for operation in a 40 degrees C ambient unless noted otherwise.
- D. Specific motor data such as Hp, rpm, etc., is specified under the detailed specification for the equipment with which the motor is supplied.

2.03 NAMEPLATES

- A. 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 MGI-10.38 or MGI-20.60, as applicable.

2.04 CONDENSATION HEATERS

- A. 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.

2.05 WINDING TEMPERATURE DETECTORS

- A. 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.
- B. All motors operating with variable frequency drives shall be equipped with winding temperature detectors.

2.06 THREE PHASE INDUCTION MOTORS

- A. Motors 50 horsepower and larger shall have a 120-volt space heater for moisture control.
- B. All motors shall be NEMA Premium efficient type.

2.07 CONSTRUCTION

- A. General:
 - 1. 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.
 - 2. 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.

3. 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.
4. Vertical motors shall be hollow or solid shaft as required by the equipment furnished under other Sections of these Specifications.
5. Totally enclosed non-ventilated (TENV) motors shall include the same ratings and accessories as specified for TEFC motors. Explosion-proof motors shall be UL listed and FM approved for Class 1, Division 1 hazardous areas.

B. Low Voltage, Three Phase Motors:

1. 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.
2. Motors shall have normal or high starting torque (as required), low starting current (not to exceed 650 percent full load current), and low slip.
3. Unless otherwise specified, motors shall be totally enclosed fan-cooled construction with a 1.15 service factor at the Class B Temperature-Rise.
4. The output shaft shall be suitable for direct connection or belt drive as required.
5. Motors shall have a Class F non-hygroscopic insulation system but shall be limited to Class B Temperature-Rise, at 1.15 service factor.
6. 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.
7. All fittings, bolts, nuts, and screws shall be plated to resist corrosion. Bolts and nuts shall have hex heads.
8. All machine surfaces shall be coated with rust inhibitor for easy disassembly.
9. 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.

10. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.
11. 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.
12. Low voltage, three phase motors shall be manufactured by U.S. Motors, Reliance Electric or Baldor.
13. Fractional Horsepower:
 - a. 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.
 - b. 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.
 - c. 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.
 - d. 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.
14. Integral Horsepower:
 - a. 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.
 - b. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.
 - c. 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.
 - d. 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.
 - e. Motors shall be equipped with vacuum-degassed anti-friction bearings made to AFBMA 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.

- f. 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 five years in accordance with AFBMA life and thrust values.
- g. Vertical hollow-shaft motors will have non-reverse ratchets to prevent backspin. Non-reverse ratchets shall be suitable for duty with variable frequency drives.

C. Low Voltage, Single Phase Motors:

1. 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.
2. Totally enclosed fan cooled motors shall be designed for severe-duty.
3. Motors shall have corrosion and fungus protective finish on internal and external surfaces. All fittings shall have a corrosion protective plating.
4. Mechanical characteristics shall be the same as specified for polyphase fractional horsepower motors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. 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.
- B. Low Voltage: For wire sizes #8 AWG and larger, long barrel tin-plated copper compression (hydraulically pressed) type connections (Burdny 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).

3.02 TESTS AND CHECKS

- A. The following tests shall be performed on all motors after installation but before putting motors into service.
 1. 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.

2. 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.
3. The Contractor shall provide to the Engineer a typed list of all motors one 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.
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 (NETA Standard ATS).

END OF SECTION

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SECTION 16191
MISCELLANEOUS EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

1.02 EQUIPMENT LIST

- A. 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.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified in sufficient detail to show compliance with the Drawings and Specifications.

1.04 REFERENCE STANDARDS

- A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16000.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disconnect Switches

1. 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. All current carrying parts shall be copper
2. NEMA 4X enclosures shall be stainless steel.
3. Switches shall be as manufactured by the Square D Co.; General Electric; Eaton, or equal.

B. Combination Magnetic Motor Starters

1. 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 horsepower shown on the Drawings. Minimum size shall be NEMA size 1. Motor circuit protectors (MCP) 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 65,000 Amps RMS symmetrical.

2. Each motor starter shall have a 120 Volt operating coil and control power transformer. Transformer primaries and secondaries shall be equipped with time-delay fuses. Three phase starters shall have three overload relays. One normally open and one normally closed auxiliary contact shall be provided as spares in addition to contacts shown on the Drawings.
3. Overload relays shall be adjustable, ambient compensated and manually reset.
4. Furnish built-in control stations and indicating lights where shown on the Drawings.
5. NEMA 4X enclosures shall be stainless steel.
6. Combination magnetic motor starters shall be as manufactured by the Square D Co.; General Electric; Eaton, or equal.

C. Unit Heater Combination Contactors

1. Combination contactors shall be a fused switch and contactor, 600 Volt, 3 Pole, 60 Hz, magnetically operated. NEMA size shall be as required for the kilowatt ratings shown on the Drawings but shall be not less than NEMA size 1.
2. Contactors shall have a 120 Volt operating coil and control power transformer fused on primary and secondary sides. Furnish the control power transformer with extra capacity for the unit heater fan.
3. NEMA 4X enclosures shall be stainless steel.
4. Combination contactors shall be as manufactured by the Square D Co.; General Electric; Eaton, or equal.

D. Control Stations

1. Control stations shall be heavy-duty type, with full size (30mm) operators. Stop buttons shall have a lockout latch that can be padlocked in the open position.
2. NEMA 4X enclosures shall be stainless steel.
3. Control stations shall be Square D Class 9001, similar by Eaton; General Electric Co., or equal.

E. General Purpose Dry Type Transformers

1. Transformers shall be dry type, two-winding with kVA and voltage ratings as shown on the Drawings. Transformer shall incorporate a 220 degree C insulation system and be designed not to exceed 80 degrees C temperature rise above a 40 degree C ambient full load
2. Four full capacity taps shall be furnished, two 2-1/2 percent above and two 2-1/2 percent below rated primary voltage.
3. Windings shall be copper.

4. Transformers shall be built in accordance with ANSI C89.2 and shall be UL.
5. Transformers shall be energy efficient type, meeting the efficiency levels specified in NEMA Standard TP1. Efficiency shall be tested in accordance with TP1.
6. Transformers shall be furnished in NEMA 2 enclosures unless otherwise noted on the Drawings or as required by Section 16000. Areas where a NEMA 4X and/or stainless steel enclosure is required, the transformer shall be of the TENV type.
7. Transformers shall be furnished with hot-dipped galvanized mounting hardware. In NEMA 4X areas or where stainless steel enclosures are required, hardware shall be Type 316 stainless steel.
8. Transformers shall have common core construction with low hysteresis and eddy current losses. The core flux density shall be below the saturation point to prevent overheating caused by harmonic distortion.
9. Transformer impedance shall be a minimum of three percent and a maximum of five percent.
10. Provide vibration isolators for transformers rated 112.5 kVA and higher.
11. Provide ground lug on frame and strap ground core assembly to frame of enclosure.
12. Transformers shall be manufactured by Square D Co.; General Electric Co.; Eaton, or equal.

F. Control Relays

1. 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 General Electric Co., Catalog No. CR120B; similar by Square D Co.; Allen-Bradley Co., or equal. Latching relays shall be General Electric Co., Catalog No. CR120BL; similar by Square D Co.; Allen-Bradley Co., or equal.
2. Time delay relays shall be pneumatic, 600 Volt, 20 Amp contacts, with calibrated knob operated adjustment. On delay and off delay types and timing ranges shall be as shown on the Drawings. Relays shall be Agastat Model 7012 or 7022; similar by Square D Co.; Eaton Electrical, or equal.

G. Detectable Warning Tape

1. Each ductbank section shall be marked by means of a detectable warning tape (tracer tape) as shown on the Drawings. The detectable warning tape shall be capable of being detected or located by either conductive or inductive location techniques.
2. The detectable warning tape shall consist of five mil (.005-in) overall thickness; five-ply composition; ultra-high molecular weight; virgin polyethylene; acid; alkaline and corrosion resistant; with 150 pounds of tensile break strength minimum per six-in. width.

3. The top side of the tracer tape shall be color banded red for electrical and high voltage lines, and orange for signal, communication, telephone and fire alarm lines. Tracer tape shall be four-in. wide with four color bands. The tape shall be inscribed with the warning message for the utility such as "CAUTION – ELECTRICAL LINED BURIED BELOW". Tape shall be as manufactured by Mutual Industries, Inc.; Terra Tape, Div. of Reef Industries Inc., or equal.

H. Terminal Blocks

1. Terminal blocks shall be NEMA type rated at 20 amperes minimum, 600 Volt, channel mounted, with tubular screw and pressure plate.
2. Terminal blocks shall be Bulletin 1492 as manufactured by the Allen-Bradley Co.; ABB; Kukla, or equal.

I. Break-Glass Emergency Station

1. Break-Glass Emergency Station shall be of the break glass design with a cast metal outer case finished in fire red and have an attached chain hung "Hammer". A weatherproof 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.

J. Equipment Mounting Stands

1. Equipment mounting stands shall be custom fabricated from 1/4-in steel plate and 4-in steel channel, as shown on the Drawings. For NEMA 4X areas or where stainless steel enclosures are required mounting stands and channels shall be Type 316 stainless steel.

K. Rubber Floor Mats

1. Furnish and install a non-conductive elastomer compound rubber floor mat extending the full length and placed in front of and in back of each switchboard, transformer, and variable frequency drive.
2. Mats shall be in accordance with ASTM D178, Type II, Class 2, 1/4-in thick minimum, 36-in wide with corrugated surface and shall be branded continuously on the back.
3. Mats shall have the following ratings:
 - a. Voltage phase to phase 17,000 V RMS
 - b. AC Proof Test Voltage 20,000 V RMS
 - c. DC Proof Test Voltage 50,000 V Average
4. Type II mats shall be ozone, flame and oil resistant.
5. Install mats in one continuous piece. Where equipment faces each other and is less than six-ft apart, provide one width of mat.
6. Mats shall be stored without distortion, free from direct sun light or sources of ozone and at a temperature not to exceed 95 degrees F (35 degrees C).

L. Arc Flash Protection Warning Signs

1. Provide field-affixed arc flash warning labels on all switchboards, panelboards, industrial control panels, and motor control centers in accordance with National Electrical Code Article 110.16.
2. As a minimum, warning signs shall state "WARNING: Arc Flash and Shock Hazard, Appropriate PPE required", and shall be designed in accordance with ANSI Z535.4-1998. Where available from the equipment manufacturer, additional information including Flash Hazard boundary, incident energy, voltage shock hazard, PPE required, etc. shall be provided.

M. Electric Warning Sign

1. Provide and install using stainless steel fasteners a total of two restrictive signs that conform with OSHA regulations for accident prevention. Size of sign: 10-in high by 14-in wide. Sign shall state "DANGER HIGH VOLTAGE". Sign shall be constructed of High Performance Plastic (HPP) by the Seton Name Plate Corp.; Global Equipment Co.; World-wide Sign Co., or equal.

N. Terminal Cabinets

1. 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.
2. 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.
3. All wiring within the cabinets shall be grouped together in harnesses and secured to the structure.
4. 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.
5. 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.
6. Boxes shall be made from 14-gauge galvanized steel and shall be of sufficient size to provide a minimum of four inches of wiring space on all sides and between adjacent terminal blocks. A minimum two-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.
7. 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.

8. 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.
9. Cabinets in wet, damp, corrosive and all outdoor locations shall be NEMA 4X 316 stainless steel.
10. Cabinets shall be Schaefer with latch kit hardware, or equal.

2.02 CONTROL SYSTEM

- A. 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.
- B. Control Panel Construction
 1. 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.
 2. 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. Latches shall be quarter turn quick release type and all hardware shall be 316 stainless steel. Where NEMA 3R or 12 enclosures are specifically required, the door shall be provided with a pad-lockable vault type three-point latch. The enclosure shall be equipped with a door and 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.
 3. 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.
 4. A thermal-magnetic air circuit breaker, Type FH (65KAIC) 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.
 5. 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. 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.

Overloads shall be of the melting alloy or bi-metallic type, adjustable overloads are not acceptable, Class 10 quick trip overloads shall be provided for all submersible 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

6. 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.
7. 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.
8. 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 switch positions, each of which shall be clearly labeled according to function.
9. Indicator lamps shall be LED (indoors) or Incandescent (outdoors) full voltage type and mounted in NEMA 4X (800H) modules, as manufactured by Allen-Bradley. 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.
10. A six digit, non-reset 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.
11. 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 lens and solid-state flasher (Ingam Products Inc. LRX-40).
12. The control panel shall operate on a power supply of 480 volts, 3-phase, 60 Hertz unless otherwise noted.
13. 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.
14. 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.
15. 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.

16. 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.
17. Alternators shall be provided to sequence motors, alternators shall be 008-120-13SP or 009-120-23AP as manufactured by Sta-con, or equal.
18. A phase monitor shall be provided for the control panel, monitors shall be model SUA-440-ASA as manufactured by Diversified Electronics Inc., or equal.
19. 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.
20. The control panel shall be provided with surge protection device (SPD). The SPD shall be mounted within the control panel enclosure. Lead lengths shall not be longer than 12 inches from the main circuit breaker and as straight as possible. The SPD shall have a minimum surge current rating of 200kA per phase. Refer to Section 16191 for additional requirements.
21. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.
22. 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.
23. 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 white letters with a black background.
24. All control panels shall be provided with a master nameplate located on the exterior door.
25. 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.
26. 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.
27. All control relays shall 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.
28. 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.

29. The completed control panel assembly shall be U.L. certified. The minimum overall short-circuit withstand rating of the control panel and devices shall be 65,000 Amperes RMS symmetrical at 480 volts.
30. Intrinsically safe relays shall be solid state type with five 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.
31. All electronic control equipment (i.e. controllers, isolators, signal boosters, transmitters, PLC's, etc.) shall be as specified in Division 13.
32. A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.
33. All signal wiring entering and exiting the control panel shall be provided with surge protection. Surge protection shall be as specified in Division 13.
34. An eight-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A four-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.
35. 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.

<u>System</u>	<u>Wire</u>	<u>Color</u>
Incoming line voltage	Phase conductors	Black
	Ground	Green
	Neutral (As Required)	White
Less than line voltage (individual conductors)	AC	Red
	24VDC	Blue
	0VDC	White/Blue Stripes
	Foreign	Yellow

C. Spare Parts

1. The following number of spare parts shall be furnished for each control panel.
 - a. One Indicator light assembly.
 - b. Two control relays for each type furnished.
 - c. Five fuses for each type/size furnished.
 - d. One set thermal overloads for each size furnished.
 - e. One selector switch for each type furnished.
 - f. One starter coil for each size furnished.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mounting Stands

1. Field mounted disconnects, pushbutton control stations, alarm panels, enclosed starters and circuit breakers, transformers, automatic transfer switches, wireways, contactors, terminal boxes, junction and pull boxes shall be mounted on galvanized or stainless steel stands as specified. Where clearance requirements for stands may not be maintained, the Engineer may direct electric control equipment to be wall-mounted adjacent to the driven equipment, but in no case shall the distance from the drive motor to the control station exceed three ft, all at no additional cost to the District.
2. All floor mounting stands, bracing, anchor bolts and appurtenances furnished to support equipment loads, dynamic loads, wind loads and seismic forces shall conform to the latest applicable requirements of the State Building Code in effect at the time of Bid.
3. All wall mounted brackets, bracing, bolts and appurtenances to support equipment loads dynamic loads, wind loads and seismic forces shall conform to the latest applicable requirements of the State Building Code in effect at the time of Bid.
4. Channel supports shall be ground smooth and fitted with plastic end caps.

- B. All panelboards located in pedestal cabinets or outdoors and panelboards that have branch circuits feeding exterior to the building shall be equipped with lightning arresters and surge capacitors.

3.02 FIELD TESTING

- A. Before supplying power to the alarm panels, the following tests shall be done: Verify that all wiring connection interfaces that are required are present. Check for secure connections. Using a continuity device, verify that all discrete inputs and output to and from the control panel are wired in correct polarity and are operating in the correct state of operation (normally open or closed state). Check for any direct short circuits across all voltage supply sources. As each of the above tests are performed, the Electrical Contractor shall highlight and initial each circuit that is tested. This set of prints shall be signed and left inside the enclosure.
- B. Check mechanical interlocks for intended operation. Make any adjustments required.
- C. In the event of an equipment fault in the panel, 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 and Engineer. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service at no additional cost to the District.

END OF SECTION

SECTION 16192
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. 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.

1.02 RELATED WORK

- A. Refer to Division 13 for SPDs for instruments, telecommunication systems, antenna systems, or computer systems.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, the following:
 - 1. Detailed catalog information with sufficient detail to determine compliance with the specifications including the electrical and physical characteristics.
 - a. Minimum electrical ratings shall include operating voltage, voltage protection rating (VPR), frequency and phasing.
 - b. Minimum performance ratings for Type 1 and Type 2 SPDs shall include nominal discharge current (I_n) rating, maximum continuous operating voltage (MCOV), and short circuit current rating (SCCR).
 - c. UL 1449, Fourth Edition (minimum) listing compliance certification.
 - 2. Warranty statement.

1.04 REFERENCE STANDARDS

- A. The materials and installation shall comply with the codes and standards of the following organizations:
 - 1. American National Standards Institute (ANSI)
 - 2. Institute of Electrical and Electronic Engineers (IEEE)
 - 3. National Electrical Manufacturers Association (NEMA)
 - 4. National Fire Protection Association (NFPA)
 - 5. Underwriters Laboratories (UL)
- B. Specific codes and standards that apply include the following:

1. ANSI/IEEE C62.41 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
 2. ANSI/IEEE C62.45 – Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
 3. NFPA 70 – National Electrical Code, Article 285
 4. NFPA 780 – Standard for the Installation of Lightning Protection Systems
 5. UL 1283 – Electromagnetic Interference Filters
 6. UL 1449 – Surge Protective Devices
- 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 WARRANTY

- A. 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

2.01 MANUFACTURERS

- A. Subject to compliance, the following manufacturers are acceptable:
1. Advanced Protection Technologies
 2. Current Technology
 3. Surge Suppression Inc.
 4. Joslyn (Total Protection Solutions)
 5. Eaton/Cutler-Hammer
 6. Square D
 7. LEA International

2.02 PRODUCTS

- A. The SPD supplied shall be selected to match the voltage, phasing, and frequency of the power system.

- B. The SCCR rating of the SPD shall have at least the same rating of the electrical equipment being protected.
- C. The SPD enclosure shall be rated NEMA 12 for indoor dry locations and NEMA 4X for outdoor, wet, damp, chemical, or corrosive areas.
- D. The SPD shall protect against surges produced by a 1.2 / 50 μ s and 8 / 20 μ s combination waveform generator.
- E. SPDs at switchgear, switchboards, and motor control centers shall have a nominal discharge current (I_n) of at least 20 kA 8 / 20 μ s per phase.
- F. SPDs shall include EMI/RFI noise filtration and comply with UL 1283.
- G. 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.
- H. The SPD shall provide LED indicator lights to provide continuous positive operational status of each individual MOV in each mode in each protected phase. Indicator lights shall be visible without the need to open any compartments.
- I. The SPD shall provide all modes of protection based on the system voltage.
- J. The voltage protection ratings (VPRs) shall not exceed the following:

<u>System Voltage</u>	<u>Line-Neutral</u>	<u>Line-Ground</u>	<u>N-Ground</u>	<u>Line-Line</u>
120 (2W+G)	700	700	700	n/a
240 (2W+G)	1200	1200	1200	n/a
120/240 (3W+G)	700	700	700	1200
120/208Y (4W+G)	700	700	700	1200
277/480Y (4W+G)	1200	1200	1200	2000
240 Δ (3W+G)	n/a	1200	n/a	1200

- K. SPD shall have a one nanosecond or less response time for any individual component and shall be self restoring and fully automatic.
- L. Minimum surge current ratings per mode shall be as follows:
 - 1. Service entrance equipment, switchgear, and switchboards (480V): 300 kA
 - 2. Distribution panels and Motor control centers (480V): 200 kA
 - 3. Branch panels and control panels (480V): 200 kA
 - 4. Branch panels (120/208/240 – single or three phase): 100 kA

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install surge protective devices as shown on the Drawings and in accordance with manufacturer's instructions.
- B. SPDs shall be installed with lead conductors as short as possible (not to exceed 24-inches), gently twisted together, and routed to avoid sharp bends or kinks.
- C. SPDs may be mounted internally in motor control centers, switchgear or switchboards provided they are in an individual compartment.
- D. SPDs may be mounted internally in variable frequency drives and control panels.
- E. SPDs may be mounted internally at panelboards.
- F. SPD's shall be externally mounted at transformer panel assemblies.

END OF SECTION

SECTION 16370
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to manufacture, assemble, shop-test, and install variable frequency drives with output filters as shown on the Drawings and as specified herein.
- B. These specifications are intended to give a general description of what is required, but do not cover all details which 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.
- C. All variable frequency drives for the entire project shall be from one manufacturer of variable frequency drives. The variable frequency drives shall be furnished and coordinated by the Pump Manufacturer.
- D. 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.

1.02 DESCRIPTION OF SYSTEMS

- A. The variable frequency drives specified hereinafter will become part of a complete system as specified in Division 11. The Contractor shall coordinate with the manufacturer of the Division 11 equipment to ensure the compatibility of the equipment.
- B. 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.
- C. Additional controls shall be provided as required by Division 11 and as shown on the drawings.

1.03 QUALIFICATIONS

- A. Variable speed drives shall be of sufficient size for the duty to be performed and shall not exceed their full-rated capacity when the driven equipment is operating as specified.
- B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five 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.

- C. 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 years.
- D. 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.
- E. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- F. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.
- G. Approved Manufacturers: Allen-Bradley, Schneider Electric/Square D, Eaton, ABB/General Electric.

1.04 SUBMITTALS

- A. Copies of all materials required to establish compliance with the specifications shall be submitted. Submittals shall include at least the following:
 - 1. 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.
 - 2. Descriptive literature, bulletins and/or catalogs of the equipment.
 - 3. 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.
 - 4. 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.
 - 5. The total weight of the equipment including the weight of the single largest item.
 - 6. A complete total bill of materials of all equipment.

1.05 OPERATING INSTRUCTIONS

- A. 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.
- B. A factory personnel of the manufacturer 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 control panels.
- C. The cost of training programs to be conducted with District'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. The manufacturer shall include the travel and expenses for two District personnel attending factory training.
- D. 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.
- E. The manufacturer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to District.
- F. The training program shall represent a comprehensive program covering all aspects of the VFD and maintenance of the system.
- G. All training schedules shall be coordinated with and at the convenience of the District. Shift training may be required to correspond to the District's working schedule.
- H. Factory Training: Factory training shall be conducted before System is commissioned, and subsequent to final manual submittals. Factory training shall consist of schooling and hands-on experience. The class shall be for two people and consist of four days of extensive training covering the following:
 - 1. Theory of Operation
 - 2. Use of Software
 - 3. Troubleshooting and Maintenance
- I. On-site Training: On-site (field) training shall be conducted at the District's site and shall provide detailed hands-on instruction to District'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 District. The training shall be conducted over a period of five days.

1.06 TOOLS AND SPARE PARTS

- A. One set of all special tools required for normal operation and maintenance shall be provided.

1.07 PRODUCT 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 completed and the units and equipment are ready for operation.
- B. All equipment and spare parts must be properly protected against any damage during a prolonged period at the site.
- C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- D. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.08 WARRANTY

- A. All equipment supplied under this Section shall be warranted for a period of one year by the Contractor and Manufacturer from the date of Partial Substantial Completion, as specified in Section 01740, to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, the part(s) shall be replaced in the equipment and the unit(s) restored to service at no expense to the District.
- B. 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 District.
- C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

1.09 HARMONICS STUDY

- A. The VFD manufacturer shall provide an electrical system harmonics study for each electrical distribution system including utility and generator sources that have VFDs rated 100 HP and larger. The goal of the studies shall be to determine requirements for the variable frequency drives as required to comply with the harmonic distortion levels.
- B. The harmonics study shall verify compliance with the harmonics and line notching requirements specified herein, with information on the filter system (if necessary) required to achieve the specified levels. The study shall be based on and contain, as a minimum, the following:
 - 1. Minimum utility system short circuit kVA (confirm in writing with utility); with all VFDs operating simultaneously, operating over a 60 to 100 percent speed range. The location point of common coupling (PCC) shall be the secondary of the respective pad mounted transformer(s).
 - 2. Explanation of method used to perform the study.
 - 3. Explanation of study results with specific recommendations on filters and/or other measures that will be implemented to meet the specified limits.
 - 4. All calculations and/or computer printouts used to arrive at the recommendations.

5. Individual drive voltage and current harmonic content up to the fiftieth harmonic, and the combined total of all the drive harmonic contents reflected in the system source supply voltage and current as a percent of the 60 Hz fundamental under actual load conditions from 0–60 Hz at 10 Hz increments.
- C. The harmonic distortion on the total installed distribution system for voltage and current distortion levels and line notching shall meet the requirements of IEEE 519-2014. Capacitor-Inductor filter traps that require tuning to the power system are not acceptable. The Variable frequency drive manufacturer shall provide for the design, furnishing and installation of the filtering and appurtenances required to meet the requirements as specified herein. Any costs associated with provision of and installation, space, wiring, conduit, etc. for filtering equipment shall be provided at no additional cost to the District.
- D. The manufacturer shall be responsible to provide all data necessary to perform the study. This includes feeder cable sizes, approximate feeder length motor data, switchgear data, utility data, generator data, existing field data (if required) and any other information relevant to the study.
- E. The reports shall be provided prior to or with the variable frequency drive shop drawings for approval. Submittals for the variable frequency drives submitted prior to or without the study will be considered incomplete and not reviewed.
- F. The variable frequency drive manufacturer is responsible to provide an up-to-date single line diagram with referenced data within the submittal for each study.
- G. The study shall also address methods the manufacturer is providing to address the problems associated with “dv/dt” and “reflected waves” based on the actual installations (wire type, conduit type, lengths, etc.). The VFD Manufacturer shall provide any/all equipment necessary to address any of the potential problems associated with dv/dt and reflective waves at no additional cost to the District. The VFD Manufacturer shall include all necessary calculations and mitigation equipment with the shop drawing submittals.

PART 2 PRODUCTS

2.01 GENERAL

- A. The Contractor shall furnish and supervise installation of variable frequency drives as described in this specification and as detailed on the applicable Drawings.
- B. The Contractor shall be responsible for the erection, installation, and start up of the equipment covered by this specification.
- C. The variable frequency drive shall comply with the latest applicable standards of ANSI, NEMA, IEEE, and the National Electrical Code.
- D. Variable frequency drives shall operate as specified on standby generators or normal power sources.
- E. Variable frequency drives shall utilize active front end (AFE) design.
- F. The variable frequency drives shall be provided with an output filter to reduce the transient voltage (dv/dt) at the motor terminals.

2.02 CONSTRUCTION

- A. The variable frequency drives (VFD) shall be rated at 480 VAC input with features and options as specified.
- B. 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.
- C. 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.
- D. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.
- E. Input Rectifier: Use a transistor-based Active Front End that uses a Selective Harmonic Elimination algorithm, mitigating the harmonics enough to meet IEEE-519 without the need for phase shifting transformers and multi-pulse diode rectifiers.
 - 1. Total current harmonic distortion shall not exceed 5 percent at the VFC input terminals in all load conditions.
 - 2. Insensitive to phase rotation, tolerant of line voltage imbalance up to 10 percent without affecting the harmonic mitigation or VFC output, and capable of operating the motor at full output with a 10 percent drop on input voltage.
 - 3. Use an LCL filter assembly to filter up to and including the 50th harmonic to reduce EMI/RFI emissions.
 - 4. Include Passive Dampening in LCL filter assembly.
 - 5. Provide Active Resonance Detection and Protection to minimize any damage to the drive from supply side resonance.
- F. Output Filtering: Passive dv/dt output filter to limit peak voltage at motor terminals to 1505 or less of the DC bus voltage for motor leads 1000 feet or less.
- G. The variable frequency drives shall be current regulated. Variable frequency drives permitting instantaneous overcurrent trips other than an output short circuit are not acceptable.

- H. The variable frequency drives shall have an efficiency that exceeds 97% at 100% speed and load. The efficiency shall exceed 90% at 50% speed and load. The variable frequency drives shall maintain the line side displacement power factor no less than .95 regardless of 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.
- I. Standard operation conditions shall be:
1. Incoming power: Three phase, 480V (+10% to -10%) and 60 hertz (+/- 2 hertz) power to a fixed potential DC bus level.
 2. Humidity: 0 to 95% (noncondensing).
 3. Altitude: 0 to 3,300 feet above sea level.
 4. Ambient temperature: 0 to 40 degrees C.
- J. The variable frequency drives shall be able to start into a spinning motor. 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.
- K. Variable frequency drive enclosures shall be NEMA Type 1 gasketed free-standing wall or floor-mounted, force ventilated (with replaceable air filters) construction requiring front access only. 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 output dv/dt filters, and shall not exceed the following dimensions:
- Intake Water Pumps: 48"W x 26"D x 90"H.
- L. 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:
1. Programmable maximum and minimum frequency.
 2. Programmable acceleration and deceleration times.
 3. Selectable carrier frequencies, V/Hz, and critical frequency avoidance lockout.
 4. Adjustable electronic overload and torque limits.
 5. Multiple attempt automatic restart following utility outage or fault condition.
 6. Jog, thread, and preset speeds.

7. Keypad lockout and factory default overrides.
 8. Adjustable slip compensation (+/- 5%).
- M. 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:
1. Local digital speed control.
 2. Local-Off-Remote (LOR) control selector switch.
 3. LED status lights for each LOR position. Push-to-test type.
 4. Momentary Start/Stop pushbuttons utilized with the LOR in “LOCAL”.
 5. Local-Remote speed control selector switch.
 6. LED status lights for each Local-Remote position. Push-to-test type.
 7. LED status lights for run, off, fault, alarm, up-to-speed, power on, and drive ready status. Push-to-test type.
 8. Emergency Stop pushbutton (Red mushroom head and maintained).
 9. 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.
- N. The variable frequency drives shall have the following system interfaces:
1. Inputs:
 - a. Two isolated process control speed reference interfaces to receive and isolate 0-10 Vdc or 4-20 mAdc signals.
 - b. Dedicated terminal blocks for interface with remote operator and field devices.
 - c. 120 Vac control to allow variable frequency drives to interface with remote contacts and with two or three-wire control.
 - d. Additional inputs as required by Division 11 or 13 and as shown on the drawings.
 2. Outputs:
 - a. Four analog output signals 0-10 Vdc or 4-20 mAdc for external metering.
 - b. Run relay with an isolated set of form C contacts.
 - c. Dry contact output (N.O.) to indicate protective function trip.
 - d. Dry contact output (N.O.) to indicate common alarm.
 - e. Additional outputs as required by Division 11 or 13 and as shown on the Drawings.
- O. Monitoring and Displays:
1. The variable frequency drives shall have a 40-character vacuum fluorescent display indicating monitored functions as described in the following paragraph.

2. The following parameters shall be monitored:

- a. Input current (three phases)
- b. Input voltage (three phases)
- c. Output current (three 3 phases)
- d. Output voltage (three phases)
- e. Output frequency
- f. Kilowatts
- g. Drive temperature
- h. Time
- i. Date
- j. Motor rpm
- k. Ten most recent trips/faults

P. Protection Functions:

1. The variable frequency drives shall have the following protective features (with indication for a. through i.):

- a. Speed compensated electronic motor overload current.
- b. Undervoltage.
- c. Overfrequency.
- d. Overtemperature.
- e. Ground Fault.
- f. DC bus protection.
- g. Inrush current limit (adjustable 50 to 150%).
- h. Input and output phase loss.
- i. Emergency stop pushbutton (Red mushroom head and maintained).
- j. Current limiting fuses shall be provided on the input side of the VFDs to protect against fault currents up to 200,000 A sym.
- k. The output side of the VFDs shall be equipped with a current limiting reactor to reduce the amount of fault current to the VFDs.
- l. Phase insensitive to input power.
- m. Surge protective device (SPD) from input AC line transients at line side of main circuit breaker. SPD shall be rated 100 kA per mode / 200 kA per phase. The SPD shall be UL 1449, latest edition.
- n. Electrical isolation between the power, control and logic circuits.
- o. Drive to be capable of withstanding output terminal line short or open circuits without component failure.

Q. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

R. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

S. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

- T. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- U. Additional Features shall be provided as follows:
1. 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.
 2. Fused space heaters with thermostat to minimize condensation potential upon drive shutdown.
 3. The variable frequency drives shall be variable torque design. Provide constant torque design as required by Division 11.
 4. Variable frequency drives shall be capable of unidirectional operation.
 5. Variable frequency drives shall have 115 VAC control power for operator devices.
 6. 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.
 7. All wiring shall be numbered at each end with permanent heat shrink markers. Wiring less than six inches may be numbered at only one end.
 8. A copper ground bus.
 9. Separate door-mounted output ammeter, ammeter switch, non-resettable elapsed time meter (0-99999.9 hour) and speed indicating meter in addition to those specified through the door display.
 10. Power unit fan loss protection by automatically switching to a 100% spare cooling fan. Cooling fans shall be on when the variable frequency drive is operating and off when drive is off (fans shall run for a period of time after the variable frequency drive shuts down to dissipate heat and controlled by a thermal switch).
 11. All bus and exposed copper shall be tin-plated.
 12. All floor mounted enclosures shall have complete 18" (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All wall mounted enclosures shall have complete 12" (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.
 13. Barriers and warning signs on terminals that are energized with the power disconnect OFF.

14. A two-inch by five-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.
15. Provide legend plates or one-inch by three-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.
16. Provide permanent warning signs as follows:
 - a. "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.
 - b. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT".
17. A switchable fluorescent light within each floor mounted section of the enclosure.

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. Field wiring shall be in accordance with manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

3.02 SHOP PAINTING

- A. Prior to shop painting, all surfaces shall be thoroughly cleaned, dry, and free from all mill/scale, rust, grease, dirt, and other foreign matter.
- B. Variable frequency drive enclosures shall be shop painted.

3.03 INSPECTION, TESTING AND STORAGE

- A. The Contractor shall notify the Engineer two weeks prior to all factory and field tests. The Engineer shall have the option to inspect all tests at the factory and in the field.
- B. Field Tests:
 1. 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.
 2. Field tests are the basis of demonstrating equipment proficiency and correct operation.
 3. 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-day 24-hour (actual operation) operating period as specified herein of the drive will be required before acceptance. The Contractor shall provide for seven-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 District. The District

shall be allowed to use any drive supplied immediately following installation and testing whether or not the equipment meets the conditions specified.

4. 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 District. These services are in addition to the services required for training.
5. 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 District as follows:

<u>Inoperable Period</u>	<u>Additional Training</u>
0-2 weeks	None
2-6 weeks	2 days
More than 6 weeks	5 days
6. All training shall be coordinated and conducted concurrently with training to be supplied by the equipment and motor manufacturers.
7. 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.
8. 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.
9. Performance Testing: Demonstrate system performance by operating the system for a seven 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.
10. Check each alarm and detection device for proper operation.
11. The drive manufacturer shall provide all necessary personnel and equipment necessary to properly start-up and pass all tests at no additional cost to District.
12. 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.

C. General:

1. All factory and field tests are typical for each variable frequency drive.
2. Electrical equipment shall at all times during manufacture, testing, delivery and 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. Temporary connections shall be provided to operate space heaters and temporary lights required for heat shall be provided to control moisture. If any apparatus has been damaged prior to acceptance the District, such damage shall be repaired by the Contractor at his own cost and expense. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the Engineer, at the cost and expense of the Contractor, or shall be replaced by the Contractor at his own expense.

END OF SECTION

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SECTION 16425
LOW VOLTAGE SWITCHBOARD

1.01 SCOPE OF WORK

- A. Furnish all labor and materials required and installed. Complete as shown on the Drawings and as specified herein.
- B. Furnish and install the low voltage switchboard equipment as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Power system studies are included in Section 16000.
- B. Equipment mounting hardware shall conform to Sections 05500.
- C. Concrete for equipment pad is included in Division 3.
- D. Concrete for equipment pads shall be furnished under this Section and comply with Division 3.
- E. Excavation is included in Section 02200.

1.03 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01300.
- B. Shop drawings shall include the following information:
 - 1. Master drawing index
 - 2. Front elevation view
 - 3. Floor plan layout
 - 4. Top view
 - 5. Dimensions, weight, and shipping splits
 - 6. Single line diagrams
 - 7. Schematic diagrams
 - 8. Nameplate schedules
 - 9. Component list including metering, protective relays, accessories and control equipment
 - 10. Conduit entry/exit locations

11. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 - d. Bus material and ratings
 12. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
 13. Cable terminal lug sizes
 14. Product data sheets and catalog numbers for circuit breakers and fused switches. List all options, trip adjustments and accessories furnished specifically for this project.
- C. Submit the following additional information where applicable
1. Busway connection
 2. Connection details between close-coupled assemblies
 3. Composite floor plan of close-coupled assemblies
 4. Key interlock scheme drawing and sequence of operations
 5. Detailed shop drawings of the utility metering compartment to the Power Company for review.
- D. Design Data
1. Submit the preliminary short circuit and selective coordination study prior to submittal of equipment shop drawings. The equipment shop drawings will not be reviewed until the preliminary power system study is approved by the Engineer.
 2. Provide manufacturer's published time-current curves of the main breaker and feeder devices per Section 16000.
- E. Test reports
1. When requested, submit design test reports. Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.
 2. Submit production test reports showing results of testing performed on the actual equipment for this project. These tests include:
 - a. 60-hertz dielectric tests
 - b. Mechanical operation tests
 - c. Electrical operation and control wiring tests

- d. Ground fault sensing equipment test.
3. Submit field test reports showing results of testing performed on the actual equipment for this project.
- F. Submit manufacturer's installation instructions for the complete assembly and each major component:
 1. Shipping, storage, and handling instructions
 2. Installation bulletins
 3. Supplemental instruction bulletins.
 4. Application software
 5. Instructions necessary for proper seismic mounting of the equipment.
- G. Statement of Qualifications
 1. When requested, submit qualifications of factory service representatives for approval.
 2. When requested, submit an acceptable list of installations with similar equipment to demonstrate compliance with this specification.
- H. Manufacturer's Field Report
 1. When requested, submit manufacturers field inspection reports.
- I. Project Record Documents
 1. Submit record document information in accordance with Section 01300.
 2. Submit the following information for record purposes:
 - a. A complete set of manufacturers "As Built" shop drawings incorporating all changes made during the manufacturing process.
 - b. "As Built" point-to-point compartment wiring diagrams for metering, relay and control circuits. Show wire and terminal numbers.
 - c. Field wiring interconnection drawings illustrating all field components and electric connections to the systems supplied under this Section.
 - d. Confirm and record all protective device settings.
 3. Furnish electronic copies of switchboard drawings, single line diagrams, and wiring diagrams in AutoCAD native file format. Drawings shall include any field modifications or changes to reflect actual as built conditions after completion of start-up and final acceptance by the District.
- J. Operation and Maintenance Data
 1. Submit operation and maintenance manuals in accordance with Section 01730.

2. Provide equipment operation and maintenance manuals with each shipped assembly including instruction leaflets, instruction bulletins and renewal parts lists for the complete assembly and each major component.
3. Manuals shall include the following as a minimum:
 - a. A comprehensive index.
 - b. A list of the equipment supplied, including serial numbers, ranges and pertinent data.
 - c. Full product specifications for each item.
 - d. Service, maintenance and operation instructions for each item.
 - e. Special maintenance requirements particular to this system shall be clearly defined, along with set up and test procedures.
 - f. Renewal parts list with stock numbers.

1.04 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)
 1. ANSI C37.50 - Test Procedures for Low-Voltage AC Power Circuit Breakers Used In Enclosures.
- B. National Electrical Manufacturers Association (NEMA)
 1. NEMA PB 2 - Deadfront Distribution Switchboards.
 2. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- C. Institute of Electrical and Electronics Engineers (IEEE)
 1. ANSI/IEEE C37.13 - Low-Voltage AC Power Circuit Breakers Used in Enclosures.
 2. ANSI/IEEE C37.90.1 - Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- D. Underwriters' Laboratories (UL).
 1. UL 891 - Dead-Front Switchboards.
 2. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 3. UL 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
- E. National Fire Protection Association (NFPA)
 1. NFPA 70 - National Electrical Code.
- F. International Electrical Testing Association (NETA)
 1. NETA ATS- Acceptance Testing Specifications.

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

1.05 QUALITY ASSURANCE

A. Qualifications

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. The switchboard equipment shall be designed, assembled and tested by the manufacturer of the major components and circuit protective devices used within the switchboard assembly.

B. Regulatory Requirements

1. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 (NEC) unless more stringent requirements are specified or indicated.

C. Certifications

1. The manufacturer shall maintain a documented ISO 9001 or 9002 quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.
2. All sections and devices shall be UL listed and labeled. Service equipment shall be UL labeled as suitable for use as service entrance equipment.

1.06 SYSTEM DESCRIPTION

A. General

1. It is the intent of these Contract Documents that the Contractor furnish and install, where indicated, free-standing, dead-front type low voltage distribution switchboard equipment, utilizing group mounted feeder circuit protective devices as specified herein, and as shown on the contract Drawings.

B. System Responsibility

1. Equipment specified under this Section shall be furnished as an integrated assembly by the manufacturer who shall have sole responsibility for furnishing all the parts and components required for a complete and operable system; however, all equipment need not be manufactured by a single manufacturer.

C. Design Requirements

1. The switchboard shall be arranged so that the uppermost operating handle shall not exceed six-ft six-in. from the floor when the switchboard is mounted on a four-in. high equipment pad.

2. Equip useable blank spaces and spaces indicated on the Drawings for future devices with all hardware necessary for the future addition of a protective device including doors, bus, device supports, mounting plates, and connections.
3. Provide key interlocks as indicated on the Drawings.

D. Performance Requirements

1. Minimum short circuit interrupting rating:
 - a. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage unless otherwise shown on the Drawings.
2. Voltage and current ratings: as indicated on the Drawings.
3. Surge Withstand Capability: per ANSI/IEEE C62.41 without damage.
4. The equipment and components shall operate continuously at its rated current under the following environmental conditions without damage or degradation of operating characteristics or life:
 - a. Operating Ambient Temperature: 0 degrees C to 40 degrees C maximum ambient temperature.
 - b. Storage Temperature: -40 degrees C to 65 degrees C.
 - c. Relative Humidity: 0 to 95%, non-condensing.
 - d. Altitude: Operating to 6500 ft, de-rate for higher elevations.
5. Metering accuracy: minimum accuracy of the complete system, including current sensors, auxiliary CTs, and the meter display, shall be +/- 1% of full scale for current values, and +/- 2% of full scale for power and energy values.

E. Power System Coordination and Protection

1. Provide a coordinated power system as specified in Section 16000.
2. The switchboard and protective devices shall be fully rated for the specified short circuit current. Systems employing series connected ratings shall not be used.
3. Power circuit breaker: provide the following minimum independent time-current curve shaping adjustments for each power circuit breaker:
 - a. Adjustable long time pick-up and delay.
 - b. Adjustable short time pick-up, delay, and I2t settings.
 - c. Adjustable ground fault pick-up, delay, and I2t settings.
 - d. Adjustable instantaneous pickup.
4. Molded case circuit breaker: provide the following minimum independent time-current curve shaping adjustments for each molded case breaker with an electronic trip unit:

- a. Adjustable long-time setting (set by adjusting the trip setting dial or rating plug)
 - b. Adjustable short-time setting and delay with selective curve shaping
 - c. Adjustable instantaneous setting
 - d. Adjustable ground fault setting and delay
5. Protective features: provide the following adjustable protective features at each main breaker location. This protection may be integral to the manufacturer's standard trip unit offering, or may be provided via separate protective relays, however it shall be furnished as a complete and functional package:
- a. Voltage phase loss.
 - b. Current phase loss.
 - c. Line voltage phase unbalance, selectable from five to 40 percent of nominal in five percent increments.
 - d. Voltage phase reversal.
 - e. Overvoltage, selectable from 105 to 140 percent in five percent increments.
 - f. Undervoltage, selectable from 95 to 60 percent in five percent increments.
 - g. Time delay (adjustable from 0 to eight seconds in one-second intervals) for overvoltage, undervoltage, and phase unbalance trip and alarm settings.

F. Metering Requirements

1. Basic metering: display the following minimum metered values at each breaker location. This metering may be integral to the manufacturer's standard trip unit offering, or may be provided via separate metering devices, however it shall be furnished as a complete and functional package:
 - a. Instantaneous value of phase current
 - b. Instantaneous value of line-to-line voltage
2. Enhanced metering: meter and display the following values at each incoming main circuit breaker location:
 - a. AC Phase Amperes +/- 0.5%
 - b. AC Phase Voltage +/- 0.5%
 - c. Watts +/- 1.0%
 - d. VA +/- 1.0%
 - e. Vars +/- 1.0%
 - f. Power Factor +/- 2.0%
 - g. Frequency +/- 0.1 Hz
 - h. Watthours +/- 1.0%
 - i. Varhours +/- 1.0%
 - j. VA hours +/- 1.0%
 - k. Watt Demand (10-, 15-, 20-, 25-, 30-, 45-, 60-minute interval)
 - l. Voltage (minimum/maximum)
 - m. Current (minimum/maximum)
 - n. Power (minimum/maximum)
 - o. Power Factor (minimum/maximum)
 - p. Frequency (minimum/maximum)
 - q. Peak Demand

3. Power quality monitoring: display the following values at each incoming main circuit breaker location:
 - a. %THD (through 31st harmonic)
 - b. Peak % THD

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping

1. Equipment shall be handled and stored in accordance with manufacturer's instructions and NEMA PB 2.1.

B. Acceptance at Site

1. The assembly shall be provided with adequate lifting means for moving into the installation position.

C. Storage and Protection

1. Refer to Section 16000.

1.08 MAINTENANCE

- ##### A. Provide the following materials in the quantity specified. Materials shall match those installed in all respects and where possible shall come from the same production lot. Materials shall be properly packaged for long storage and containers shall be clearly and indelibly labeled on the exterior.

1. One quart of touch-up paint.
2. One dozen each of cover bolts, spring nuts and door fasteners.

B. Spare Parts

1. Provide the following spare parts in the quantities specified
 - a. 10% Fuses of each type and size.
 - b. 10% Spare static trip device.
 - c. 10% Pilot lamps of each type.
2. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number.

C. Tools

1. Provide a single hand- held portable test kit capable of testing each of the microprocessor-based trip device functions.

1.09 NOMENCLATURE AND IDENTIFICATION

- A. Provide engraved laminated plastic nameplates on all doors for unit load description and for each control or indicating device. Nomenclature shall be as shown 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 use white letters on a black background. The engraving shall extend through the exterior lamination to the core. Nameplates shall be screw fastened.
- B. The manufacturer shall fasten a master NEMA nameplate to the front of the switchboard indicating model number, serial number, order number, manufacturing date, bus amperes, volts, overall short circuit rating, etc.
- C. Provide permanent electrical hazard warning signs marked per OSHA requirements.
- D. Provide permanent arc flash PPE signs marked per 16000 requirements.

1.10 MANUFACTURERS' SERVICES

- A. Provide services of a manufacturer's service representative for testing and start-up, as required in Section 16000.
- B. Provide services of a manufacturer's service representative for training, as required in Section 16000.
- C. Furnish the services of a manufacturer's representative for a minimum period of three eight-hour days for setup and programming of the power management system and metering devices. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the software, hardware, and system programming.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. Products of the following manufacturers are acceptable.
 - 1. Eaton
 - 2. General Electric
 - 3. Square D
 - 4. Siemens

2.02 MATERIALS

- A. Wiring

1. Low voltage instrument and control wiring: Stranded copper, minimum size No. 14 AWG, with 600 Volt, 90 degree C, flame retardant, Type SIS, bundled and secured with nylon ties. Provide wire markers at each end of all control wiring.
2. Control wiring terminations: provide insulated locking spade terminals, except where saddle type terminals are provided integral to a device. Current transformer secondary leads shall first be connected to conveniently accessible shorting type terminal blocks before connecting to any other device.
3. Terminal blocks: Groups of control wires leaving the motor control center shall be provided with terminal blocks with numbering strips.
4. Wiring identification: provide heat shrinkable wire markers at each termination point, marked with identification corresponding to appropriate designations on manufacturer's wiring diagrams, color coding per NEMA standards and the NEC.
5. Component identification: fuse blocks, relays, pushbuttons, switches, etc., shall be marked with identification corresponding to appropriate designations on manufacturer's wiring diagrams.
6. Line and load terminations: mechanical type terminals, suitable for 75 or 90 degrees C, copper or aluminum cable of the size indicated on the Drawings.
7. Grounding lugs: provided in the incoming line section for connection of the main conductor with additional lugs for supplemental grounding conductors as indicated on the Drawings.

B. Buses

1. Buses: non-tapered, tin-plated copper. Provide a fully rated neutral bus where a neutral bus is indicated on the Drawings.
2. Bus bracing: exceed the specified equipment short circuit current rating, but not less than 65,000 amperes RMS symmetrical.
3. Bus joints: welded connections or accessible bolted joints with high-tensile strength, zinc-plated hardware and conical spring-type washers.
4. Ground bus: provide a copper ground bus extending throughout the entire length of the switchboard, firmly secured to each vertical section structure and equipped with lugs for external ground connections, sized for cables shown on the Drawings.

C. Control and Metering Transformers

1. 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 Standard C57.13.
2. Current transformers: 600 volt rated, toroidal type with accuracy class per ANSI Standard C57.13 requirements for the specified metering application.

3. Control power transformers: Two-winding dry type with primary fuses, secondary circuit breaker, sized for the application per NFPA 70 (NEC).

2.03 EQUIPMENT

- A. Switchboard shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure.
- B. All sections of the switchboard shall be front and rear aligned with depth as shown on the Drawings. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall. Side access shall not be required. All connections and bus maintenance shall be from the front or the top.
- C. Enclosure
 1. NEMA 1 enclosure consisting of side, top and rear covers bolted to steel frame structure members. Front doors shall be hinged and gasketed with captive quarter turn fasteners.
- D. Main Section
 1. Main section: consists of an incoming cable compartment with main lugs or a main disconnecting device as shown on the Drawings.
 2. Main lug terminations: provide adequate space for the type and size and quantity of cable as indicated on the Drawings. Lugs shall be compression-type with anti-turn feature.
 3. Main breaker: individually mounted, molded-case circuit breaker as indicated on the Drawings
- E. Distribution Sections
 1. The distribution sections shall consist of group mounted molded-case circuit breakers as indicated. Feeder sections shall be isolated from main section, and from adjacent feeder sections.

2.04 MOLDED CASE CIRCUIT BREAKERS

- A. Molded case circuit breakers: provide inverse time and instantaneous tripping characteristics, listed per UL 489 for applications at 100% of their continuous ampere rating in their intended enclosure.
- B. Trip mechanism: quick-make, quick-break, mechanically trip-free over-center switching mechanism operated by a toggle-type handle. Handle shall indicate breaker position. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- C. Contacts: non-welding silver alloy with arc extinction accomplished via arc chutes.

- D. Minimum symmetrical interrupting capacity: not less than overall switchboard interrupting rating. Provide current limiting circuit breakers where indicated or required to meet the specified short circuit rating.
- E. Trip units for circuit breakers below 400 ampere frame: thermal-magnetic trip units.
- F. Trip units for 400 ampere frame circuit breakers and larger: adjustable, microprocessor-based, electronic overcurrent trip device with true three phase RMS sensing of sinusoidal and non-sinusoidal currents, and the following minimum features and functions:
 - 1. Rating plugs shall be adjustable and interlocked so they are not interchangeable between frames and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - 2. Trip mode indicators for ground fault, overload and short circuit.
 - 3. An operator interface display panel showing diagnostic information and metering information.

2.05 METERING AND CONTROL

A. Digital Metering Unit (DMU)

- 1. Type: UL listed, CUL, CSA and CE certified microprocessor based, solid state, door mounted digital line meter device with accuracy per ANSI C12.16.
- 2. Surge withstand rating: meet ANSI standard C37.90.1 for surge withstand.
- 3. Monitored parameters: display values for each metered parameter and automatically range between units, kilo units and mega units for all displayed values.
- 4. Inputs: Provide external current transformers with rating as indicated on the drawings. Fused internal self-contained potential transformers for voltages up to 600 volts. Control power shall be supplied internally from the switchboard.
- 5. Operator interface: faceplate shall be membrane type, rated NEMA 12, with a durable backlit display to allow simultaneous viewing of multiple parameters. The meter shall be completely programmable using the display keypad or via network communications. All set points and recorded minimum and maximums shall be stored in non-volatile memory.
- 6. Operating temperature range: 0 to 70 degrees C, and 0 to 95 percent relative humidity non-condensing.

B. Digital Metering and Protection Device

- 1. Type: UL listed, CUL, CSA and CE certified microprocessor based, solid state, door mounted digital line meter and protective device with accuracy per ANSI C12.16.
- 2. Surge withstand rating: meet ANSI standard C37.90.1 for surge withstand.

3. Inputs: Provide external current transformers with rating as indicated on the drawings. Fused internal self-contained potential transformers for voltages up to 600 volts. Control power shall be supplied internally from the switchboard.
4. Operator interface: faceplate shall be membrane type, rated NEMA 12, with a durable backlit display to allow simultaneous viewing of multiple parameters. The meter shall be completely programmable using the display keypad or via network communications to allow the user to disable undesired values/functions and to later reactivate them if required. The display screen shall indicate trip and alarm conditions.
5. Non-volatile memory: All set points and recorded minimum and maximums shall be stored in non-volatile memory and not require battery backup. In the event of a power failure, the meter shall retain all preset parameters, accumulated watt-hours and watt demand. Data at time of power loss and cause of trip shall be stored.
6. Synchronous pulse input: when activated shall override the preset watt demand interval and let the utility control the demand window.
7. Trip and alarm outputs: provide separate programmable contacts that actuate when a protective function exceeds its setpoint. The contacts shall have ratings of 10 Amps at 115/240 VAC and shall be NO/NC.
8. kWh pulse output: provide a separate field programmable NO/NC contact for a kilowatt hour pulse.
9. Operating temperature range: 0 to 70 degrees C, and 0 to 95 percent relative humidity non-condensing.
10. Reset function: a built-in reset button shall allow manual reset of a trip or alarm condition. Watt-hours and watt demand shall be resettable.

C. Electronic Trip Unit Monitor

1. Provide a microprocessor-based device designed to monitor and display parameters of the circuit breaker electronic trip units. The monitor shall have the following features:
 - a. Alphanumeric display.
 - b. Indication of circuit breaker status; tripped, open, closed.
 - c. Cause of circuit breaker trip.
 - d. Phase, neutral, and ground current for each breaker.
 - e. Energy parameters for each breaker.

D. Provide interface hardware, cabling, and software to enable the following microprocessor-based devices to communicate with the plant Ethernet TCP/IP network:

1. Metering devices
2. Main circuit breaker trip units

E. Communicate metering and trip device data to a plant-wide power management network.

- F. Communications gateway: Provide a distributed data logging gateway, interface hardware, power supplies, cabling, and software to connect local microprocessor-based devices to a plant-wide Ethernet TCP/IP fiber optic communications network.

2.06 SURFACE PREPARATIONS AND SHOP COATINGS

- A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be manufacturer's standard light gray.
- B. Outdoor equipment shall be painted with two finish coats of polyurethane or epoxy enamel, one to two mil thickness. Exterior color shall be manufacturer's standard gray.
- C. Unpainted non-current carrying parts shall be galvanized to prevent corrosion.

2.07 SHOP TESTING

- A. Perform manufacturers standard production testing and inspection in accordance with NEMA and UL standards. If requested by the Engineer, the manufacturer shall submit certified copies of test results to indicate proof of compliance with NEMA and UL Standards.

PART 3 EXECUTION

3.01 GENERAL

- A. Install the switchboard as shown on the Drawings and in accordance with manufacturer's instructions and approved shop drawings.
- B. Install the equipment in accordance with NEMA PB 2.1.

3.02 FIELD CONNECTIONS

- A. Provide driven ground rods as specified in Section 16660. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment ground bus.
- B. Provide bare copper cable not smaller than No. 4/0 AWG not less than 24 inches below grade connecting to the grounding electrode system.
- C. Make wiring interconnections between shipping splits.
- D. Install bus splice plates and torque the connections.
- E. Install field wiring per Section 16120. Field wiring shall be grouped by circuit and tie wrapped. Terminations shall not be stressed.

3.03 INSTALLATION

- A. Remove temporary lifting angles, lugs and shipping braces. Remove all current transformer shunts after completing secondary circuits.

- B. Mount indoor switchboards on a four-inch-thick concrete slab, unless otherwise indicated. Edges shall have 1/2-inch chamfer. The slab shall extend at least four inches beyond the equipment.
- C. Unless otherwise indicated, the thickness of the concrete slab shall be increased to eight inches thick for outdoor applications, reinforced with six-in. by six-in. No. 6 mesh placed uniformly four in. from the top of the slab. Slab shall be placed on a six-in. thick, well-compacted gravel base.
- D. The assembly shall be bolted directly to floor sills set level in concrete per manufacturer's recommendations. Floor sills are not required if the floor is level to 1/8-inch per three-foot distance in any direction. Provide all necessary hardware to secure the assembly in place.
- E. Locate conduit and cable entrances in the space designated by the equipment manufacturer. Install conduits to prevent water from entering the enclosure. Bond all conduits including stubs to the equipment ground bus. Seal voids around conduit openings in the slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits three inches above slab surface.
- F. Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.
- G. Repair damage to galvanized coatings using zinc rich paint.

3.04 FIELD TESTING

- A. Perform physical, electrical, and mechanical inspections in accordance with the manufacturer's recommendations and the following. Provide all temporary power for testing.
 - 1. Compare equipment nameplate data with specifications and approved shop drawings.
 - 2. Inspect physical, electrical, and mechanical condition.
 - 3. Confirm correct application of manufacturer's recommended lubricants.
 - 4. Verify appropriate anchorage, required area clearances, and correct alignment.
 - 5. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
 - 6. Verify that fuse and circuit breaker sizes and types correspond to approved shop drawings.
 - 7. Verify that current transformer ratios correspond to approved shop drawings.
 - 8. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
 - 9. Inspect insulating materials and structure for evidence of physical damage, reduced clearances, or contaminated surfaces.
 - 10. Verify that field wiring is adequately separated from live busses. Physically secure the field wiring to withstand the effects of fault currents.

11. Check all devices for damage and make all necessary repairs or replacements, prior to energizing.
 12. Verify correct barrier and shutter installation and operation.
 13. Exercise all active components.
 14. Inspect all mechanical indicating devices for correct operation.
 15. Verify that vents are clear.
 16. Test operation, alignment, and penetration of disconnecting contacts.
 17. Inspect control power transformers.
 18. Verify all ground connections have been made.
 19. Verify operation of space heaters.
- B. Perform the following electrical acceptance tests on the switchboard in accordance with NETA ATS.
1. Conduct an electrical insulation resistance test to verify that the equipment and field wiring are free from short circuits and grounds. Test phase-to-ground, phase-to-phase, and phase-to-neutral, with the switches or circuit breakers opened.
 2. Over-potential tests.
 3. Insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
 4. Control wiring performance test.
 5. Primary current injection tests on the entire current circuit in each section of assembly.
 6. Phasing check on double-ended switchboard to ensure correct bus phasing from each source.
 7. Conduct earth resistance ground testing.
- C. Perform the following electrical acceptance tests on insulated case and molded case circuit breakers with solid state trips in accordance with NETA ATS.
1. Contact resistance tests.
 2. Insulation resistance tests.
 3. Long-time delay time-current characteristic tests.
- D. Perform the following before energizing the equipment in accordance with NEMA PB 2.1:
1. Retighten all accessible electrical connections to the manufacturer's torque values.

2. Retighten the wire clamping members of all accessible mechanical pressure wire type connectors to the values specified by the manufacturer.
3. Retighten conical spring washers according to manufacturer's instructions.
4. Turn all circuit breakers and fusible switches to the OFF position before energizing the bus.
5. Adjust ground fault and instantaneous protective devices to their most sensitive settings during start-up. Reset the devices after startup is complete and the equipment has been successfully energized.
6. Reinstall all parts and barriers removed to facilitate wiring and installation.
7. Before closing the enclosure, remove all metal chips, scrap wire, and other debris from the motor control center interior. Remove accumulated dust and dirt by using a brush, vacuum cleaner or clean, lint-free rags.
8. Install covers, close doors, and make certain that no wires are pinched and that all enclosure parts are properly aligned and tightened.

E. Performance Test

1. Verify complete system operation including all hardware, software and communication devices.
2. Verify networking performance with all interfacing systems by other manufacturers.

3.05 ADJUSTMENT

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit and protective devices coordination study.
- B. The manufacturer's representative shall provide the following services for starting up and programming of the power management system and metering devices:
 1. Set all the adjustable or programmable parameters of all devices in the equipment.
 2. Coordinate startup with other manufacturer's equipment.
 3. Verify the integrity of the data communications network and troubleshoot as necessary.
 4. Set all the network addresses of all devices in the equipment.

3.06 CLEANING

- A. Remove all rubbish and debris from inside and around the switchgear. Remove dirt, dust, and concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags.
- B. Vacuum clean the interior of the equipment. Do not use compressed air.

END OF SECTION

SECTION 16470
PANELBOARDS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install all panelboards as shown on the Drawings and as specified herein.
- B. All panelboard wiring shall include wiring numbers and terminal point numbers cross referenced to shop drawing and subsequent record drawing submittals.

1.02 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data, for the following as a minimum:
 - 1. Equipment outline drawings showing elevation and plan views, dimensions and weight. Indicate all options, special features, ratings and deviations from this Section.
 - 2. Bus arrangement drawings.
 - 3. Product data sheets and catalog numbers for circuit breakers, etc. List all options, trip adjustments and accessories furnished specifically for this project.
 - 4. Instruction and renewal parts books.
 - 5. Test and inspection reports.
 - 6. Complete bill of materials list.
 - 7. 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).

1.03 REFERENCE STANDARDS

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

1.04 MANUFACTURERS

- A. 120/240 Volt, single phase, 3 Wire and 120/208 Volt, 3 Phase, 4 Wire panelboards shall be Type NQOD as manufactured by Square D; Type Pow-R-Line by Eaton; Type AQ by General Electric; or P Series by Siemens.

- B. 277/480 Volt, 3 Phase, 4 Wire panelboards shall be; Type NF as manufactured by Square D; Type Pow-R-Line by Eaton; Type AE by General Electric; or P Series by Siemens.
- C. 480 Volt, 3 Phase, 3 Wire panelboards shall be; I-Line series as manufactured by Square D; Type Pow-R-Line by Eaton; Type Spectra by General Electric; or P Series by Siemens.
- D. 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.
- E. Refer to additional requirements for manufacturers in Section 16000. Alternate suppliers must be submitted for approval to the Engineer in writing four weeks prior to the original bid date with supporting documentation to confirm all aspects of the specifications.

PART 2 PRODUCTS

2.01 GENERAL

A. Rating

- 1. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.
- 2. 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.

2.02 MATERIALS (NEMA 1)

A. Interiors

- 1. 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.
- 2. 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.
- 3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.
- 4. A nameplate shall be provided listing manufacturer's name, panel type and rating.

B. Buses

- 1. 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.

2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.
4. Tin plated copper equipment ground bars shall be furnished.

C. Boxes

1. 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 four-in. on all sides.
2. Surface mounted boxes and trims shall have an internal and external finish as specified in Paragraph 2.04D4 below.
3. At least four studs for mounting the panelboard interior shall be furnished.
4. All conduit entrances shall be field punched.

D. Trim

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.
2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in. in height shall have a vault handle and three-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.
3. The trims shall be fabricated from code gauge sheet steel.
4. 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.
5. 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.

2.03 MATERIALS (NEMA 3R and 4X)

A. Interiors and Buses

1. Interiors and buses shall be as hereinbefore specified for NEMA 1 construction.

B. Boxes and Covers

1. Boxes, covers and hardware shall be made from 316 stainless steel with natural finish.
2. Boxes and covers shall have continuous welded seams and shall be hinged (piano type) together and gasketed.
3. Conduit openings shall be tapped.

2.04 CIRCUIT BREAKERS

- A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.
- B. Circuit breakers shall be molded case, bolt-in type. Refer to Drawings for interrupting capacity.
- C. 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 of 10,000 Amps, RMS.
- D. Circuit breakers shall be manufactured by the panelboard manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.
- B. 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.
- C. Install markers on the front cover of all panelboards which identify the voltage rating. Markers shall be made of self-sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by nine-in. wide, Style A as manufactured by W.H. Brady Co. or equal.
- D. Install a one-in. by three-in. nominal laminated plastic nameplate with 1/2-in white letters on a black background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.

- E. Unless otherwise noted on the Drawings, top of cabinets shall be mounted six feet-0-inch above the floor, properly aligned and adequately supported independently of the connecting raceways.
- F. All wiring in panelboards shall be neatly formed, grouped, and identified to provide a neat and orderly appearance. A typewritten directory card identifying all circuits shall be placed in the card holder inside the front cover.
- G. 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 District.
- H. 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.
- I. 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.

3.02 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

END OF SECTION

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SECTION 16502
LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide a complete lightning protection system for the following buildings and structures at Black Creek WRD Project: Electrical Building and Intake Pump Station. The system shall be UL Master Labeled and shall be designed and installed in compliance with provisions of UL 96A and NFPA 780.
- B. 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.
- C. 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 re-inspections as required.
- D. 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.
- E. The lightning protection system contractor shall coordinate his work with the electrical contractor.
- F. 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.

1.02 RELATED WORK

- A. Refer to Section 16660 for Grounding Systems.

1.03 SUBMITTALS

- A. Contractor shall submit to the Engineer/District for review the facility lightning protection system. The submittal data shall contain the following minimum information.
 - 1. 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.

2. 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.
3. Locations of connection points of lightning protection system to facility grounding system.
4. Bill-of-materials.

1.04 REFERENCE STANDARDS

- A. Underwriters Laboratories (UL)
 1. UL 96 – Standard for Lightning Protection Components
 2. UL 96A – Standard for Installation Requirements for Lightning Protection Systems
- B. National Fire Protection Association (NFPA)
 1. NFPA 780 – Standard for the Installation of Lightning Protection Systems
- C. 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 MATERIALS

- A. All materials shall be new and shall comply in weight, size, and composition with the requirements of UL and NFPA.
- B. Grounding materials and methods shall be equal to those specified under Section 16660.
- C. The following is a brief description of the various items of material.
 1. Air Terminals
 - a. Buildings 75 feet and less in height shall use Class I air terminals. Aluminum air terminals shall be solid aluminum, 1/2" minimum diameter. Copper air terminals shall be nickel plated solid copper, 3/8" minimum diameter. Length 18".
 - b. 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, 1/2" minimum diameter. Length 18".
 - c. 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.
 - d. 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.

2. Conductors

- a. 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).
- b. 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).
- c. 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.

3. Fasteners

- a. Conductor fasteners shall be an approved type of non-corrosive metal and have ample strength to support conductors.

4. Cable Connectors

- a. 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

3.01 INSTALLATION

- A. 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.
- B. 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.
- C. Lightning Protection System shall be installed in a neat and inconspicuous manner.
- D. 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.
- E. Excavate and backfill as required. Finish grade and restore to original condition.
- F. All metal bodies within six 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.
- G. 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.

H. Air Terminals:

1. 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.
2. Air terminals shall not project more than 24 inches nor less than 10 inches above the protected object.

I. Conductor Routing:

1. All main conductors shall maintain a downward or horizontal course, free from "U" or "V" pockets.
2. Conductors shall not form an angle of less than 90 degrees nor less than an eight-inch radius bend.
3. 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.
4. Fasteners shall be spaced not more than three feet horizontally or vertically and shall be the same material as the conductor.
5. Bimetallic fittings shall be used for all connections between dissimilar metals.

J. Down Conductors:

1. Down conductors shall follow the most direct patch possible between roof conductors and ground terminals.
2. 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.
3. 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.
4. 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.
5. Splices will not be permitted on conductors embedded in concrete.
6. 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.

K. Roof Conductors:

1. Roof conductors shall interconnect and provide a two-way path from all air terminals.
2. Roof conductors shall bond together all air terminals and shall be installed exposed except that where connections are made to equipment located under roof.

3. Conductors on perimeters of flat roofs shall form closed loops.
4. Dead end air terminals shall not be permitted.
5. All interconnecting cables from air terminals to roof conductors or metal roof decks shall be similar to roof conductor.

L. Pitch Pockets:

1. Contractor shall subcontract all pitch pocket work to a qualified roofing contractor.

M. Grounding System:

1. Ground rods shall be provided at each down conductor and they shall be installed a minimum of three feet away from the foundation walls.
2. The ground rods shall be in addition to the ground rods provided for the system grounding grid.
3. 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.
4. Bonding of down conductors to the system grounding grid and splicing of conductors in concealed work shall be made by an exothermic weld process.
5. 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.
6. Contractor shall notify design Engineer prior to concealment for Engineer's inspection.

3.02 TESTING

A. General:

1. The Lightning Protection System shall be tested for continuity of all conductors and air terminals.
2. Maximum resistance of system shall not exceed five ohms unless otherwise specified or scheduled.
3. Contractor shall submit written test results to the Engineer.

B. Indicators:

1. 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.
 - a. Down leads connected to water pipes shall also be indicated.
 - b. Tags shall be of a corrosion resistant metal and shall be placed at a height of five feet above finish grade.

END OF SECTION

SECTION 16600
UNDERGROUND SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. 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.

1.02 RELATED WORK

- A. 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.
- B. 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.
- C. Conduit, fittings, installation, etc. shall be as specified in Section 16110.
- D. Ground rods and other grounding materials and methods shall be as specified in Section 16660.
- E. Precast electrical concrete manholes and handholes shall be furnished under Division 16 and shall be in compliance with precast concrete structures as specified in Section 02605.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data, for the following:
 - 1. Manholes and handholes
 - 2. Plastic duct spacers
 - 3. Manhole and handhole frames and covers

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cable racks, supports, pulling-in irons, manhole steps and hardware shall be hot dipped galvanized steel as manufactured by Line Materials Co. or equal.
- B. 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.

- C. 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".
- D. 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".
- E. Bell ends and plastic duct spacers shall be as manufactured by Carlon or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. 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 three-in. per 100-ft.
- B. Reinforce raceway banks as shown on the Drawings.
- C. Lay raceway lines in trenches on a clean backfill bedding not less than six inches thick and well graded and compacted.
- D. 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 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.
- E. 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.
- F. For bends in two-inch and larger raceways, long radius elbows, sweeps and offsets shall be used.
- G. All two-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.
- H. Plug spare raceways and seal them watertight at all buildings and structures.
- I. Raceways in use shall be sealed watertight at all buildings and structures.
- J. Install pulling-in irons opposite all raceway entrances to manholes.
- K. Cables shall be trained in manholes and supported on racks and hooks at intervals not greater than three 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.

- L. All joints shall be made so as to prevent the passage of concrete inside the conduit to form obstructions or cause cable abrasions.
- M. Manhole covers in streets shall finish flush with finished paving and in other areas shall finish three 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 one foot above the floor and center line of the highest conduit entering will be not less than one foot below the roof slab.
- N. 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.
- O. A #6 bare copper wire (stranded) shall be installed in each four-inch PVC conduit containing control cable unless otherwise noted.
- P. A 3/4-inch by 10-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.
- Q. 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.
- R. Spare and empty conduits shall have a pull wire (3/16 inch polypropylene) installed.
- S. As-built drawings shall be furnished showing each conduit terminations, elevations, locations, manholes, handholes, etc.

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SECTION 16660
GROUNDING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. 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.
- B. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be No. 12 AWG.

1.02 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data, for the following:
 - 1. Manufacturer's name and catalog data for ground rods, materials and exothermic welding methods and materials.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Conduit shall be as specified under Section 16110.
- B. Wire shall be as specified under Section 16120.
- C. Ground rods shall be 3/4-in diameter by 10-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.
- D. 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.
- E. 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.
- F. Buried grounding connections shall be by Cadweld process, or equal exothermic welding system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. 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.
- B. Install equipment grounding conductors with all feeders and branch circuits.
- C. 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.
- D. Ground wire connections to structural steel columns shall be made by exothermic welding.
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. 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.
- J. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.
- K. 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.
- L. 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.
- M. 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.

3.02 INSPECTION AND TESTING

- A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.
- B. 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. 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.
- C. All test equipment shall be provided under this Section and approved by the Engineer.
- D. 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.
- E. Testing shall be performed before energizing the distribution system.
- F. A separate test shall be conducted for each building or system.
- G. 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 District.

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