

180-48 BM Buffalo Ave Pump Station Rehabilitation Project

Bid Documents Submittal

TECHNICAL SPECIFICATIONS

March 2019

JEA 21 W. Church Street Jacksonville, FL 32202

180-48 BM 5301 BUFFALO AVENUE PUMP STATION REHABILITATION PROJECT BID DOCUMENTS SUBMITTAL

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SECTION 01100

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Work covered by the Contract Documents.
 - 2. Organization and interpretation of Contract Documents.

1.02 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: Buffalo Avenue Pump Station Rehabilitation Project, Constantine Project No. 100431.17
 - 1. Project Location: 5301 Buffalo Avenue, Jacksonville, Florida 32206
- B. OWNER: JEA
 - 1. OWNER's Representative: Samuel Ramirez, PE, Project Manager, JEA, 21 West Church Street, Jacksonville, Florida 32202-3139
- C. ENGINEER: Constantine Engineering, Inc.
 - 1. ENGINEER's Representative: Kartik Vaith, PE, Project Manager, Constantine Engineering Inc., 100 Center Creek Road, Suite 108, St Augustine, Florida 32804
- D. The Work consists of the following:
 - 1. The project consists of improvements to the Buffalo Avenue Pump Station. Work includes, but is not limited to, the following:
 - a. Mobilization/Demobilization, General Requirements, Bonds and Insurance.
 - b. Furnish, install and operate a temporary station bypass system to facilitate the rehabilitation work.
 - c. Rehabilitate the entire superstructure (influent channels, wetwell, screenings room, motor room, pump room, generator room, etc.) and all accessories (e.g., doors, thresholds, stairways, fall protection items, covers, grating, etc.), including surface preparation and specified surface coating systems for all surfaces.

- d. Replace existing piping, fittings, valves and apparatus with new piping, fittings, valves and apparatus that complies with the latest JEA standards. Replace and/or provide with new all mechanical process components (sluice gates, service pumps, drywell sump pumps and wetwell mixing system) including specified VFDs and controls. Provide seal water system with a wash water pump, valves, and piping with the service pumps as an integrated package.
- e. Remove the bar screens and rehabilitate channels bar screens will be replaced by JEA with its own forces after this project is complete.
- f. Replace or provide with new all associated electrical, instrumentation, controls and integration as required for a complete operating system that complies with the latest JEA standards.
- g. Rehabilitate the existing monorail lift system, including hoist and trolley.
- h. Provide and install a new discharge flowmeter and other miscellaneous yard piping and valving.
- i. Replace existing HVAC system with a new HVAC system including ventilation fans, related ductwork and accessories.
- j. Replace existing lighting system with new lighting system.
- k. Replace existing potable water system with a new potable water system, including all plumbing and plumbing fixtures.
- 1. Replace existing electrical powering system with a new electrical powering system including grounding and emergency powering. Provide a new MCC system in a partitioned, climate-controlled Electrical Room within the existing pump building. Upgraded electrical system shall include replacing the existing generator with a new emergency generator and automatic transfer switch for generator.
- m. Construct site improvements including grading, paving, fencing, and security-related components, all in accordance with JEA requirements.
- E. Project will be constructed under a single prime contract.

1.03 INTERRUPTION OF PUMP STATION OPERATION

- A. The Buffalo Avenue Pump Station must be taken offline for an extended period of approximately 4 months or more, and possibly other brief periods during portions of the Work. No station shutdown will be allowed without the prior approval of a Shutdown Plan submittal reviewed by ENGINEER and OWNER.
- B. CONTRACTOR must clearly identify required shutdown periods and bypass pumping provisions within the detailed Construction Schedule and the proposed Shutdown Plan.
- C. Shutdown Plans with detailed sequences of events shall be submitted at least 14 days in advance of extended shutdown periods, and OWNER'S written permission shall be obtained at least 5 days in advance of brief shutdown periods.
- D. Shutdown Plans shall include the following, and all other information necessary to allow OWNER to plan OWNER'S operations.
 - 1. A detailed description of the steps necessary to bring new equipment online or make connections with existing facilities.
 - 2. Time schedules for the Work, including coordination with the overall Construction Schedule.
 - 3. Schedule shall include allowances for concrete repair cure times prior to specialty coating applications, as well as coating cure times prior to coating submergence, all in accordance with the coating system manufacturer's recommendations.
 - 4. Schedule shall meet any other restrictions and conditions specified in the Contract Documents and as shown on the Drawings.
- E. CONTRACTOR shall minimize shutdown times by thorough advanced planning and shall have all required equipment, materials, and labor on hand at time of shutdown.

1.04 WORK SEQUENCING

- A. CONTRACTOR shall be solely responsible for all work sequencing.
- B. As part of the overall Construction Schedule, CONTRACTOR shall submit a proposed Work Sequence with specific dates for the start and completion of tasks to OWNER and ENGINEER for review and approval.
- C. CONTRACTOR shall perform the Work in sequence and with appropriate bypass pumping provisions to eliminate any disruption of wastewater collection or transmission during the construction activities.

- D. The completion of all specific preliminary tasks in the approved Work Sequence shall be accomplished prior to any significant site demolition.
- E. CONTRACTOR shall perform the Work in proper sequence to ensure completion of the Work within the Contract Time. Completion dates for the various stages shall be in accordance with the approved Construction Schedule submitted by CONTRACTOR.
- F. CONTRACTOR shall coordinate all on-site work activities with OWNER and shall conduct all on-site activities within the allowable working hours of 8:00 a.m. to 5:00 p.m., Monday through Friday, unless prior arrangements are made with OWNER.

1.05 SEQUENCING CONSTRAINTS

- A. The sequencing constraints of this section are in addition to standard procedures such as maintaining working drawings, testing, commissioning, training, etc. These constraints shall be included in CONTRACTOR's detailed Construction Schedule.
- B. CONTRACTOR shall conduct the following general construction activities, at a minimum, in the sequence presented:
 - 1. Establish all erosion control measures on the site prior to any demolition, excavation, grading or construction improvement activities.
 - 2. Conduct limited site improvements as shown in the Drawings, including demolition and replacement of fencing where indicated and construction of the bypass connection riser assembly.
 - 3. Set up temporary station bypass pumping equipment, piping and controls as shown in the Drawings, with connection to the bypass riser.
 - 4. Immediately prior to station bypassing operations, make final tie-in connections between bypass riser and existing station forcemain piping.
 - 5. Once station bypassing has been initiated and has demonstrated automatic functioning to the OWNER'S satisfaction, begin station dewatering, cleaning and demolition/rehabilitation activities.
 - 6. Perform per the Contract Documents, at a minimum, all demolition, structural repairs and modifications, coatings, equipment and piping installation and other required improvements for the critical proposed operational components within the influent channels, wetwell, Pump Room, Motor Room, Generator Room and proposed Electrical Room.
 - 7. Construct yard piping modifications, including ARV components and vaults, as shown in the Drawings.

- 8. Other project improvements not deemed critical to the proper, safe and reliable operation of the pump station may be deferred until after the approved bypass period. Such improvements shall be clearly listed in the Construction Schedule may include, at OWNER'S discretion, partial installation of lighting, plumbing, HVAC components, security and communication features, architectural finishes, asphalt paving, concrete flatwork, etc.
- 9. Once the critical operational components have been installed, tested and demonstrated to ENGINEER'S satisfaction to conform to the requirements of the Contract Documents, bypassing may be terminated, with normal wastewater flow and pumping operations resumed.
- 10. Once station bypassing is terminated, the temporary bypass equipment and piping shall remain on-site and available for use for a minimum of seven (7) days, during which time normal station functioning will be monitored. At the end of the 7-day period and at OWNER'S acceptance, the temporary bypass system shall be dismantled and removed from the site.
- 11. Complete any and all remaining demolition and improvement tasks required by the Contract Documents for substantial and final completion of the Work. Remaining tasks shall include coordination with OWNER for those tasks to be performed by OWNER, including modifications to the existing site transformer and primary power service to the site, as well as the provision of fiber optic cable (FOC) service to the site.

1.06 CONTRACTOR'S USE OF SITE

- A. CONTRACTOR shall limit use of the site and premises for work and storage to allow for the following:
 - 1. Coordination of site use with OWNER, including OWNER occupancy and access to operate existing facilities.
 - 2. Responsibility for protection and safekeeping of products under this Contract.
 - 3. Providing additional offsite storage, as needed, at no additional cost to OWNER. CONTRACTOR may coordinate with OWNER for possible use of OWNER's designated sites for offsite storage, such as the Buckman Water Reclamation Facility site.

1.07 RECEIVING, INSPECTION, AND UNLOADING PRODUCTS

A. CONTRACTOR shall record the receipt of products at the job site.

- B. Upon receipt of products at the job site, CONTRACTOR shall inspect for completeness and evidence of damage during shipment.
 - 1. OWNER's representative may be present for inspection.
 - 2. Should there appear to be damage, notify the OWNER's representative immediately and inform the manufacturer(s) and the transportation company.
 - 3. Expedite replacement of damaged, incomplete, or lost items.
- C. After completion of inspection, unload products in accordance with manufacturer's instructions for unloading, or as specified. Do not unload damaged or incomplete products to be returned to manufacturer for replacement, except as necessary to expedite return shipment.

1.08 HANDLING, STORAGE, AND MAINTENANCE OF PRODUCTS

- A. Handle products in accordance with the product manufacturers' written recommendations and in a manner to prevent damage.
- B. Store products prior to installation as recommended by the manufacturer.
 - 1. Store products such as pipe and reinforcing steel off the ground in approved storage yards.
 - 2. Store items subject to damage by the elements, vandalism, or theft in protected and secure locations.
 - 3. Provide environmentally-controlled storage facilities for items requiring environmental control for protection.
- C. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by OWNER.
- D. Store products to provide access for inspection and inventory control. CONTRACTOR shall document products in storage to facilitate inspection and to estimate progress payments for products delivered but not installed in the Work.

1.09 STORAGE OF MATERIALS

A. Materials shall be stored to ensure the preservation of their quality and fitness for the Work. When considered necessary, stored materials shall be placed on wooden platforms or other hard, clean surfaces and not on the ground. Stored materials shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without the written permission of the property owner or lessee.

B. Delicate instruments and materials subject to vandalism shall be placed under locked cover and, if necessary, provided with climate control as recommended by the manufacturer.

1.010 EQUIPMENT AND SYSTEM TESTING

- A. Functional (or run) testing, in the presence of the manufacturer's representative and/or ENGINEER, will be required for each item of equipment following installation. Functional testing is defined as that testing necessary to determine if installed equipment and systems will operate as intended.
- B. In addition to functional testing, specific performance testing of installed equipment and systems shall be conducted by CONTRACTOR as required in the section specifying the equipment or system.
- C. CONTRACTOR shall furnish all labor, materials, tools, equipment, instruments, and services necessary to perform the functional and performance testing.

1.011 ORGANIZATION AND INTERPRETATION OF CONTRACT DOCUMENTS

- A. Specifications and Drawings included in these Contract Documents establish the performance, quality requirements, location and general arrangement of materials and equipment, and establish the minimum standards for quality of workmanship and appearance.
- B. Any part of the work that is necessary or required to make each installation satisfactory and operable for its intended purpose, even though it is not specifically included in the Specifications or on the Drawings, shall be performed as incidental work as if it were described in the Specifications and shown on the Drawings.
- PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01200

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 MEASUREMENT AND PAYMENT

A. Measurement and payment will be based upon actual quantities of work completed and accepted in accordance with the Contract Documents for those specific items listed within the Bid Form. All other work shall be completed on a lump sum basis.

1.02 ESTIMATED QUANTITIES

A. Where quantities are shown they are approximate and are given only as a basis of calculation upon which the award of the contract is to be made. OWNER or ENGINEER do not assume any responsibility for the final quantities, nor shall CONTRACTOR claim misunderstanding because of such estimate of quantities. Final payment will be made only for the satisfactorily completed quantity of each item.

1.03 METHOD OF MEASUREMENT

- A. Unless otherwise specified for the particular items involved, all measurements of distance for items to be paid for on the basis of length shall be taken horizontally or vertically.
- B. Measurement of Area: In the measurement of items paid for on the basis of area of finished work, the lengths and/or widths to be used in the calculations shall be the actual dimensions measured along the surface of the completed work within the neat lines shown or designated.

1.04 MEASUREMENT

A. The contract includes a 'Part A' lump sum bid and a 'Part B' unit price bid, which were combined for bidding review. CONTRACTOR shall develop a Schedule of Values for 'Part A' in accordance with Specification Section 01370. 'Part B' unit prices shall be measured as follows:

1. Item 25 - Concrete Repair Type 'A' (not including coating): Following cleaning and surface preparation, the Engineer will coordinate with the Contractor to define the limits of the Type 'A' concrete repair per JEA Water and Wastewater Standards Section 448. Payment will be based on the actual, field-measured square footage completed in accordance with the Section 448, Type 'A' Repair requirements excluding the specialty coating system. All other work to prepare the structure for cleaning including but not limited to: slab demolition, interior channel wall demolition, structure bracing, personnel supports, OSHA

compliance, etc. shall be included in the Contractor's lump sum bid as part of 'Part A'.

2. Item 26 - Concrete Repair Type 'B' (not including coating): Following cleaning and surface preparation, the Engineer will coordinate with the Contractor to define the limits of the Type 'B' concrete repair per JEA Water and Wastewater Standards Section 448. Payment will be based on the actual, field-measured square footage completed in accordance with the Section 448, Type 'B' Repair requirements excluding the specialty coating system. All other work to prepare the structure for cleaning including but not limited to: slab demolition, interior channel wall demolition, structure bracing, personnel supports, OSHA compliance, etc. shall be included in the Contractor's lump sum bid as part of 'Part A'.

3. Item 27 - Concrete Repair Type 'C' (not including coating): Following cleaning and surface preparation, the Engineer will coordinate with the Contractor to define the limits of the Type 'C' concrete repair per JEA Water and Wastewater Standards Section 448. Payment will be based on the actual, field-measured square footage completed in accordance with the Section 448, Type 'C' Repair requirements excluding the specialty coating system. All other work to prepare the structure for cleaning including but not limited to: slab demolition, interior channel wall demolition, structure bracing, personnel supports, OSHA compliance, etc. shall be included in the Contractor's lump sum bid as part of 'Part A'.

4. Item 28 - Concrete Repair Type 'D' (not including coating): Following cleaning and surface preparation, the Engineer will coordinate with the Contractor to define the limits of the Type 'D' concrete repair per JEA Water and Wastewater Standards Section 448. Payment will be based on the actual, field-measured square footage completed in accordance with the Section 448, Type 'D' Repair requirements excluding the specialty coating system. All other work to prepare the structure for cleaning including but not limited to: slab demolition, interior channel wall demolition, structure bracing, personnel supports, OSHA compliance, etc. shall be included in the Contractor's lump sum bid as part of 'Part A'.

5. Item 29 - Concrete Repair Type 'E' (not including coating): Following cleaning and surface preparation, the Engineer will coordinate with the Contractor to define the limits of the Type 'E' concrete repair per JEA Water and Wastewater Standards Section 448. Payment will be based on the actual, field-measured square footage completed in accordance with the Section 448, Type 'E' Repair requirements excluding the specialty coating system. All other work to prepare the structure for cleaning including but not limited to: slab demolition, interior channel wall demolition, structure bracing, personnel supports, OSHA compliance, etc. shall be included in the Contractor's lump sum bid as part of 'Part A'.

6. Item 30 – Non-Destructive Testing (NDT): Payment will be based on the actual number of Non-Destructive Tests (NDTs) completed within the superstructure as specified within the Drawings. All other work to prepare the structure for cleaning including but not limited to slab demolition, interior wall demolition, structure bracing, personnel supports, OSHA compliance, etc. shall be included in the Contractor's lump sum bid as part of 'Part A'.

1.05 PAYMENT

- A. Lump Sum Items: Where payment for items is shown to be paid for on a lump sum basis, no separate payment will be made for any item of work required to complete the lump sum item.
- B. Unit Price Items: Where payment for items is shown to be paid for on a unit price basis, separate payment will be made for the items of work described herein and listed on the Bid Form. Any related work not specifically listed, but required for satisfactory completion of the Work, shall be included in the scope of the appropriate listed workitems.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01300 SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

- A. This Section specifies the general methods and requirements of submissions applicable to Shop Drawings, Product Data, and Samples. Detailed submittal requirements are specified in the Technical Sections.
- B. All submittals shall be clearly identified by reference to Section Number, Paragraph, Drawing Number or Detail as applicable. Submittals shall be clear, legible, and of sufficient size for presentation of data.

1.02 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

- A. Shop Drawings
 - 1. Shop drawings as specified in individual Sections include customprepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the work,
 - 2. All shop drawings submitted by suppliers and subcontractors shall be sent directly to CONTRACTOR for checking. CONTRACTOR shall be responsible for their submission at the proper time to prevent delays in delivery of materials.
 - 3. Check all suppliers and subcontractors shop drawings regarding measurements, size of members, materials and details to make sure that they conform to the intent of the Drawings and related Sections. Return shop drawings found to be inaccurate or otherwise in error to the second-tier subcontractors for correction.
 - 4. All details on shop drawings shall show clearly 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.

B. Product Data

- 1. Product data specified in individual Sections include standard prepared data for manufactured products (sometimes referred to as catalog data) such as the manufacturer's product specification and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spareparts listing and printed product warranties, as applicable to the work.
- C. Samples
 - 1. Samples specified in individual Sections include, 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 units of work to be used by CONTRACTOR or OWNER for independent inspection and testing, as applicable to the Work.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Review shop drawings, product data and samples, including those by second tier subcontractors, prior to submission to determine and verify the following:
 - 1. Field measurements
 - 2. Field construction criteria
 - 3. Catalog numbers and similar data
 - 4. Conformance with related Sections
- B. Each shop drawing, sample and product data submitted by CONTRACTOR shall have affixed to it the following Certification Statement including CONTRACTOR's company name and signed by CONTRACTOR: "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." Shop drawings and product data sheets 11-in x 17-in or smaller shall be bound together in an orderly fashion and shall bear the above Certification Statement on the cover sheet. 8.5-in x 11-in sheets shall be the minimum sized submittal size. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to OWNER's representative a copy of each transmittal sheet for shop drawings, product data and samples.
- C. CONTRACTOR shall utilize a 10-character submittal identification numbering system in the following manner:

- 1. The first character shall be a D, S, P or M which represents Shop/Working Drawing and other Product Data (D), Sample (S), Preliminary Submittal (P) or Operating/ Maintenance Manual (M).
- 2. The next five digits shall be the applicable Section Number.
- **3.** The next three digits shall be the numbers 001 to 999 to sequentially number each initial separate item or drawing submitted under each specific Section Number.
- 4. The last character shall be a letter, A to Z, indicating the submission, or resubmission of the same Drawing, i.e., "A=1st submission, B=2nd submission, C=3rd submission, etc. A typical submittal number would be as follows:

D-03300-008-B

D	= Shop Drawing
03300	= Section for Concrete
008	= The eighth initial submittal under this section
В	= The second submission (first resubmission) of that particular shop drawing

- D. Notify ENGINEER in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
- E. The review and approval of shop drawings, samples or product data by ENGINEER shall not relieve CONTRACTOR from the responsibility for the fulfillment of the terms of the contract. All risks of error and omission are assumed by CONTRACTOR and ENGINEER will have no responsibility, therefore.
- F. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased, or on-site construction accomplished which does not conform to approved shop drawings and data shall be at CONTRACTOR's risk. OWNER shall not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- G. Project work, materials, fabrication, and installation shall conform to approved shop drawings, applicable samples, and product data.

1.04 SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule and in such sequence as to cause no delay in the Work or in the work of any other contractor.
- B. Each submittal, appropriately coded, should allow 14 calendar days following receipt of submittal to ENGINEER for review and return to CONTRACTOR.

- C. Number of submittals required:
 - 1. Shop Drawings: Five copies.
 - 2. Product Data: Five copies.
 - 3. Samples: Submit the number stated in the respective Sections, two minimum for each submittal.
- D. Submittals shall contain:
 - 1. The date of submission and the dates of any previous submissions.
 - 2. The Project title and number.
 - 3. CONTRACTOR identification.
 - 4. The names of:
 - a. CONTRACTOR
 - b. Supplier
 - c. Manufacturer
 - 5. Identification of the product, with the section number, page and paragraph(s).
 - 6. Field dimensions, clearly identified as such.
 - 7. Dimensioned layout drawings, to scale, of all proposed equipment including, but not limited to, sluice gates, service pumps, ancillary pumps, mixers, storage tanks, HVAC equipment and ducts, generator set, fuel tanks, field instruments and electrical, control, and communication panels.
 - 8. Dimensioned layout drawings, to scale, of all proposed piping components including, but not limited to, piping, fittings, valves, couplings, restraining devices and locations of pipe supports and hangers.
 - 9. Relation to adjacent or critical features of the work or materials.
 - 10. Applicable standards, such as ASTM or Federal Standards numbers.
 - 11. Identification of deviations from Design Documents.
 - 12. Identification of revisions on resubmittals.
 - 13. A blank space suitably sized for CONTRACTOR stamps.
 - 14. Where calculations are required to be submitted by CONTRACTOR, the calculations shall have been checked by a qualified individual other than the preparer. The submitted calculations shall clearly show the names of the preparer and of the calculations checker.
- 1.05 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES
 - A. The review of shop drawings, data and samples will be for general conformance with the design concept and design documents. They shall not be construed as:

- 1. permitting any departure from the design requirements;
- 2. relieving CONTRACTOR of responsibility for any errors, including details, dimensions, and materials;
- 3. approving departures from details furnished by ENGINEER, except as otherwise provided herein.
- B. CONTRACTOR remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.
- C. If the shop drawings, data or samples as submitted describe variations and show a departure from the design requirements which CONTRACTOR finds to be in the interest of OWNER and to be so minor as not to involve a change in Contract Price or Contract Time, CONTRACTOR may return the reviewed drawings with the minor changes noted.
- D. Submittals will be returned to CONTRACTOR under one of the following codes.
 - Code 1 "RETURNED WITH NO EXCEPTIONS" is assigned when there are no notations or comments on the submittal. When returned under this code CONTRACTOR may release equipment and/or material for manufacture.
 - Code 2 "RETURNED AS NOTED" is assigned when a confirmation of the notations and comments IS NOT required by CONTRACTOR. CONTRACTOR may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.
 - Code 3 "RETURNED AS NOTED/CO" is assigned when a confirmation of the notations and comments is required by CONTRACTOR. CONTRACTOR may, at his own risk, release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by ENGINEER within 14 calendar days of the date of ENGINEER's transmittal requiring the confirmation.
 - Code 4 "RETURNED AS NOTED/RESUBMIT" is assigned when notations and comments are extensive enough to require a resubmittal of the package. This resubmittal is to address all comments, omissions and non-conforming items that were noted.
 - Code 5 "REVISE AND RESUBMIT" is assigned when the submittal does not meet the intent of the Subcontract Documents. 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 Contract Documents.
 - Code 6 "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid CONTRACTOR.

Code 7 - "RECEIPT ACKNOWLEDGED" is assigned to acknowledge receipt of a submittal that is not subject to 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 plan, field conformance test reports, and Health and Safety plans.

Codes 1 through 5 designate the status of the reviewed submittal, with Code 6 showing there has been an attachment of additional data.

- E. Resubmittals will be handled in the same manner as first submittals. On resubmittals CONTRACTOR shall identify all revisions made to the submittals, either in writing on the letter of transmittal or on the shop drawings by use of revision triangles or other similar methods. The resubmittal shall clearly respond to each comment made on the previous submission. Additionally, CONTRACTOR shall direct specific attention to any revisions made other than the corrections requested on previous submissions.
- F. Partial submittals may not be reviewed. ENGINEER will be the judge as to the completeness of a submittal. Submittals not complete will be returned to CONTRACTOR and will be considered "Not Approved" until resubmitted. ENGINEER may at his option provide a list or mark the submittal directing CONTRACTOR to the areas that are incomplete.
- G. Repetitive Review
 - 1. Shop Drawings and other submittals will be reviewed no more than twice at the ENGINEER's expense. All subsequent reviews will be performed at times convenient to ENGINEER and at CONTRACTOR's expense, based on ENGINEER's then prevailing rates. CONTRACTOR shall reimburse OWNER for all such fees invoiced to OWNER by ENGINEER. Submittals are required until they are acceptable to ENGINEER.
 - 2. Any need for more than one resubmission, or any other delay in obtaining ENGINEER's review of submittals, will not entitle CONTRACTOR to extension of the Contract Time.
- H. If CONTRACTOR considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, CONTRACTOR shall give written notice thereof to ENGINEER at least 5 working days prior to release for manufacture.
 - 1. When the shop drawings have been completed to the satisfaction of the ENGINEER, CONTRACTOR shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from ENGINEER.

1.06 DISTRIBUTION

A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by ENGINEER. Number of copies shall be as directed ENGINEER but shall not exceed six.

1.07 PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. If specifically required in other related Sections, submit a Professional Engineer Certification for each item required, in the form attached to this Section, filled in completely and stamped.

1.08 GENERAL PROCEDURES FOR SUBMITTALS

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), coordination with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. No extension of time will be authorized because of CONTRACTOR's failure to transmit submittals sufficiently in advance of the Work.

END OF SECTION

P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a Professional Engineer (P.E.) licensed by the State of Florida and that he/she has been employed by

(Name of Contractor/Subcontractor/Manufacturer)

to design _____

(Insert P.E. Responsibilities)

in accordance with Section _____

for the_____

(Name of Project)

The undersigned further certifies that he/she has performed the design of the

(Name of Component)

that said design is 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 OWNER)

or Owner's representative within seven days following written request.

P.E. Name

Contractor/Manufacturer's Name

Signature

Signature

Address

Address

SECTION 01370

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Submit to ENGINEER a Schedule of Values allocated to the various portions of the Work, within 14 days after the effective date of the Agreement.
- B. Upon request of ENGINEER, support the values with data which will substantiate their correctness.
- C. The Schedule of Values, unless objected to by ENGINEER, shall be used only as the basis for the CONTRACTOR's Applications for Payment.

1.02 RELATED WORK

A. See CONDITIONS OF THE CONTRACT and Section 01100 Summary of Work, for information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SCHEDULE OF VALUES

- A. 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. A listing of the minimum list of components to be itemized on the schedule of values is provided in tabular format at the end of this Section.
- C. 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.
- D. Identify each line item with the number and title of the respective major section of the specifications.
- E. For each major line item list sub-values of major products or operations under the item.

- F. For the various portions of the Work:
 - 1. Each item shall include a directly proportional amount of CONTRACTOR's overhead and profit.
 - 2. For items on which progress payments will be requested for stored materials, break down the value into:

i.The cost of the materials delivered and unloaded, with taxes paid. Paid invoices are required for materials upon request by ENGINEER.

ii.The total installed value.

- 3. The sum of all values listed in the schedule shall equal the total Contract Sum.
- PART 2 PRODUCTS (Not Used)
- PART 3 EXECUTION (Not Used)

END OF SECTION

Schedule of Values								
l ine No	JEA M&P	Estimated	Unit	Item Description	Unit Pricing	Total Pricing		
Line No.	Spec No.	Quantity	Unit	item Description	onit Pricing	Total Pricing		
Civil								
1		1	LS	Replace Dock Bumpers		\$		
2		1	LS	Earthwork & Site Prep		\$		
3		1,000	SY	Limerock Base Installation (12")	\$	\$		
4		1,000	SY	S-1 Asphalt Installation (2")	\$	\$		
5		1	LS	Bypass Pumping System (Temporary Piping & Equipment Rental)		\$		
6		1	LS	Landscaping & Grassing		\$		
7		1	LS	Dewatering (Yard Piping)		\$		
8		50	CY	A3 Sand	\$	\$		
9		50	CY	57 Stone	\$	\$		
Electrical Work								
10		1	LS	Electrical Apparatus		\$		
11		1	LS	SCADA/PLC Controls		\$		
12		1	LS	Wetwell Level Controls		\$		
13		1	LS	Motor Control Center (MCC)		\$		
14		1	LS	Main Control Panel		\$		
15		1	LS	Pump Control Panel				
16		1	LS	Misc Electrical Work				
17		1	LS	Security Upgrades		\$		
18		1	LS	Interior Lighting		\$		
19		1	LS	VFD Installation		\$		
Demolition/Removal/Disposal Work								
20		1	LS	Demo Equipment Pads and Aluminum Framing at Channels and Screen Room		\$		
21		1	LS	Equipment Demolition		\$		
22		1	LS	Site Demo (Concrete)		\$		
23		1	LS	Site Demo (Fencing)		\$		
24		1	LS	Piping Demolition		\$		
				Structural/Architectural Work				
25		470	LF	Guardrail and Safety Chains	\$	\$		
26		13000	SF	Other Surface Prep & Painting	\$	\$		
27		10000	SF	Wetwell Surface Prep & Specialty Coating	\$	\$		
28		50	SF	Concrete Repair Type A	\$	\$		
29		50	SF	Concrete Repair Type B	\$	\$		
30		20	SF	Concrete Repair Type C	\$	\$		
31		200	SF	Concrete Repair Type D	\$	\$		
32		50	LF	Concrete Repair Type E	\$	\$		
33		1	LS	Paint Existing W Beams	÷	\$		
34		5	CY	Concrete Support Beams	\$	\$		
35		1	IS	Cantilever Conc Slab and Alum Stairs	Ψ	\$		
36		216	SE	Acoustical Tile Ceiling	\$	\$		
37		50		Aluminum HVAC Platform Supports	Ψ \$	Ψ \$		
38		30	SF	HVAC Platform Grating	\$	¢ ¢		
30		1150	SF	Stud Wall Framed w/ Metal Studs	Ψ \$	Ψ \$		
40		140	l F	Pine Support Beams	\$	\$		
41		200		Alum Toe Board	\$	¢ ¢		
42		1	LS	Replace Loose Stair Nosings	Ψ	\$		
43		1	15	Replace Alum Cover Plates		¢ ¢		
43		2	FΔ	Overhead Doors (manual)	\$	Ψ \$		
45		10	EA	Man Doors, Hardware and Threshold	¢	¢		
40		10		Restroom	ψ	Ψ ¢		
40		1200	SE SE	Concrete Walkways	¢	Ψ ¢		
18		1200	19	8' CL Security Eencing	Ψ	¢		
40		1	1.5	Aluminum Platform and Stairs (NE Corner)		ŝ		
43			1.5	Mechanical Equipment and Other Items	u	Ψ		
50		1	15	Interior Plumbing - Demolition		\$		
50		4	19	Interior Plumbing - New Install	<u> </u>	¢		
50		1	1.5	Precast Vaults (ARV)	<u> </u>	ŝ		
52		4	19	Plump Suction and Discharge	<u> </u>	Ψ ¢		
53		4	19	n ump suction and Discharge Drains and Operational Pining		Ψ ¢		
54		1	15	HVAC - Demolition		¢ ¢		
55		1	19	HVAC - Fans & Ductwork	<u> </u>	¢		
50		1	19	HV/AC - Solit Unite		Ψ ¢		
57		1	19			Ψ ¢		
50		1	19			φ ¢		
59		1	LO	Faid Piping	¢			
60		2	EA	Sinice Gales	Ф Ф	φ ¢		
10		3		Service Fumps	ው ወ	φ		
62		1	LO	Sedi Water Talik System Submorpible Mixer		φ ¢		
03		1		Above Ground Fuel Storage Tank		φ ¢		
04		1		Above Ground Fuel Storage Tallk	ው ወ	φ		
65		1	LO	Anomary Fumps Standby Concreter w/ ATS	Ф Ф	φ Φ		
66		1		Standby Generator W/ A15	Ф Ф	Э ¢		
67		1	EA		<u></u> Ф	<u>э</u>		
68		1			<u>э</u>	<u>э</u>		
69		1	EA DAY	Non-Destructive Lesting Allowance	\$	5		
70		1	LS	Permit Allowance		\$		
71		1	LS	Bonds and Insurance	l	\$		
72		1	LS	SWA	ļ	\$		
73		1	LS	Mobilization	ļ	\$		
74		1	LS	Demobilization	ļ	\$		
75	1	1	LS	General Conditions		\$		

00SECTION 02065

TEMPORARY BYPASS PUMPING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. CONTRACTOR shall furnish, install, operate, maintain, and remove a temporary station bypass pumping system in accordance with the Contract Drawings and when necessary for construction activities.
- B. At a minimum, CONTRACTOR shall provide station bypass pumping during the critical work period associated with rehabilitating the existing pump station influent channels and wetwell, and with replacing the existing service pumps and associated piping, power and controls.
- C. The allowable site area in which the bypass pump system may be installed, and temporary bypass withdrawal and forcemain connection points are shown in the Contract Drawings.
- D. Bypass pumping shall be required 24 hours per day during the above-described rehabilitation work. Refer to the paragraphs "Work Sequencing" and "Sequencing Constraints" in Section 01100 of the Technical Specifications.

1.02 RELATED WORK

A. See CONDITIONS OF THE CONTRACT and Section 01100 Summary of Work, for information and requirements that apply to the work specified herein and are mandatory for this project.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Section 01300.
- B. Submit to ENGINEER for review detailed plans and descriptions outlining all provisions and precautions to be taken by CONTRACTOR to establish compliance with this Section. The bypass pumping system design shall be reviewed and verified by CONTRACTOR's operational vendor, and system layout drawings shall be submitted to ENGINEER for review and approval.
- C. Approval of the proposed bypass system design shall not relieve CONTRACTOR from full responsibility for performance of the system.
- D. The bypass plan shall include, but is not limited to, the following information:
 - 1. Configuration of pumps, piping and fuel storage;

- 2. Size, materials, location, elevations, and method of installation of all suction and discharge piping;
- 3. Bypass pump size, capacity, number of each size to be onsite, and fuel requirements;
- 4. Pump curves showing pump operating conditions;
- 5. Level-monitoring and pump control equipment, including critical control and alarm elevations in the junction manhole.
- 6. A minimum of eight (8) monitoring and alarm conditions, automatic communication equipment and alarm response protocols.
- 7. Equipment and pipe supports, anchoring requirements and pipe restraint methods;
- 8. Method of noise control for each pump; and
- 9. Schedule of installation and maintenance of bypass pumping equipment and piping.

1.04 QUALITY ASSURANCE

A. The design, installation and operating of the temporary pumping system shall be CONTRACTOR'S responsibility. CONTRACTOR shall employ the service of a vendor who can demonstrate to ENGINEER that he specializes in the design and operations of the temporary bypass pumping system. The vendor shall provide at least five project references of similar size and complexity as this project, performed by vendor's firm within the past three (3) years. The bypass system shall meet the requirements of all codes and regulations by agencies having jurisdiction.

1.05 SYSTEM DESCRIPTION

- A. The bypass pumping system shall have a minimum firm capacity of 4,828 gpm (6.95 MGD) at 46 ft TDH, based on the station's design peak hour flowrate (PHF). Limited surcharging of the influent gravity system, as shown in the Contract Drawings, is permissible during peak flow events.
- B. The bypass pumping system shall be capable of pumping at variable rates to approximate incoming wastewater flowrates, including flows down to 656 gpm (0.94 MGD), based on the station's design annual average daily flowrate (AADF).
- C. CONTRACTOR shall provide all pipeline plugs, pumps of adequate size to handle average and peak flows, controls, monitoring devices, and temporary discharge piping to ensure that the design flows can be safely diverted around the station during the above-described rehabilitation work.

PART 2 PRODUCTS

2.01 PUMP SYSTEM

- A. All pumps used shall be fully-automatic, self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps shall be diesel powered. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of influent flows. OWNER shall provide diesel fuel to CONTRACTOR for use by the temporary bypass pumps. CONTRACTOR shall coordinate with OWNER for delivery of fuel during the entire bypass period.
- B. CONTRACTOR shall provide the necessary instrumentation and controls for starting/stopping each pump and for monitoring wetwell level, pump status, critical engine functions, battery status, fuel level, etc.
- C. Local audible and visible alarms shall be provided, and automatic communication for alarms shall be by cellular telephone autodialing system with at least ten (10) programmable emergency contact phone numbers.
- D. Spare parts for the pumps and piping shall be kept onsite as required. Adequate hoisting equipment for each pump and accessories shall be maintained onsite.
- E. All equipment or piping failures or malfunctions shall be corrected immediately.
- F. CONTRACTOR is advised that OWNER has no control over the maximum flow that will occur in the sewer.
- G. It is essential to the operation of the existing sewer system that there is no interruption in the flow of wastewater for the duration of the bypass period. CONTRACTOR shall provide, maintain, and operate all temporary facilities such as pumping equipment, piping, valves, plugs, all necessary power, and all labor and equipment necessary to intercept the sewage flow before it overflows the influent gravity system or interferes with the work, direct it past the work, and discharge it to the existing downstream sewer system.
- H. CONTRACTOR shall provide all necessary means to safely convey the wastewater past the work area. CONTRACTOR will not be permitted to stop or impede the normal sewer system flow under any circumstance.
- I. CONTRACTOR shall protect all water resources wetlands and other natural resources from wastewater overflows or hazardous liquid spills, including fuels, lubricants and coolants.

2.02 PUMP DISCHARGE

A. The bypass pumps shall manifold into a temporary bypass forcemain that connects to a permanent bypass connection riser on the pump station site. Refer

to the Contract Drawings for the locations and configuration of the proposed bypass pumps, bypass piping, and connection riser.

- B. The temporary bypass piping shall be as shown on the drawings, shall be of sound material and shall not leak during operation. Joints shall be supported and restrained to preclude movement or separation. Under no circumstances will aluminum "irrigation" type piping or solvent-weld PVC pipe be allowed.
- C. A properly-sized air relief valve shall be provided at each local high point of the temporary bypass piping.

PART 3 EXECUTION

3.01 INSTALLATION

- A. System layout shall provide for ready removal and replacement of every pumping unit without affecting the others.
- B. Protective barriers and covers shall be installed to prevent debris of any type from entering the piping system. Any debris inadvertently allowed into the system shall be immediately removed.
- C. Pumps shall not be closer than 100 feet from any residence and shall not exceed the noise limit of 85 dBA at a distance of 5 feet from any part of the unit.
- D. When working inside the collection system or pump station, CONTRACTOR shall exercise caution and comply with the OSHA requirements for confined spaces and in the potential presence of combustible or oxygen-deficient atmospheres.
- E. CONTRACTOR shall be responsible for furnishing the necessary labor and supervision to set up and operate the pumping system. The system shall be fully inspected daily to ensure that the system is working correctly. CONTRACTOR shall coordinate with OWNER for delivery of fuel (at OWNER'S expense) during the entire bypass period.

3.02 FLOW CONTROL MEASURES

A. CONTRACTOR shall be responsible and liable for any wastewater overflows resulting from inadequate construction, maintenance or operation of the bypass system, including reporting to the State of Florida and any resulting fines.

3.03 REMOVAL AND RESTORATION

A. CONTRACTOR shall remove all pumping system components and restore any modifications to the existing structure as directed by ENGINEER. Any soil containing grease, oil, or fuel from the pump engines shall be removed from the site and replaced with topsoil.

B. All sewer plugs and other bypass system appurtenances shall be removed, and any damage to the station, gravity sewer pipes or manhole shall be repaired.

3.04 PAYMENT

A. Payments for the temporary bypass pumping system shall be in accordance with the Bid Tab for the project, including the unit pricing shown for bypass requirements beyond the anticipated period included in the Bid Tab.

END OF SECTION
SECTION 02270

EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. CONTRACTOR shall 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, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching and final cleanup.
- B. All soil erosion and sediment control activities, provisions and measures shall comply with the "Manual for Erosion and Sediment Control in Florida", latest edition, and NPDES General Permit. CONTRACTOR shall be responsible for designing, providing and maintain effective erosion and sedimentation control during construction. The control must ensure erosion and sedimentation will minimal and limited to within the project boundaries for the duration of the Work.
- C. The effectiveness of sedimentation and erosion control depends on effective initial installation and continual modification and maintenance during the course of work. CONTRACTOR shall make a continual reasonable effort to achieve the objective of providing positive sedimentation and erosion control over all disturbed areas of the work site at all times.

1.02 RELATED WORK

- A. Earthwork is included in JEA's Water and Sewer Standards Manual, Section 408 Excavation and Earthwork.
- B. Seeding is included in JEA's Water and Sewer Standards Manual, Section 441 Grassing.

1.03 SUBMITTALS

A. CONTRACTOR shall submit, in accordance with Section 01300, within 10 days after award of Contract, technical product literature for all commercial products to be used for erosion and sedimentation control.

1.04 QUALITY ASSURANCE

A. CONTRACTOR shall 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 offsite 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 CONTRACTOR. No additional charges to OWNER will be considered.

B. Sedimentation and erosion control measures shall conform to the requirements of all permits and Regulatory Agencies, and to requirements outlined in the State of Florida Erosion and Sediment Control Designer and Reviewer Manual, latest edition, Florida Department of Transportation Design Standards, latest edition, and requirements of the Contract Drawings.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Crushed stone for sediment filtration devices, access ways and staging areas shall conform to Florida Department of Transportation Standard Specifications for Road and Bridge, latest edition.
- B. Sediment Fence
 - 1. Sediment fence shall be a prefabricated commercial product made of a woven, polypropylene, ultraviolet resistant material such as "Envirofence" by Mirafi Inc., Charlotte, NC, or equal.
- C. 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.
- D. Latex acrylic copolymer or organic tackifier shall be a commercial product specifically manufactured for use as straw mulch tackifier.
- E. 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 OWNER.
- F. Temporary seeding shall be with annual ryegrass. Permanent grass and sod shall be in accordance with JEA's Water and Sewer Standard Manual Section 441 Grassing.

PART 3 EXECUTION

3.02 INSTALLATION

- A. Sediment Fence Installation
 - 1. Sediment fences shall be positioned around the perimeter of the work area

and as necessary to prevent off site movement of sediment produced by construction activities as directed by ENGINEER.

- 2. CONTRACTOR shall dig a trench approximately 6-in wide and 6-in deep along proposed fence lines.
- 3. CONTRACTOR shall drive stakes, 8-ft on center (maximum) at back edge of trenches.

Stakes shall be driven 2-ft (minimum) into ground.

- 4. CONTRACTOR shall hang filter fabric on posts carrying to bottom of trench with about 4-in of fabric laid across bottom of trench. Stretch fabric fairly taut along fence length and maintain secure both ways.
- 5. CONTRACTOR shall backfill trench with suitable material as indicated in the geotechnical exploration report.
- 6. CONTRACTOR shall install pre-fabricated silt fence according to manufacturer's instructions.
- B. Staging areas and access ways shall be surfaced with a minimum depth of 4-in of crushed stone.
- 3.03 MAINTENANCE AND INSPECTIONS
 - A. Inspections
 - 1. CONTRACTOR shall 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, CONTRACTOR shall promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.
 - B. Device Maintenance
 - 1. Sediment Fences
 - a. CONTRACTOR shall remove accumulated sediment once it builds up to 1/2 of the height of the fabric.
 - b. CONTRACTOR shall replace damaged fabric, or patch with a 2-ft minimum overlap.
 - c. CONTRACTOR shall make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.
 - 2. CONTRACTOR shall add crushed stone to access ways and staging area

as necessary to maintain a firm surface free of ruts and mudholes.

3.04 TEMPORARY MULCHING

- A. CONTRACTOR shall 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.

3.05 PERFORMANCE

A. If temporary erosion and sedimentation control measures employed by CONTRACTOR are insufficient or fail to be effective in opinion of ENGINEER or OWNER, or fail to produce results which comply with the requirements of OWNER, CONTRACTOR shall immediately take whatever steps are necessary to correct the deficiency at no additional cost to OWNER.

3.06 REMOVAL AND FINAL CLEANUP

A. Once the site has been fully stabilized against erosion, CONTRACTOR shall remove sediment control devices and all accumulated silt. CONTRACTOR shall dispose of silt and waste materials in proper manner. CONTRACTOR shall regrade all areas disturbed during this process and stabilize against erosion with surfacing materials and shall perform final top-soiling, preparation, and seeding per Section 441 of the JEA Water and Sewer Standards.

END OF SECTION

SECTION 02515

ROADS AND DRIVEWAYS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Work necessary to complete the roads and driveways, including asphalt paving, and drainage structures.

1.02 GENERAL

A. See CONDITIONS OF THE CONTRACT and Section 01100 Summary of Work for information and requirements that apply to the Work specified herein and are mandatory for this Project.

1.03 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01300 and the requirements of this Section.
- B. Provide the following submittals:
 - 1. Certification, test results, and source for asphalt concrete material.

1.04 SYSTEM DESCRIPTION

- A. Paving: Designed for movement and parking of trucks up to thirty fourthousand (34,000) lbs (HS-20) tandem axles.
- 1.05 QUALITY ASSURANCE
 - A. Perform Work in accordance with the current edition of the "Florida Department of Transportation Standard Specifications for Road and Bridge Construction", herein referred to as the Standard Specifications. In case of conflict, the Standard Specifications shall prevail.

PART 2 PRODUCTS

- 2.01 BASE COURSE
 - A. Materials for base course shall be as specified in Section 911 of the Standard Specifications.

2.02 PRIME COAT

A. Materials for prime coat (emulsified asphalt) and cover (hot asphalt-coated sand) shall be as specified in Sections 916 and 902, respectively, of the Standard Specifications.

2.03 TACK COAT

A. Materials for tack coat (emulsified asphalt) shall be Grade RS-2, complying with the Standard Specifications.

2.04 ASPHALTIC CONCRETE PAVEMENT

- A. Asphaltic concrete shall be Type S-I or Type SP-12.5. Materials shall conform to Sections 334, 901, 902, 916, and 917 of the Standard Specifications.
- B. The job-mix formula shall indicate the gradation of each of the aggregate constituents to be used in the mixture and shall establish the exact proportion of each constituent to be used to produce a combined gradation of aggregate within the appropriate limits stated above.

PART 3 EXECUTION

3.01 BASE CONSTRUCTION

- A. Construct base course at the location and to the grades and cross sections shown on the Drawings and as specified in Section 200 of the Standard Specifications.
- B. Base course may be placed when the atmospheric temperature is above thirty (30) degrees F and rising.
- C. Once the drive area is at grade, the area shall be thoroughly proofrolled. Any soft or loose areas shall be undercut and replaced with compacted fill.
- D. The base shall be compacted to a minimum of 100 percent maximum dry density Modified Proctor (AASHTO T-180) at a moisture content that is within 2 percentage points of the optimum moisture content.

3.02 PRIMING AND TACKING

- A. Prime and tack coats shall be applied in accordance with Section 300 of the Standard Specifications.
- B. Prime and tack coats shall not be applied when the ground temperature is lower than fifty (50) degrees F without permission of ENGINEER. Do not apply prime and tack coats when the base contains an excess of moisture.

3.03 ASPHALT PAVEMENT CONSTRUCTION

A. Asphaltic concrete of the type and thickness shown in the Drawings shall be applied in accordance with Sections 320, 330 and 334 of the Standard Specifications.

- B. Asphalt concrete shall not be placed when the atmospheric temperature is lower than forty (40) degrees F nor during heavy rainfall nor when the surface upon which it is to be placed is thirty-two (32) degrees F or lower.
- C. Lay asphalt concrete over the base course to the compacted depth shown on the Drawings. The method of proportioning, mixing, transporting, laying, processing, rolling the material, and the standards of workmanship shall conform to the applicable requirements the Standard Specifications. At no time shall the coarse aggregate segregated from the mix from hand spreading or raking of joints be scattered across the paved mat.
- D. Roll each lift of the asphalt concrete and compact to the density specified in the Standard Specifications. Asphalt or asphalt stains, which are noticeable upon surfaces of concrete or materials, which will be exposed to view shall be promptly and completely removed.
- E. Where the asphalt pavement is to be connected with an existing roadway surface, the Contractor shall modify the existing roadway profile to produce a smooth riding connection between new and existing paving. Where it is necessary to remove existing asphalt surfaces, burn or chip the existing surface to provide a minimum 2-inch depth of asphalt concrete. The edges of meet line cuts shall be straight and vertical. Existing asphalt edges shall be painted with tack coat before placing new asphalt.
- F. The completed surface of the asphalt pavement shall be of uniform texture, uniform grade, smooth, and free from defects of all kinds. The completed surface shall not vary more than 1/8-inch from the lower edge of a ten (10)-foot straightedge placed on the surface parallel to the centerline. The transverse slope shall not vary more than 1/4-inch in ten (10)-feet from the rate of transverse slope shown on the Drawings.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to design, install and remove formwork for cast-in-place concrete complete as shown on the Drawings and specified herein.
- B. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts and other items furnished under other Sections and required to be cast into concrete, or approved in advance by the Engineer.

1.02 RELATED WORK

- A. Concrete Reinforcement is included in Section 03200.
- B. Concrete Joints and Joint Accessories are included in Section 03250.
- C. Cast-in-Place Concrete is included in Section 03300.
- D. Grout is included in Section 03600.

1.03 SUBMITTALS

- A. Submit to the Engineer, shop drawings, and product data showing materials of construction and details of installation for:
 - 1. Form release agent
 - 2. Form ties
 - 3. Tapered Ties: Proposed method and products for sealing form tie hole.
- B. Samples
 - 1. Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not adversely affect concrete surfaces to be painted, coated or otherwise finished and will not affect the forming materials.
- C. Certificates
 - 1. Statement of qualification for the formwork designer retained by Contractor. Formwork designer shall be a professional engineer registered

in the State of Florida. Designer shall have at a minimum five years of experience designing the required formwork and falsework systems.

2. Certify that form release agent is suitable for use in contact with potable water after 30 days (non-toxic and free of taste and odor).

1.04 REFERENCE STANDARDS

- A. American Concrete Institute (ACI)
 - 1. ACI 301 Standard Specification for Structural Concrete
 - 2. ACI 318 Building Code Requirements for Reinforced Concrete
 - 3. ACI 347 Formwork for Concrete
- B. American Plywood Association (APA)
 - 1. Material grades and designations as specified
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- 1.05 SYSTEM DESCRIPTION
 - A. Formwork shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete. Design forms and ties to withstand concrete pressures without budging, spreading, or lifting forms.
 - B. Architectural Concrete is wall, slab, beam or column concrete which will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of walls to 2-ft below the normal water surface in open tanks and basins.

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. General: Forms for cast in place concrete shall be made of wood, metal, or other approved material. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for

exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved by the Engineer and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.

- B. Wall Forms
 - 1. Forms for all exposed exterior and interior concrete walls shall be "Plyform" exterior grade plywood panels manufactured in compliance with the APA and bearing the trademark of that group, or equal acceptable to the Engineer. Provide B grade or better veneer on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and grinding.
 - 2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging.
 - 3. Circular Structures: Use forms conforming to the circular shape of the structure. Straight panels may be substituted for circular form. Provided panels to not exceed two (2) feet in horizontal width and angular deflection is no greater than 3 ½ degrees per joint.
- C. Column Forms
 - 1. Rectangular Columns: as specified for walls
 - 2. Circular Columns: Fabricated steel or fiber reinforced plastic with bolted together sections or spirally wound laminated fiber form internally treated with form release agent for height of columns.
- D. Rustication strips shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.
- E. Form Release Agent
 - 1. Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste or odor and meet the requirements of NSF/ANSI Standard 61. Form release agent shall be Farm

Fresh by Unitex, Duogard II by W.R. Meadows, and Formsheild WB by Euclid.

- F. Form Ties
 - 1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 1 1/2 in off the face of the concrete. The part of the tie to be removed shall be at least 1/2 in diameter or be provided with a wood or metal cone at least 1/2 in diameter and 1 1/2 in long. Form ties in concrete exposed to view shall be the cone washer type.
 - 2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be of approved wood or plastic.
 - 3. Flat bar ties for panel forms, if used, shall have plastic or rubber inserts having a minimum depth of 1-1/2-in and sufficient dimensions to permit proper patching of the tie hole.
 - 4. Ties for liquid containment structures shall have an integral waterstop that is tightly welded to the tie.
 - 5. Common wire shall not be used for form ties.
 - 6. Alternate form ties consisting of tapered through-bolts at least 1-in in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used at the Contractor's option. Obtain Engineer's acceptance of system and spacing of ties prior to ordering or purchase of forming. Clean, fill and seal form tie hole with non-shrink cement grout. A vinyl plug shall be inserted into the hole to serve as a waterstop. The Contractor shall be responsible for water-tightness of the form ties and any repairs needed.

PART 3 EXECUTION

3.01 GENERAL

- A. Forms shall be used for all cast-in-place concrete including sides of footings. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions and appearance indicated on the drawings.
- B. Forms for walls shall have removable panels at the bottom for cleaning, inspection and joint surface preparation. Forms for walls of considerable height (15 feet or greater) shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to allow concrete inspection, to prevent segregation and to prevent the accumulation of hardened concrete on the forms above the fresh concrete.

- C. Molding, bevels, or other types of chamfer strips shall be placed to produce block outs, rustications, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a ³/₄-in chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the Drawings. Sizes of moldings shall conform to the sealants manufacturer's recommendations.
- D. Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms so that the concrete will not be damaged by their removal. The contractor shall be entirely responsible for the adequacy of the forming system.
- E. Before form material is re-used, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like new" condition of the form is maintained.

3.02 FORM TOLERANCES

- A. Forms shall be surfaced, designed and constructed in accordance with the recommendations of ACI 301 and shall meet the following additional requirements for the specified finishes.
 - 1. Formed Surface Exposed to View: Edges of all form panels in contact with concrete shall be flush within 1/16-in and forms for plane surfaces shall be such that the concrete will be plane within 3/16-in in 4-ft. Forms shall be tight to prevent the passage of mortar, water and grout. The maximum deviation of the finish wall surface at any point shall not exceed ¼-in from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.
 - 2. Formed surfaces not exposed to view or buried shall meet requirements of Class "C" Surface in ACI 301.
 - 3. Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 1-in.

3.03 FORM PREPARATION

- A. Wood forms in contact with the concrete shall be coated with an effective release agent prior to form installation.
- B. Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms,

except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.

3.04 REMOVAL OF FORMS

- A. The Contractor shall be responsible for all damage resulting from removal of forms. Forms and shoring for structural slabs or beams shall remain in place in accordance with ACI 301. Form removal shall conform to the requirements specified in Section 03300 including curing requirements.
- B. Repair all damages resulting from removal of forms.
- C. Clean, fill and seal form tie hole with non-shrink cement grout. The Contractor shall be responsible for the watertightness of the form ties holes and any repair necessary to maintain watertightness of tie holes.

3.05 INSPECTION

- A. The Engineer on site shall be notified when the forms are complete and ready for inspection at least 6 hours prior to the proposed concrete placement.
- B. Failure of the forms to comply with the requirements specified herein or to produce concrete complying with the requirements of Section 03300 shall be grounds for rejection of that portion of the concrete work. Rejected work shall be repaired or replaced as directed by the Engineer at no additional cost to the Owner. Such repair or replacement shall be subject to the requirements to this Section and approval of the Engineer.

END OF SECTION

SECTION 03180

CONCRETE COATING SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install all labor, materials, equipment and incidentals required to supply and install the concrete coating system on the pump station as indicated on the Drawings.

1.02 RELATED WORK

- A. Concrete Finishes in Section 03350.
- B. Section 446 and Section 448 of JEA Water & Wastewater Standards Manual

1.03 SUBMITTALS

- A. Submit for review, in accordance with Section 01340, complete detailed shop drawings for all materials furnished under this Section.
- B. A rehabilitation plan detailing the methods, materials and procedures proposed for the rehabilitation of the facilities shall be prepared by the Contractor.
- C. The manufacturer of the coating system shall furnish an affidavit attesting to the successful use of its material as a coating for concrete structures for a minimum period of 5 years in wastewater conditions recognized as corrosive or otherwise detrimental to concrete.

1.04 QUALITY ASSURANCE

- A. The coatings system manufacturer shall provide a representative to visit the jobsite at intervals during surface preparation and coating application as may be required for product application quality assurance, and to determine compliance with supplier's instructions and these Specifications, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract.
- B. The following minimum site visits shall be provided for inspections by the coating system manufacturer's representative:
 - 1. Prior to surface preparation, inspection of all concrete surfaces specified in this section to be coated. At this time, the manufacturer's representative shall review and recommend the surface preparation and repair procedures with the applicator.

- 2. Inspection of all prepared surfaces prior to repair activities. At this time, the manufacturer's representative shall approve the surface preparation for repair coating application.
- 3. Inspection of all areas of exposed reinforcing steel after application of the bonding agent and prior to application of repair coating.
- 4. Post-repair inspection prior to application of the coating system. At this time, the manufacturer's representative shall approve the re-surfaced surfaces for final coating application.
- 5. The manufacturer shall visit the site during the coating application to ensure that the application process is proceeding in accordance with its recommendations.
- 6. A post installation inspection shall be provided by the manufacturer's representative prior to issuance of a guarantee for the work specified herein.
- 7. The manufacturer's factory representative shall submit all inspection reports to the Engineer within five days of each site visit documenting its observations and certifying the suitability of the applicator's work for the coating application.
- C. The coating system applicator shall have a minimum of five years' practical experience in applying the approved coating system. Prior to application of any coating, Contractor shall furnish the Engineer with a detailed list of previous jobs and references substantiating the requirement. Records of such jobs showing project name, owner's name and contact information, engineer's name and contact information, date of completion, and results of subsequent inspections and tests shall be submitted as verification of performance. The coating system manufacturer shall submit a letter stating that the proposed applicator is qualified to apply the coatings specified herein and that all components proposed for use in the project are acceptable and will not adversely affect the finish coating system or its warranty.
- D. It is the responsibility of the Contractor to inspect and provide substrate surfaces that are prepared in accordance with these Specifications and the printed directions and recommendations of the Manufacturer's representative.
- E. Report in writing to Engineer, with copy to manufacturer, of deficiencies that could impair work. Surfaces must be approved by the coating system manufacturer and the installing contractor prior to application of coating.

PART 2 PRODUCTS

2.01 COATING SYSTEMS

A. See Section 446 of JEA Water & Wastewater Standards Manual.

PART 3 EXECUTION

- 3.01 GENERAL
 - A. Surface preparation shall be performed in accordance with Manufacturer's requirements and at a minimum shall remove all deteriorated materials, dirt, oil, grease, and all other bond inhibiting materials from the surface by dry mechanical means, i.e. sandblasting, grinding, etc, as approved by the Engineer.
 - B. Where existing reinforcement is exposed the reinforcement shall be cleaned of all rust and coated with a corrosion inhibitor as recommended by the coating Manufacturer.
 - C. Installation, curing and testing shall be performed in accordance with the Manufacturer's specifications and requirements.
 - D. In all cases where coating work must be performed in a non-flow condition the Contractor shall be responsible for coordinating and facilitating all flow diversion and bypass pumping during the coating operation.
 - E. New Portland cement concrete structures shall have been cured for a minimum of 28 days prior to commencing coating installation. Should earlier coating be required, coating product manufacturer shall recommend specifications including appropriate cure assessment testing and use of specialty primers and sealers.

3.02 REPAIRS AND SURFACE PREPARATION

- A. Excessive debris, sediment, root intrusion or other foreign materials which may impact the effectiveness of the surface preparation process shall be removed prior to the commencement thereof.
- B. Offset structural components, lids, covers, frames, etc. shall be repaired, replaced, or reset prior to the commencement of surface preparation.
- C. External soil/fill voids shall be remediated and/or stabilized by replacement or injection of stabilizing grout as determined appropriate by the engineer.
- D. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed in accordance with SSPC-SP 1 Solvent Cleaning.

Choice of surface preparation method(s) should be per the coating manufacturer's recommendation which shall be based upon the condition of the structure and concrete or masonry surface, potential contaminants present, access to perform

work, and the required cleanliness and profile of the prepared surface to receive the repair and/or coating product(s).

- E. Surface preparation method shall be abrasive blasting.
 - 1. SSPC SP-13/NACE No. 6 Surface Preparation of Concrete,
 - 2. ASTM D-4258 Standard Practice for Surface Cleaning Concrete for Coating and ASTM-D-4259 Standard Practice for Abrading Concrete,
 - 3. ICRI Technical Guideline No. 03732 Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 - 4. NACE/SSPC Standards for the surface preparation of steel.
- F. Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound, clean, and neutralized surface suitable for the specified coating product(s).
 - 1. Resulting surface profile of the prepared concrete substrate shall be (as described in ICRI Technical Guideline No. 03732):
 - **a**. For application of cementitious materials; at least a CSP2
 - b. For application of coating products: at least a CSP2.
 - 2. Concrete and/or mortar damaged by corrosion, chemical attack or other means of degradation shall be removed so that sound substrate remains,
 - a. In conditions where severe chemical/microbiological attack has occurred the prepared substrate shall exhibit a pH of 8-12. Additional cleaning and/or contaminated substrate removal may be required to achieve the specified pH level.
 - 3. Steel surfaces to be coated shall be abrasive blast cleaned.
 - a. Blast air shall be free of oil and water.
 - b. Abrasive shall be as required to produce the specified level of cleanliness and profile in an efficient and uniform manner. Abrasive shall not be recycled.
 - c. Abrasive blasting shall not be performed when the air or steel temperature is below 40 deg F, when the relative humidity exceeds 80%, or when the steel is less than 5 deg F warmer than the dew point. The Contractor will provide dehumidification, and/or temperature control as necessary to meet these conditions.

- d. Blast cleaning shall be in accordance with SSPC-SP 5, White Metal Blast Cleaning for immersion service of the coated areas. Blast cleaning for other surfaces shall be in accordance with SSPC-SP 10, Near White Blast Cleaning. Anchor profile shall be 2.5-5.0 mils and relative to the coating thickness specified.
- e. Alternatively, surfaces to be recoated may be cleaned according to SSPC-SP 12/NACE No. 5 Surface Preparation and Cleaning of Metals by Water jetting prior to Recoating.
- G. At the time of the recoating, the amount of flash rust shall be no greater than "No Flash Rust" as defined in SSPC-SP 12.
- H. Prior to the application of the coating product repairs shall be completed to ensure the following:
 - 1. All inflow and infiltration shall be eliminated by use of appropriate repair material(s), such as hydraulic cements and/or chemical grouts.
 - 2. All repairs to joints, pipe seals, steps, mechanical penetrations, benches, inverts, pipes or other appurtenances to be coated shall be completed and repaired surfaces prepared according to this section.
 - a. Benches or other horizontal surfaces shall have adequate slope (1" rise per lineal foot minimum) to minimize the retention of debris following surcharge.
 - b. Inverts or flow channels shall be smooth without lips, rough edges or other features which may cause debris to collect; contoured to minimize turbulent flow; and be sloped to promote adequate flow from the inlet(s) to the outlet pipe.
 - **c.** All joints, pipe seals, steps or other penetrations shall be sealed against inflow, infiltration and exfiltration and be adequately filled, smoothed and contoured to promote monolithic coating application.
- I. Areas where reinforcing steel has been exposed shall be repaired in accordance with the Project Engineer's recommendations or at the minimum all exposed steel shall be prepared prior to coating with the coating product specified or other approved primer as specified by the coating product manufacturer.

3.03 FIELD QUALITY CONTROL AND TESTING

A. The CONTRACTOR shall give the ENGINEER a minimum of 3 days advance notice of the start of any field surface preparation work or coating application work, and a minimum of 7 days advance notice of the start of any surface preparation work.

- B. The CONTRACTOR shall furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Dry-film thickness gages shall be made available for the ENGINEER'S use at all times while coating is being done, until final acceptance of such coatings. The CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings.
- C. Coating system thickness shall be inspected to ensure compliance with the specifications herein.
 - 1. During application a wet film thickness gauge, meeting ASTM D4414 -Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, documented, and attested to by Contractor for submission to Owner.
 - 2. After the coating product(s) have cured in accordance with manufacturer recommendations, coating system thickness may be measured according to SSPC-PA 9 Measurement of Dry Coating Thickness on Cementitious Substrates Using Ultrasonic Gages.
- D. High voltage holiday detection for coating systems installed in corrosive environments, when it can be safely and effectively employed, shall be performed to ensure monolithic protection of the substrate. After the coating product(s) have cured in accordance with manufacturer recommendations, all surfaces shall be inspected for holidays in accordance with NACE RPO 188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates or ASTM D4787 Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates. All detected holidays shall be marked and repaired according to the coating product(s) manufacturer's recommendations.
 - 1. Test voltage shall be a minimum of 100 volts per mil of coating system thickness.
 - 2. Detection of a known or induced holiday in the coating product shall be confirmed to ensure proper operation of the test unit.
 - 3. All areas repaired shall be retested following cure of the repair material(s).
 - 4. In instances where high voltage holiday detection is not feasible a close visual inspection shall be conducted and all possible holidays shall be marked and repaired as described above.
 - 5. Documentation of areas tested, equipment employed, results, and repairs made shall be submitted to the Owner/Engineer by Contractor.
- E. Visual inspection shall be made by the Engineer. Any deficiencies in the finished coating affecting the performance of the coating system or the operational

functionality of the structure shall be marked and repaired according to the recommendations of the coating product(s) manufacturer.

- F. Inspection by the ENGINEER, or the waiver of inspection of any particular portion of the WORK, shall not relieve the CONTRACTOR of its responsibility to perform the work in accordance with these Specifications.
- G. Prior to demobilization from the site, the Contractor shall remove all construction debris, stabilize any spill areas and wash roadway areas affected by the work.
- H. Inspection by the Owner shall be scheduled after the work is complete, and again within the warranty period.

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.

1.02 RELATED WORK

- A. Concrete Formwork is included in Section 03100.
- B. Cast-in-place Concrete is included in Section 03300.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Reinforcing steel: Placement drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and ACI SP-66. All reinforcement in a concrete placement shall be included on a single placement drawing or cross referenced to the pertinent main placement drawing. The main drawing shall include the additional reinforcement (around openings, at corners, etc) shown on the standard detail sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified. For all cast-in-place concrete tanks, retaining walls, building stem walls, wall sections shall be included in the drawings.
 - 2. All splice and joint locations shall be indicated on placement drawings. Splice lengths shall be clearly dimensioned.
 - 3. Reinforcement cover shall be clearly indicated.
 - 4. Submit reinforcement shop drawing for each structure as a complete package. Submittal showing portions of a structure will not be acceptable, unless acceptable by Engineer in advance.
 - 5. Submittals consisting of schedules without accompanying placement drawings will not be acceptable, unless acceptable by Engineer in advance.
 - 6. Bar bending details. The bars shall be referenced to the same identification marks shown on the placement drawings and shipping tags. Schedules shall be located on the same sheet where the bar mark is referenced.

Schedule of all placements to contain synthetic reinforcing fibers. The amount of fibers per cubic yard to be used for each of the placements shall be noted on the schedule. The name of the manufacturer of the fibers and the product data shall be included with the submittal.

- B. Test Reports
 - 1. Certified copy of mill test on each steel proposed for use showing the physical properties of the steel and the chemical analysis.
 - 2. Mechanical Reinforcing Bar Couplers. Current Evaluation Report prepared by ICC-ES or by other approved testing agency.
- C. Certificates
 - 1. Welder's certification. The certification shall be in accordance with AWS D1.4 when welding of reinforcement is required.
 - 2. Weld Procedures. Provide procedure for each type of welded reinforcing splice in accordance with AWS D1.4 when welding of reinforcing is required.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 2. ASTM A184 Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 - 3. ASTM A185 Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
 - 4. ASTM A496 Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
 - 5. ASTM A497 Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
 - 6. ASTM A615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - 7. ASTM A616 Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
 - 8. ASTM A617 Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement

- 9. ASTM A706 Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
- 10. ASTM A767 Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
- 11. ASTM A775 Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
- 12. ASTM A884 Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement.
- 13. ASTM A934 Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
- B. American Concrete Institute (ACI)
 - 1. ACI 301 Standard Specification for Structural Concrete
 - 2. ACI 315 Details and Detailing of Concrete Reinforcement.
 - 3. ACI 318 Building Code Requirements for Structural Concrete
 - 4. ACI SP-66 ACI Detailing Manual
- C. Concrete Reinforcing Steel Institute (CRSI)
 - 1. Manual of Standard Practice
- D. American Welding Society (AWS)
 - 1. AWS D1.4 Structural Welding Code Reinforcing Steel
- 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. Provide services of a manufacturer's representative, with at least 2 years experience in the use of the reinforcing fibers for a preconstruction meeting and assistance during the first placement of the material.

1.06 DELIVERY, HANDLING AND STORAGE

- A. Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.
- B. Reinforcing steel shall be shipped and stored with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with

waterproof markings showing the same "mark" designations as those shown on the submitted Placing Drawings.

C. Reinforcing steel shall be stored off the ground and kept free from dirt, oil, or other injurious contaminants

PART 2 PRODUCTS

2.01 MATERIALS

- A. Materials shall be new, of domestic manufacture and shall comply with the following material specifications.
- B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.
- C. Concrete Reinforcing Bars required on the Drawings to be Welded: ASTM A706.
- D. Welded Steel Wire Fabric: ASTM A185. Provide in flat sheets.
- E. Welded Deformed Steel Wire Fabric: ASTM A497. Provide in flat sheets.
- F. Welded Plain Bar Mats: ASTM A704 and ASTM A615 Grade 60 plain bars.
- G. Fabricated Deformed Steel Bar Mats: ASTM A184 and ASTM A615 Grade 60 deformed bars.
- H. Reinforcing Steel Accessories
 - Plastic Protected Bar Supports: CRSI Bar Support Specifications, Class 1 - Maximum Protection.
 - 2. Stainless Steel Protected Bar Supports: CRSI Bar Support Specifications, Class 2 - Moderate Protection.
 - 3. Precast Concrete Block Bar Supports: CRSI Bar Support Specifications, Precast Blocks. Blocks shall have equal or greater strength than the surrounding concrete.
 - 4. Steel Protected Bar Supports: #4 Steel Chairs with plastic or rubber tips.
- I. Tie Wire
 - 1. Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire or stranded wire.
- J. Mechanical Reinforcing Bar Couplers
 - 1. General : Use only at locations indicated on the Drawings or where written approval has been obtained from the Engineer.

- 2. Mechanical reinforcing steel butt splices shall be positive connecting taper threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products Inc., Solon, OH or equal. They shall meet all ACI 318 Building Code requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement.
- 3. Bar couplers shall be torqued to manufacturer's recommended value.
- 4. Unless otherwise noted on the Drawings, mechanical tension splices shall be designed to produce a splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the rebar.
- 5. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar and shall be capable of developing the ultimate strength of the rebar in compression.
- 6. Form saver type mechanical couplers shall have flanges with nailing holes to positively attach coupler to formwork.
- K. Fiber Reinforcement
 - 1. Synthetic reinforcing fiber for concrete shall be 100 percent polypropylene collated, fibrillated fibers as manufactured by Fibermesh Company of Synthetic Industries Inc., Chattanooga, TN Fibermesh or equal. Fiber length and quantity for the concrete mix shall be in strict compliance with the manufacturer's recommendations as approved by the Engineer.

2.02 FABRICATION

- A. Fabrication of reinforcement shall be in compliance with the CRSI Manual of Standard Practice and ACI SP-66.
- B. Bars shall be cold bent. Bars shall not be straightened or rebent.
- C. Bars shall be bent around revolving collar having a diameter of not less than that recommended by the ACI SP-66.
- D. Bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded, shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Surface condition, bending, spacing and tolerances of placement of reinforcement shall comply with the CRSI Manual of Standard Practice and ACI SP-66. The Contractor shall be solely responsible for providing and adequate number of bars and maintaining the spacing and clearances shown on the Drawings.
- B. Except as otherwise indicated on the Drawings, the minimum concrete cover of reinforcement shall be as follows:
 - 1. Concrete cast against and permanently exposed to earth: 3-in
 - 2. Concrete exposed to soil, water, sewage, sludge and/or weather: 2-in (Including bottom cover of slabs over water or sewage)
 - 3. Concrete not exposed to soil, water, sewage, sludge and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells and folded plate members 3/4 in.
 - b. Beams and columns (principal reinforcement, ties, spirals and stirrups) 1-1/2 in.
- C. Reinforcement which will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.
- D. No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified herein, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall comply with AWS D1.4.
- E. Reinforcing steel interfering with the location of other reinforcing steel, conduits or embedded items, may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacement of bars to avoid interference shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.
- F. Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- G. Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold-bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is

damaged, replace, Cadweld or otherwise repair as directed by the Engineer. Do not bend reinforcement after it is embedded in concrete unless specifically shown otherwise on the Drawings.

3.02 REINFORCEMENT AROUND OPENINGS

A. Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by an opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.03 SPLICING OF REINFORCEMENT

- A. Splices designated as compression splices on the Drawings, unless otherwise noted, shall be 30 bar diameters, but not less than 12-in. The lap splice length for column vertical bars shall be based on the bar size in the column above.
- B. Tension lap splices shall be provided at all laps in compliance with ACI SP-66. Splices in adjacent bars shall be staggered. Class A splices may be used when 50 percent or less of the bars are spliced within the required lap length. Class B splices shall be used at all other locations.
- C. Splicing of reinforcing steel in concrete elements noted to be "tension members" on the Drawings shall be avoided whenever possible. However, if required for constructability, splices in the reinforcement subject to direct tension shall be welded to develop, in tension, at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be offset the distance of a Class B splice.
- D. Install wire fabric in as long lengths as practicable. Wire fabric from rolls shall be rolled flat and firmly held in place. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI SP-66 but not less than 12-in. The spliced fabrics shall be tied together with wire ties spaced not more than 24-in on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.
- E. Mechanical reinforcing steel splicers shall be used only where shown on the Drawings. Splices in adjacent bars shall be offset by at least 30 bar diameters. Mechanical reinforcing splices are only to be used for special splice and dowel conditions approved by the Engineer.

3.04 ACCESSORIES

A. Determine, provide and install accessories such as chairs, chair bars and the like in sufficient quantities and strength to adequately support the reinforcement and

prevent its displacement during the erection of the reinforcement and the placement of concrete.

- B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.
- C. Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use of galvanized or plastic tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified herein.
- D. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

3.05 INSPECTION

A. In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished his/her observations of the reinforcing steel.

END OF SECTION

SECTION 03250

CONCRETE JOINTS AND JOINT ACCESORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints as shown on the Drawings and as specified herein

1.02 RELATED WORK

- A. Concrete Formwork is included in Section 03100.
- B. Concrete Reinforcement is included in Section 03200.
- C. Cast-In-Place Concrete is included in Section 03300.
- D. Concrete Finishes are included in Section 03350.
- E. Grout is included in Section 03600.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data. Submittals shall include at least the following:
 - 1. Standard Waterstops: Product data including catalogue cut, technical data, storage requirements, splicing methods and conformity to ASTM standards.
 - 2. Special Waterstops: Product data including catalogue cut, technical data, location of use, storage requirements, splicing methods, installation instructions and conformity to ASTM standards.
 - 3. Premolded joint fillers: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
 - 4. Bond breaker: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
 - 5. Expansion joint dowels: Product data on the complete assembly including dowels, coatings, lubricants, spacers, sleeves, expansion caps, installation requirements and conformity to ASTM standards.

- 6. Compressible joint filler: Product data including catalogue cut, technical data, storage requirements, installation requirements, location of use and conformity to ASTM standards.
- 7. Bonding agents: Product data including catalogue cut, technical data, storage requirements, product life, application requirements and conformity to ASTM standards.
- B. Certifications
 - 1. Certification that all materials used within the joint system is compatible with each other.
 - 2. Certifications that materials used in the construction of joints are suitable for use in contact with potable water 30 days after installation.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM A675 Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
 - 2. ASTM C881 Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - 3. ASTM C1059 Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
 - 4. ASTM D 570 Standard Test Method for Water Absorption of Plastics.
 - 5. ASTMD 624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - 6. ASTM D 638 Standard Test Method for Tensile Properties of Plastics.
 - 7. ASTM D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - 8. ASTM D 747 Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
 - 9. ASTM D 792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 10. ASTM D1751 Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).

- 11. ASTM D1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- B. U.S. Army Corps of Engineers (CRD)
 - 1. CRD C572 Specification for Polyvinylchloride Waterstops.
- C. Federal Specifications
 - 1. FS SS-S-210A Sealing Compound for Expansion Joints.
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B. All materials used together in a given joint (bond breakers, backer rods, joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and produce to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.
- C. All chemical sealant type waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used on similar structures for more than five years.

2.02 MATERIALS

- A. Standard Waterstops
 - 1. PVC Waterstops The waterstop shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. The waterstop shall be Greenstreak Group, Inc. model No. 679 or approved equal for construction joints. The waterstop shall be Sika Greenstreakmodel No.732 or approved equal for control joints and Sika Greenstreak Model No. 738 for expansion joints. Provide grommets or prepunched holes spaced at 12 inches on center along length of waterstop.
 - 2. Factory Fabrications: Provide factory made waterstop fabrications for all changes of direction, transitions, and intersections, leaving only straight butt joints of sufficient length for splicing in the field.

- B. Special Waterstops
 - 1. Retrofit PVC Waterstop The waterstop shall be made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 1750 psi. The waterstop shall conform to CRD-C572. Waterstops shall be style 667 by Sika Greenstreak or equal.
 - 2. Preformed adhesive waterstops The waterstop shall be a rope type preformed plastic waterstop meeting the requirements of Federal Specification SS-S-210A. The rope shall have a cross-section of approximately one square inch unless otherwise specified or shown on the Drawings. The waterstop shall be Synko-Flex waterstop as manufactured by Henry Company, Lockstop by Sika Greenstreak , or equal. Primer and surface preparation for the material shall be as recommended by the waterstop manufacturer.
- C. Expansion Joint Material
 - 1. Joint Material at Structures Self-expanding cork, premolded joint filler shall conform to ASTM D1752, Type III. The thickness shall be 3/4-in unless shown otherwise on the Drawings.
 - 2. Joint Material at sidewalk and roadway concrete pavements or where fiber joint filler is specifically noted on the Drawings The joint filler shall be asphalt-impregnated fiber board conforming to ASTM D1751. Thickness shall be 3/4-in unless otherwise shown on the Drawings.
- D. Bond Breaker
 - 1. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape which will satisfactorily adhere to the premolded joint filler or concrete surface as required. The tape shall be the same width as the joint.
 - 2. Except where tape is specifically called for on the drawings, bond breaker for concrete shall be either bond breaker tape or a nonstaining type bond prevention coating such as Maxi-Tilt with Dye by Dayton Superior, Inc.; Silcoseal 77, by SCA Construction Supply Division, Superior Concrete Accessories or equal.
- E. Expansion Joint Dowels
 - 1. Dowels shall be smooth steel conforming to ASTM A675, Grade 70. Dowels must be straight and clean, free of loose flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04-in on the diameter of the dowel and extends no more than 0.04-in from the end. Bars shall be coated with

a bond breaker on the expansion end of the dowel. Expansion caps shall be provided on the expansion end. Caps shall allow for at least 1-1/2-in of expansion.

- 2. Dowel Bar Sleeves: Provide two component Speed Dowel System by Sika, to accept 1" diameter x 12" long slip dowels. Speed Dowel System is comprised of a reusable base and a plastic sleeve. Both pieces shall be manufactured from polypropylene plastic.
- F. Bonding Agent
 - 1. Epoxy bonding agent shall be a two-component, solvent-free, moisture insensitive, epoxy resin material conforming to ASTM C881, Type II. The bonding agent shall be Sikadur 32 Hi-Mod by Sika Corporation of Lyndhurst, N.J.; MasterEmaco ADH 326 by BASF or equal. Acrylic may be used if approved by the Engineer.
- G. Compressible Joint Filler
 - 1. The joint filler shall be a non-extruded watertight strip material use to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 68 degrees F and subsequently recovering at least 20 percent of its original thickness in the first 1/2 hour after unloading. Compressible Joint filler shall be Wabo®Evasote, by BASF, Inc., or equal.
- H. Joint Sealant
 - 1. The joint sealant shall be a 1-component, polyurethane-based, non-sag elastomeric sealant. Joint sealant shall be Sikaflex-1a or equal.

PART 3 EXECUTION

- 3.01 INSTALLATION
 - A. Standards Waterstops
 - 1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Provide factory made waterstop fabrications for all changes in direction, intersections and transitions leaving only straight butt joints splices for the field.
 - 2. Horizontal waterstops in slabs shall be clamped in position by the bulkhead (unless previously set in concrete).
 - 3. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete. All waterstops shall be tied

to reinforcement with reinforcing tie wire through the factory provided grommets.

- 4. Waterstops shall be terminated 3-in below the exposed top of walls. Expansion joint waterstop center bulbs shall be plugged with foam rubber, 1-in deep, at point of termination.
- B. Special Waterstops
 - 1. Install special waterstops at joints where specifically noted on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Provide factory made waterstop fabrications for all changes in direction, intersections and transitions leaving only straight butt joints splices for the field.
 - 2. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of connections or splices. Connections and splices shall conform to the manufacturer's recommendations and as specified herein.
 - 3. Waterstops shall be terminated 3-in below the exposed top of walls.
- C. Construction Joints
 - 1. Make construction joints only at locations shown on the Drawings or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor, must be submitted to the Engineer for written approval. Joints shall be spaced at a maximum of 40ft O.C. unless noted otherwise on the Drawings.
 - 2. Additional or relocated joints should be located where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.
 - 3. All joints shall be perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings. When joints in beams are allowed, provide a shear key and inclined dowels as approved by the Engineer.
 - 4. Provide sealant grooves for joint sealant where indicated on the Drawings.
- 5. At all construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 1/4-in to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water-blasting or sandblasting and prepare for bonding.
- 6. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.
- 7. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the Engineer.
- D. Expansion Joints
 - 1. Do not extend through expansion joints, reinforcement or other embedded metal items that are continuously bonded to concrete on each side of joint.
 - 2. Position premolded joint filler material accurately. Secure the joint filler against displacement during concrete placement and compaction. Place joint filler over the face of the joint, allowing for sealant grooves as detailed on the Drawings. Tape all joint filler splices to prevent intrusion of mortar. Seal expansion joints as shown on the Drawings.
 - 3. Expansion joints shall be 3/4-in in width unless otherwise noted on the Drawings.
 - 4. Where indicated on Drawings, install smooth dowels at right angles to expansion joints. Align dowels accurately with finished surface. Rigidly hold in place and support during concrete placement. Unless otherwise shown on the Drawings, apply oil or grease to one end of all dowels through expansion joints. Provide plastic expansion caps on the lubricated ends of expansion dowels.
 - 5. Provide center bulb type waterstops in all wall and slab expansion joints in liquid containment structures and at other locations shown on the Drawings.
- E. Control Joints
 - 1. Provide sealant grooves, sealants and waterstops at control joints in slabs on grade or walls as detailed. Provide waterstops at all wall and slab control joints in water containment structures and at other locations shown on the Drawings.
 - 2. Control joints may be sawed if specifically approved by the Engineer. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened

sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during sawcutting.

3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Where specifically noted on the Drawings, coat the concrete surface with a bond breaker prior to placing new concrete against it. Avoid coating reinforcement or waterstops with bond breaker at these locations.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor and materials required and install cast-in-place concrete 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. 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. Modifications and Repair to Concrete are included in section 03740.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data including the following:
 - 1. Sources of cement, pozzolan and aggregates.
 - 2. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
 - 3. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 4. Water-reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 5. High-range water-reducing admixture (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.

- 6. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, concrete slump, type and manufacturer of cement. Provide either a. or b. below for each mix proposed.
 - a. Standard deviation data for each proposed concrete mix based on statistical records.
 - b. The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory tests. The cylinder strength shall be the average of the 28 day cylinder strength test results for each mix. Provide results of 7 and 14 day tests if available.
- 7. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.
- 8. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.
- B. Samples
 - 1. Fine and coarse aggregates if requested by the Engineer.
- C. Test Reports
 - 1. Fine aggregates Sieve analysis, physical properties, and deleterious substance.
 - 2. Coarse aggregates Sieve analysis, physical properties, and deleterious substances.
 - 3. Cements Chemical analysis and physical properties for each type.
 - 4. Pozzolans Chemical analysis and physical properties.
 - 5. Proposed concrete mixes Compressive strength, slump and air content.
- D. Certifications
 - 1. Certify admixtures used in the same concrete mix are compatible with each other and the aggregates.
 - 2. Certify admixtures are suitable for use in contact with potable water after 30 days of concrete curing.
 - 3. Certify curing compound is suitable for use in contact with potable water after 30 days (non-toxic and free of taste or odor).

1.04 REFERENCE STANDARDS

- A. American Concrete Institute (ACI).
 - 1. ACI 301 Standard Specification for Structural Concrete
 - 2. ACI 305.1 Standard Specification for Hot Weather Concreting.
 - 3. ACI 306.1 Standard Specification for Cold Weather Concreting.
 - 4. ACI 318 Building Code Requirements for Structural Concrete and Commentary
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33 Standard Specification for Concrete Aggregates.
 - 3. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 4. ASTM C42 Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 5. ASTM C94 Standard Specification for Ready-Mixed Concrete.
 - 6. ASTM C143 Standard Test Method for Slump of Hydraulic Cement Concrete
 - 7. ASTM C150 Standard Specification for Portland Cement
 - 8. ASTM C171 Standard Specification for Sheet Materials for Curing Concrete
 - 9. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 10. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - 11. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete.
 - 12. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

- 13. ASTM C494 Standard Specification for Chemical Admixtures for Concrete.
- 14. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- 15. ASTM C1017 Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete.
- C. Nation Ready Mixed Concrete Association (NRMCA)
- D. Where reference is made to one of the above standards, the revision in effect at the time of bid shall apply.
- 1.05 QUALITY ASSURANCE
 - A. Reinforced concrete shall comply with specifications and standards noted above. The most stringent requirement of the specifications, standards and this Section shall apply when conflicts exist.
 - B. Only one source of cement and aggregates shall be used on any one structure. Concrete shall be uniform in color and appearance.
 - C. Well in advance of placing concrete, discuss with the Engineer the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops and curing. Propose methods of hot and cold weather concreting as required. Prior to the placement of any concrete containing a high-range water-reducing admixture (plasticizer), the Contractor, accompanied by the plasticizer manufacturer, shall discuss the properties and techniques of batching and placing plasticized concrete.
 - D. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at the Contractor's expense.
 - E. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, the Contractor shall, at his/her expense, make new acceptance tests of aggregates and establish new design mixes.
 - F. Testing of the following materials shall be furnished by the Contractor to verify conformity with this Specification Section and the stated ASTM Standards.
 - 1. Fine aggregates for conformity with ASTM C33 Sieve analysis, physical properties, and deleterious substances.

- 2. Coarse aggregates for conformity with ASTM C33 Sieve analysis, physical properties, and deleterious substances.
- 3. Cements for conformity with ASTM C150 Chemical analysis and physical properties.
- 4. Pozzolans for conformity with ASTM C618 Chemical analysis and physical properties.
- 5. Proposed concrete mix designs Compressive strength, slump and air content.
- G. Field testing and inspection services will be provided by the Owner. The cost of such work, except as specifically stated otherwise, shall be paid by the Owner. Testing of the following items shall be by the Owner to verify conformity with this Specification Section.
 - 1. Concrete placements Compressive strength (cylinders), compressive strength (cores), slump, and air content.
 - 2. Other materials or products that may come under question.
- H. All materials incorporated in the work shall conform to accepted samples.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Cement: Store in weather-tight buildings, bins or silos to provide protection from dampness and contamination and to minimize warehouse set.
- B. Aggregate: Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding 3 feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.
- C. Sand: Arrange and use stockpiles to avoid contamination. Allow sand to drain to uniform moisture content before using. Do not use frozen or partially frozen aggregates.
- D. Admixtures: Store in closed containers to avoid contamination, evaporation or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.
- E. Pozzolan: Store in weather-tight buildings, bins or silos to provide protection from dampness and contamination.

- F. Sheet Curing Materials: Store in weather-tight buildings or off the ground and under cover.
- G. Liquid 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. Cement: U.S. made Portland cement complying with ASTM C150. Air entraining cements shall not be used. Cement brand shall be subject to approval by the Engineer and one brand shall be used throughout the work.

2.02 MATERIALS

- A. Materials shall comply with this Section and any applicable State or local requirements.
- B. Cement: The following cement type(s) shall be used:
 - 1. All Classes Type I/II or Type II
- C. Fine Aggregate: Washed inert natural sand conforming to the requirements of ASTM C33.
- D. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in ASTM C33 Table 2 for the specified coarse aggregate size number. Limits of Deleterious Substances and Physical Property Requirements shall be as listed in ASTM C33 Table 3 for severe weather regions. Size numbers for the concrete mixes shall be as shown in Table 1 herein.
- E. Water: Potable water free from injurious amounts of oils, acids, alkalis, salts, organic matter, or other deleterious substances.
- F. Admixtures: Admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures and shall be suitable for use in contact with potable water after 30 days of concrete curing.
 - 1. Air-Entraining Admixture: The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.

- 2. Water-Reducing Agent: The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
- 3. High-Range Water-Reducer (Plasticizer): The admixture shall comply with ASTM C494, Type F and shall result in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations. Where walls are 14 inches thick or less and the wall height exceeds 12 feet a mix including a plasticizer must be used.
- 4. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the Engineer. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.
- G. Pozzolan (Fly Ash): Pozzolan shall be Class C or Class F fly ash complying with ASTM C618 except the Loss on Ignition (LOI) shall be limited to 3% maximum.
- H. Ground-Granulated Blast Furnace Slag. Ground-granulated blast furnace slag shall conform to the following:
 - 1. ASTM C989.
 - 2. Slag activity classification: Grade 100 or 120.
- I. Sheet Curing Materials. Waterproof paper, polyethylene film or white burlap-polyethylene sheeting all complying with ASTM C171.
- J. Liquid Curing Compound. Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309, Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil. Curing compound shall be approved for use in contact with potable water after 30 days (non-toxic and free of taste or odor). Curing compound shall comply with Federal, State and local VOC limits.
- 2.03 MIXES
 - A. Development of mix designs and testing shall be by an independent testing laboratory acceptable to the Engineer engaged by and at the expense of the Contractor.
 - B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles

of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

- C. The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory, acceptable to the Engineer, engaged by and at the expense of the Contractor. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between water cementitious ratio and 7 and 28 day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.
- D. Compression Tests: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the specified design strength requirements in conformity with the above paragraph.
- E. 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.
- F. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducer (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 5 to 8 inches.
- G. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

TABLE 1 - CONCRETE MIX REQUIREMENTS						
Class	Design Strength (1)	Cement (2)	Fine Aggregate (2)	Coarse Aggreg	gate (3)	Cementitious Content (4)
А	2,500	C150 Type II	C33	57		440 min.
В	3,000	C150 Type II	C33	57		480 min.
С	4,000	C150 Type II	C33	57		560 min.
D	5,000	C150 Type II	C33	57		660 min.
Class	W/cm Ratio (5)	Fly Ash	AE Range (6)	WR (7)	HRWR (8)	Slump Range (inches)
А	0.63 max		3.5 to 5	Yes		1-4
В	0.54 max		3.5 to 5	Yes	*	1-3
С	0.44 max	25% max	3.5 to 5	Yes	*	3-5
D	0.40 max		3.5 to 5	Yes	*	3-5
NOTES:						
(1)	Minimum compressive strength in psi at 28 days.					
(2)	ASTM Designation.					
(3)	Size number in ASTM C33.					
(4)	Cementitious content in pounds/cubic yard.					
(5)	W/Cm is water-cementitious ratio by weight.					
(6)	AE is percent air-entrainment.					
(7)	WR is water-reducer admixture.					
(8)	HRWR is high-range water-reducer admixture.					
*	HRWR used at the Contractor's option except where walls are 14 inches thick or less and the wall height exceeds 12 feet, a mix including a plasticizer must be used.					

PART 3 EXECUTION

3.01 MEASURING MATERIALS

- A. Concrete shall be composed of portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and shall be produced by a plant acceptable to the Engineer. All constituents, including admixtures, shall be batched at the plant except a high-range water-reducer may also be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within 1 year of use.
- C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as-batched on printed batching tickets.
- D. Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.02 MIXING AND TRANSPORTING

- A. Batch plants shall have a current NRMCA Certification or equal.
- B. Concrete shall be ready-mixed concrete produced by equipment acceptable to the Engineer. No hand-mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.
- C. Ready-mix concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.
- Keep the water tank valve on each transit truck locked at all times. Any addition of water above the appropriate W/Cm ratio must be directed by the Engineer. Added water shall be incorporated by additional mixing of at least 35 revolutions. All added water shall be metered and the amount of water added shall be shown on each delivery ticket.
- E. All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.

- F. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Metal or metal-lined non-aluminum discharge chutes shall be used and shall have slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- G. Retempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar which has reached initial set will not be permitted.
- H. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.
- I. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Each ticket shall provide a printed record of the weight of cement and each aggregate as batched individually. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer.
- J. Temperature and Mixing Time Control
 - 1. In cold weather, do not allow the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms to drop below 40 degrees F.
 - 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, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. If necessary, substitute well-crushed ice for all or part of the mixing water.
 - 4. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the values shown in Table 2.

TABLE 2 - MAXIMUM TIME TO DISCHARGE OF CONCRETE					
Air or Concrete Temperature (whichever is higher)	Maximum Time				
80 to 90 Degree F (27 to 32 Degree C)	45 min				
	utes				
70 to 79 Degree F (21 to 26 Degree C)	60 minutes				
40 to 69 Degree F (5 to 20 Degree C)	90 minutes				

5. If an approved high-range water-reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

3.03 CONCRETE APPARANCE

- A. Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:
 - 1. The gradation of aggregate.
 - 2. The proportion of fine and coarse aggregate.
 - 3. The percentage of entrained air, within the allowable limits.
- B. Concrete for the work shall provide a homogenous structure which, when hardened, will have the required strength, durability and appearance. Mixtures and workmanship shall be such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete, when viewed in good lighting from 10-ft away, shall be pleasing in appearance, and at 20-ft shall show no visible defects.

3.04 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, excess water, dirt and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent workman

at the location of the placement who can assure that reinforcing steel and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Seal extremely porous subgrades in an approved manner.

- 2. Deposit concrete as near its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate which ensures the concrete is being 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 suitable for pumping and submit for approval.
- 4. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.
- 5. Do not place concrete for supported elements until concrete previously placed in the supporting element (columns, slabs and/or walls) has reached adequate 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 with a suitable tool to bring the full surface of the mortar against the form. Prevent the formation of excessive surface voids.
- 7. Slabs
 - a. After suitable bulkheads, screeds and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.
 - b. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.

- c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow 1 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 so as to prevent cold joints.
- 8. Formed Concrete
 - a. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4-ft. Place concrete for walls in 12 to 24-in lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 4-ft.
- 9. Underwater concreting shall be performed in conformity with the recommendations of ACI 304.1. The tremie system shall be used to place underwater concrete. Tremie pipes shall be in the range of 8 to 12-in in diameter and be spaced at not more than 16-ft on centers nor more than 8-ft from an end form. Where concrete is being placed around a pipe, there shall be at least one tremie pipe on each side of each pipe. Where the tremie system is not practical, direct pumped concrete for underwater placement may be used subject to approval of the system including details by the Engineer.
- B. Compacting
 - 1. Consolidate concrete by vibration, puddling, spading, rodding or forking so that concrete is thoroughly worked around reinforcement, embedded items and openings and into corners of forms. Puddling, spading, etc, shall be continuously performed along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.
 - 2. All concrete shall be placed and compacted with mechanical vibrators. The number, type and size of the units shall be approved by the Engineer in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job.
 - 3. A minimum frequency of 7000 rpm is required for mechanical vibrators. Insert vibrators and withdraw at points from 18 to 30-in apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.
 - 4. Concrete Slabs: Concrete for slabs less than 8-in thick shall be consolidated with vibrating screeds; slabs 8 to 12-in thick shall be compacted with

internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.

- 5. Walls and Columns: Internal vibrators (rather than form vibrators) shall be used unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
- 6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete but shall not be used to move or transport concrete in the forms. Vibration shall continue until:
 - a. Frequency 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.

3.05 CURING AND PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.
- B. Curing Methods
 - 1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Curing methods to be used are as follows:
 - a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.
 - b. Sheet Material Curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing: Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where

additional concrete is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.

- 2. Specified applications of curing methods.
 - a. Slabs for Water Containment Structures: Water curing only.
 - b. Slabs on Grade and Footings (not used to contain water): Water curing, sheet material curing or liquid membrane curing.
 - c. Structural Slabs (other than water containment): Water curing or liquid membrane curing.
 - d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.
 - e. Formed Surfaces: None if nonabsorbent forms are left in place 7 days. Water cure if absorbent forms are used. Water cure if forms are removed prior to 7 days. Exposed horizontal surfaces of formed walls or columns shall be water cured for 7 days or until next placement of concrete is made.
 - f. Surfaces of Concrete Joints: Water cured or sheet material cured.
 - g. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.
 - h. Cold Weather Concreting:
- 3. "Cold weather" is defined as a period when for more than 3 successive days, the average daily outdoor temperature drops below 40 degrees F. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight.
- 4. Cold weather concreting shall conform to ACI 306.1 and the additional requirements specified herein. Temperatures at the concrete placement shall be recorded at 12 hour intervals (minimum).
- 5. Discuss a cold weather work plan with the Engineer. The discussion shall encompass the methods and procedures proposed for use during cold

weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete. The procedures to be implemented upon abrupt changes in weather conditions or equipment failures shall also be discussed. Cold weather concreting shall not begin until the work plan is acceptable to the Engineer.

- 6. During periods of cold weather, concrete shall be protected to provide continuous warm, moist curing (with supplementary heat when required) 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 (eg: 5 days at an average 70 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.
- 7. Salt, manure or other chemicals shall not be used for protection.
- 8. The protection period for concrete being water cured shall not be terminated during cold weather until at least 24 hours after water curing has been terminated.
- C. Hot Weather Concreting
 - 1. "Hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation estimated in accordance with ACI 305.1, approaching or exceeding 0.2 lbs/sqft/hr).
 - 2. Concrete placed during hot weather, shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305.1 and the additional requirements specified herein.
 - a. Temperature of concrete being placed shall not exceed 90 degrees F and every effort shall be made to maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set or cold joints.
 - b. All necessary precautions shall be taken to promptly deliver, to promptly place the concrete upon its arrival at the job and to provide vibration immediately after placement.

- c. The Engineer may direct the Contractor to immediately cover plastic concrete with sheet material
- 3. Discuss with the Engineer a work plan describing the methods and procedures proposed to use for concrete placement and curing during hot weather periods. Hot weather concreting shall not begin until the work plan is acceptable to the Engineer.

3.06 REMOVAL OF FORMS

A. Except as otherwise specifically authorized by the Engineer, forms shall not be removed 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 3 - MINIMUM TIME TO FORM REMOVAL				
Forms For	Degree Days			
Beams and slabs	500			
Walls and vertical surfaces	100			
(see definition of degree-days in Paragraph 3.05B.6 above)				

B. Shores shall not be removed 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 construction live loads.

3.07 INSPECTION AND FIELD TESTING

- A. The batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Engineer at all times. The Contractor shall advise the Engineer of his/her readiness to proceed at least 24 hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel and the alignment, cleanliness and tightness of formwork. No placement shall be made without the inspection and acceptance of the Engineer.
- B. Sets of field control cylinder specimens will be taken by the Engineer (or inspector) during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 150 cu yds of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls.

- 1. A "set" of test cylinders consists of five cylinders: one to be tested at 7 days and two to be tested and their strengths averaged at 28 days. The fourth may be used for a special test at 3 days or to verify strength after 28 days if 28 day test results are low. The fifth is to be used at 28 days or 56 days where test results are low.
- 2. When the average 28 day compressive strength of the cylinders in any set falls below the specified design strength or below proportional minimum 7 day strengths (where proper relation between seven and 28 day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve the required strengths.
- C. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations and furnish material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Owner. Curing boxes shall be acceptable to the Engineer.
- D. Slump tests will be made in the field immediately prior to placing the concrete. Such tests shall be made in accordance with ASTM C143. If the slump is greater the specified range, the concrete shall be rejected.
- E. Air Content: Test for air content shall be made on fresh concrete samples. 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.
- F. 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.
- G. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes. The work of cutting and testing the cores will be at the expense of the Owner.
- H. See Specification Section 03900 for Leak Testing.

3.08 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 shall have the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens which failed. The cost of such additional curing shall be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In such cases of failure to meet strength requirements the Contractor and Engineer shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the Contractor in this Section.

- B. When the tests on control specimens of concrete fall below the specified strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the Engineer, in addition to other recourses, may require, at the Contractor's expense, load tests on any one of the slabs, beams, piles, caps, and columns in which such concrete was used. Tests need not be made until concrete has aged 60 days.
- C. Should the strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced.

3.09 PATCHING AND REPAIRS

- A. It is the intent of this Section to require quality work including adequate forming, proper mixture and placement of concrete and curing so completed concrete surfaces will require no patching.
- B. Defective concrete and honeycombed areas as determined by the Engineer shall be repaired as specified by the Engineer.
- C. As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed; recesses left by the removal of form ties shall be filled; and surface defects which do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.
- D. Immediately after removal of forms remove plugs and break off metal ties as required by Section 03100. Promptly fill holes upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spiderweb. Trowel smooth with heavy pressure. Avoid burnishing.

E. When patching exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with a fine Carborundum stone at an age of 1 to 5 days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

3.10 SCHEDULE

A. The following (Table 4) are the general applications for the various concrete classes and design strengths:

TABLE 4 - CONCRETE SCHEDULE					
Class	Design Strength (psi)	Description			
А	2,500	Concrete fill and duct encasement			
В	3,000	Concrete overlay slabs and pavements			
С	4,000	Walls, slabs on grade, suspended slab and beam systems, columns, grade beams and all other structural concrete			
D	5,000	Prestressed concrete			

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 shown on the Drawings and as specified herein.
- 1.02 RELATED WORK
 - A. Concrete Formwork is included in Section 03100.
 - B. Cast-In-Place Concrete is included in Section 03300.
 - C. Grout is included in Section 03600.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Concrete sealer. Confirmation that the sealer is compatible with additionally applied coatings shall also be submitted.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 Standard Specification for Concrete Aggregates.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Finishes
 - 1. For concrete which will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finishes are required and provide the proper finishes to receive these products.
 - 2. Changes in finishes made to accommodate products different from those specified shall be performed at no additional cost to the Owner. Submit

the proposed new finishes and their construction methods to the Engineer for approval.

- 3. Services of Manufacturer's Representative
 - a. Make available at no extra cost to the Owner, upon 72 hours notification, the services of a qualified field representative of the manufacturer of curing compound, sealer or hardener to instruct the user on the proper application of the product under prevailing job conditions.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Chemical hardener shall be Lapidolith by Sonneborn; Hornolith by A.C. Horn; Penalith by W.R. Meadows or equal fluosilicate base material.
- B. Concrete sealer shall be "MasterKure CC 180 WB", by Master Builders Solutions, Shakopee, MN or equal.

PART 3 EXECUTION

3.01 FORMED SURFACES

- A. Forms shall not be removed before the requirements of Section 03300, have been satisfied.
- B. Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications or corners when removing the forms or performing any other work adjacent thereto.
- C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.
- D. Rough-Form Finish
 - 1. Immediately after stripping forms and before concrete has changed color, carefully remove all fins and projections.
 - 2. Promptly fill holes left by tie cones and defects as specified in Section 03300.
- E. Rubbed Finish
 - 1. Immediately upon stripping forms and before concrete has changed color, carefully remove all fins. While the wall is still damp apply a thin coat of medium consistency neat cement slurry by means of bristle brushes to provide a bonding coat within all pits, air holes or blemishes in

the parent concrete. Avoid coating large areas with the slurry at one time.

- 2. Before the slurry has dried or changed color, apply a dry (almost crumbly) grout proportioned by volume and consisting of 1 part cement to 1-1/2 parts of clean masonry sand having a fineness modulus of approximately 2.3 and complying with the gradation requirements of ASTM C33 for such a material. Grout shall be uniformly applied by means of damp pads of coarse burlap approximately 6-in square used as a float. Scrub grout into the pits and air holes to provide a dense mortar in all imperfections.
- 3. Allow the mortar to partially harden for 1 or 2 hours depending upon the weather. If the air is hot and dry, keep the wall damp during this period using a fine, fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the edge of a steel trowel without damaging the grout in the small pits or holes, cut off all that can be removed with a trowel. (Note: Grout allowed to remain on the wall too long will harden and will be difficult to remove.)
- 4. Allow the surface to dry thoroughly and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout shall remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow sufficient time for grout to dry after it has been cutoff with the trowel so it can be wiped off clean with the burlap.
- 5. On the day following the repair of pits, air holes and blemishes, the walls shall again be wiped off clean with dry, used pieces of burlap containing old hardened mortar which will act as a mild abrasive. After this treatment, there shall be no built-up film remaining on the parent surface. If, however, such a film is present, a fine abrasive stone shall be used to remove all such material without breaking through the surface film of the original concrete. Such scrubbing shall be light and sufficient only to remove excess material without changing the texture of the concrete.
- 6. A thorough wash-down with stiff bristle brushes shall follow the final bagging or stoning operation. No extraneous materials shall remain on the surface of the wall. The wall shall be sprayed with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after the application of the repair grout.
- 7. It is the intent of this finish to provide a surface that is uniform in appearance with no blemishes, imperfections, discolorations, etc.

- F. Abrasive Blast Finish
 - 1. Coordinate with Rubbed Finish application. Do not begin until Rubbed Finish operation is complete or before concrete has reached minimum 7-day strength. The Rubbed Finish application may be deleted by the Engineer if the unfinished concrete surface is of superior quality. Apply the abrasive blast finish only where indicated on Drawings.
 - 2. Prepare a sample area of minimum 4-ft high by 16-ft wide Blast Finish as directed by Engineer on a portion of new wall construction which will not be exposed in the final work. Sample area shall contain a variety of finishes obtained with different nozzles, nozzle pressures, grit materials and blasting techniques for selection by Engineer. Final accepted sample shall remain exposed until completion of all Blast Finish operations.
 - 3. Blast finish operation shall meet all regulatory agency requirements. Blast Finish contractor shall be responsible for obtaining all required permits and/or licenses.
 - 4. Perform abrasive blast finishing in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns or variances in depths of blast as present on the accepted sample.
 - 5. Use an abrasive grit of proper type and gradation as well as equipment and technique to expose aggregate and surrounding matrix surfaces as follows:
 - a. Medium: Generally expose coarse aggregate 1/4-in to 3/8-in reveal.
 - 6. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure and blasting techniques required to match Architect's samples.
 - 7. Upon completion of the Blast Finish operation, thoroughly flush finished surfaces with clean clear water to remove residual dust and grit. Allow to air dry until curing of concrete is complete.
 - 8. After the concrete has cured for a minimum of 28 days, apply a clear acrylic sealer as directed by manufacturer.

3.02 FLOORS AND SLABS

- A. Floated Finish
 - 1. Machine Floating

- a. Screed floors and slabs with straightedges to the established grades shown on the Drawings. Immediately after final screeding, a dry cement/sand shake in the proportion of two sacks of portland cement to 350 lbs of coarse natural concrete sand shall be sprinkled evenly over the surface at the rate of approximately 500 lbs /1,000 sq ft of floor. Do not sprinkle neat, dry cement on the surface.
- b. The application of the cement/sand shake may be eliminated at the discretion of the Engineer if the base slab concrete exhibits adequate fattiness and homogeneity and the need is not indicated. When the concrete has hardened sufficiently to support the weight of a power float without its digging into or disrupting the level surface, thoroughly float the shake into the surface with a heavy revolving disc type power compacting machine capable of providing a 200 lb compaction force distributed over a 24-in diameter disc.
- c. Start floating along walls and around columns and then move systematically across the surface leaving a matte finish.
- d. The compacting machine shall be the "Kelly Power Float with Compaction Control" as manufactured by Kelley Industries of SSP Construction Equipment Inc., Pomona, CA or equal. Troweling machines equipped with float (shoe) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades will not be permitted. The use of any floating or troweling machine which has a water attachment for wetting the concrete surface during finishing will not be permitted.
- 2. Hand Floating
 - a. In lieu of power floating, small areas may be compacted by hand floating. The dry cement/sand shake previously specified shall be used unless specifically eliminated by the Engineer. Screed the floors and slabs with straightedges to the established grades shown on the Drawings. While the concrete is still green, but sufficiently hardened to support a finisher and kneeboards with no more than 1/4-in indentation, wood float to a true, even plane with no coarse aggregate visible. Use sufficient pressure on the wood floats to bring moisture to the surface.
- 3. Finishing Tolerances
 - a. Level floors and slabs to a tolerance of plus or minus 1/8-in when checked with a 10-ft straightedge placed anywhere on the slab in any direction. Where drains occur, pitch floors to drains such that

there are no low spots left undrained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other correction as directed by the Engineer.

- B. Broom Finish
 - 1. Screed slabs with straightedges to the established grades indicated on the Drawings. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a stiff bristle broom lightly across the surface in the direction of drainage, or, in the case of walks and stairs, perpendicular to the direction of traffic to provide a non-slip surface.
- C. Steel Trowel Finish
 - 1. Finish concrete as specified in Paragraph 3.04 and 3.05. Then, hand steel trowel to a perfectly smooth hard even finish free from high or low spots or other defects.
- D. Concrete Sealer
 - 1. Prepare and seal surfaces indicated on the room finish schedule to receive a sealer as follows:
 - a. Finish concrete as specified in the preceding paragraphs and in accordance with the Schedule in Paragraph 3.05 below.
 - b. Newly Placed Concrete: Surface must be sound and properly finished. Surface is application-ready when it is damp but not wet and can no longer be marred by walking workmen.
 - c. Newly-Cured Bare Concrete: Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that surface is no more than damp, and not wet.
 - d. Aged Concrete: Restore surface soundness by patching, grouting, filling cracks and holes, etc. Surface must also be free of any dust, dirt and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required, following the procedure indicated under cured concrete.
 - e. Methods: Apply sealer so as to form a continuous, uniform film by spray, soft-bristle pushbroom, long-nap roller or lambswool applicator. Ordinary garden-type sprayers, using neoprene hose, are recommended for best results.

- f. Applications: For curing only, apply first coat evenly and uniformly as soon as possible after final finishing at the rate of 200 to 400 sq ft per gallon. Apply second coat when all trades are completed and structure is ready for occupancy at the rate of 400 to 600 sq ft per gallon.
- g. To meet guarantee and to seal and dustproof, two coats are required. For sealing new concrete, both coats shall be applied full-strength. On aged concrete, when renovating, dustproofing and sealing, the first coat should be thinned 10 to 15 percent with reducer per manufacturer's directions.

3.03 CONCRETE RECEIVING CHEMICAL HARDENER

A. After 28 days, minimum, concrete cure, apply chemical hardener in three applications to a minimum total coverage of the undiluted chemical of 100 sq ft per gallon and in accordance with manufacturer's recommendations as reviewed.

3.04 APPROVAL OF FINISHES

- A. All concrete surfaces, when finished, will be inspected by the Engineer.
- B. Surfaces which, in the opinion of the Engineer, are unsatisfactory shall be refinished or reworked.
- C. After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03300 unless otherwise directed by the Engineer.

3.05 SCHEDULE OF FINISHES

- A. Concrete shall be finished as specified either to remain as natural concrete to receive an additional applied finish or material under another section.
- B. Concrete for the following conditions shall be finished as noted on the Drawings and as further specified herein:
 - 1. Concrete to Receive Dampproofing: Rough-form finish. See Paragraph 3.01D above.
 - 2. Concrete Not Exposed to View and Not Scheduled to Receive an Additional Applied Finish or Material: Rough-form finish. See Paragraph 3.01D above.
 - 3. Exterior Vertical Concrete Above Grade Exposed to View: Rubbed finish. See Paragraph 3.01E above.

- 4. Interior Vertical Concrete Exposed to View Except in Water Containment Areas: Rubbed finish. See Paragraph 3.01E above.
- 5. Vertical Concrete in Water Containment Areas. Rubbed finish on exposed surfaces and extending to two feet below normal operating water level: Rough-form finish on remainder of submerged areas. See Paragraphs 3.01E and 3.01D above.
- 6. Interior and Exterior Underside of Concrete Exposed to View: Rubbed finish. See Paragraph 3.01E above.
- 7. Exterior surfaces exposed to view and indicated to have an abrasive blast finish. See Paragraph 3.01F above.
- 8. Interior or Exterior Horizontal Concrete not Requiring Floor Hardener or Sealer: Floated finish. See Paragraph 3.02A above.
- 9. Concrete for Exterior Walks, Interior and Exterior Stairs: Broomed finish perpendicular to direction of traffic. See Paragraph 3.02B above.
- 10. Concrete Slabs On Which Process Liquids Flow or In Contact with Sludge: Steel trowel finish. See Paragraph 3.02C above.
- 11. Concrete to Receive Hardener: See Paragraph 3.03 above.
- 12. Concrete to Receive Floor Sealer: See Paragraph 3.02D above.
- 13. Concrete tank bottoms to be covered with grout: See Section 03600.

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Formwork is included in Section 03100.
- B. Concrete Reinforcement is included in Section 03200.
- C. Concrete Joints and Joint Accessories are included in Section 03350.
- D. Cast-in-Place Concrete is included in Section 03300.
- E. Masonry Grout is included in Section 04230.

1.03 SUBMITTALS

- A. Submit to the Engineer, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Commercially manufactured nonshrink cementitious grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature consideration, conformity to required ASTM standards and Material Safety Data Sheet.
 - 2. Commercially manufactured nonshrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.
 - 3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures and the proposed mix of the grout.
 - 4. Concrete grout. The submittal shall include data as required for concrete as delineated in Section 03300 and for fiber reinforcement as delineated in Section 03200. This includes the mix design, constituent quantities per cubic yard and the water/cement ratio.
- B. Laboratory Test Reports

- 1. Submit laboratory test data is required under Section 03300 for concrete to be used as concrete grout.
- C. Certifications
 - 1. Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with potable water after 30 days curing.
- D. Qualifications
 - 1. Grout manufacturers shall submit documentation that they have at least 10 years experience in the production and use of the proposed grouts which they will supply.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C531 Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes
 - 2. ASTM C579 Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes
 - 3. ASTM C827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
 - 4. ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- B. U.S. Army Corps of Engineers Standard (CRD)
 - 1. CRD C-621 Corps of Engineers Specification for Nonshrink Grout
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Qualifications
 - 1. Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.
- B. Pre-installation Conference

- 1. Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.
- C. Services of Manufacturer's Representative
 - 1. A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend the pre-installation conference and shall be present for the initial installation of each type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems.
- D. Field Testing
 - 1. All field testing and inspection services required shall be provided by the Owner. The Contractor shall assist in the sampling of materials and shall provide any ladders, platforms, etc, for access to the work. The methods of testing shall comply in detail with the applicable ASTM Standards.
 - 2. The field testing of Concrete Grout shall be as specified for concrete in Section 03300.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.
- C. Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the Owner.
- D. Nonshrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.
- E. Nonshrink epoxy grouts shall be delivered as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.07 DEFINITIONS

A. Nonshrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

PART 2 PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.
- B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

- A. Nonshrink Cementitious Grout
 - 1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD C-621. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.
 - a. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Set Grout by Master Builders, Inc.; Gilco Construction Grout by Gifford Hill & Co.; Euco NS by the Euclid Chemical Co.; NBEC Grout by U.S. Grout Corp. or equal.
 - Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders, Inc.; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp. ; Supreme Grout by Gifford Hill & Co. ; Five Star Grout by U.S. Grout Corp. or equal.
- B. Nonshrink Epoxy Grout
 - 1. Nonshrink epoxy-based grout shall be a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30 x 10-6 when tested in conformity with ASTM C531. The grout shall be MasterFlow 648 by Master Builders Inc.;
Five Star Epoxy Grout by U.S. Grout Corp.; Sikadur 42 Grout-Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co. or equal.

- C. Cement Grout
 - 1. Cement grouts shall be a mixture of one part portland cement conforming to ASTM C150, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.
- D. Concrete Grout
 - 1. Concrete grout shall conform to the requirements of Section 03300 except as specified herein. It shall be proportioned with cement, coarse and fine aggregates, water, water reducer and air entraining agent to produce a mix having an average strength of 2900 psi at 28 days, or 2500 psi nominal strength. Coarse aggregate size shall be 1/2-in maximum. Slump should not exceed 5-in and should be as low as practical yet still retain sufficient workability.
 - 2. Synthetic reinforcing fibers as specified in Section 03200 shall be added to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.
- E. Water
 - 1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

- A. Grout shall be placed over cured concrete which has attained its full design strength unless otherwise approved by the Engineer.
- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may effect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to a minimum of 1/4" amplitude or provide a raked finish in order to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or

projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

- 1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.
- D. Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of baseplates prior to the installation of the grout.
- E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24 hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the Engineer for each specific location of grout installation.
- F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- G. Construct grout forms or other leakproof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.
- H. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- I. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- J. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.02 INSTALLATION – GENERAL

- A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.

- C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours thereafter or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.
- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.
- E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.
- F. Reflect all existing underlying expansion, control and construction joints through the grout.
- 3.03 INSTALLATION CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS
 - A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.
 - B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
 - C. Placements greater than 3-in in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.
 - D. Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
 - E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
 - F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.

G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION - NONSHRINK EPOXY GROUTS

- A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.
- C. Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- F. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.05 INSTALLATION - CONCRETE GROUT

- A. Screed underlying concrete to the grade shown on the Drawings. Prepare the surface according to 3.01B. Protect and keep the surface clean until placement of concrete grout.
- B. Remove the debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.
- C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use or soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the

concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste. (A bonding grout composed of 1 part portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)

- D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated where application is at clarifier bottom. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.
- E. Provide synthetic reinforcing fibers in all applications unless steel reinforcement is indicated in the Drawings.
- F. Provide grout control joints as indicated on the Drawings.
- G. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.06 SCHEDULE

- A. The following list indicates where the particular types of grout are to be used:
- B. General purpose nonshrink cementitious grout: Use at all locations where non shrink grout is called for on the plans except for base plates greater in area than 3-ft wide by 3-ft long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.
- C. Flowable nonshrink cementitious grout: Use under all base plates greater in area than 3-ft by 3-ft. Use at all locations indicated to receive flowable nonshrink grout by the Drawings. The Contractor, at his/her option and convenience, may also substitute flowable nonshrink grout for general purpose nonshrink cementitious grout..
- D. Nonshrink epoxy grout: Use for the setting of anchor rods, anchor bolts and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.
- E. Cement grout: Cement grout may be used for grouting of incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.
- F. Concrete grout: Use for overlaying the base concrete under scraper mechanisms of clarifiers to allow more control in placing the surface grade. Use at grout fillets or grout pours greater than 4" thick.

END OF SECTION

SECTION 04230

REINFORCED UNIT MASONRY

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Provide all materials, equipment and labor required to complete the reinforced unit masonry construction in accordance with the Drawings and Specified herein. Coordinate all work with that of other trades.
- B. The work under this section includes, but is not necessarily limited to, the following:
 - 1. Split-face concrete masonry units (CMU)
 - 2. Reinforced CMU block and lintels
 - 3. Masonry reinforcing, ties, and anchors
 - 4. Grouting for masonry work

1.02 QUALITY ASSURANCE

A. Prior to construction of any masonry buildings, sample wall sections shall be constructed in location(s) approved by the OWNER, to establish a standard of quality for masonry construction for the entire Project. A sample wall section shall be constructed for each type of concrete masonry units (standard, split-face, etc.) to be used on the Project. Include 1 complete exterior and interior control joint to be caulked. Each sample wall section shall have a minimum of 50-square feet of wall face and shall be at least 6 block courses high and 12.67-feet long. For multicolored, split-face CMU sample walls, at least 3-courses shall be constructed for each color of split-face CMU to be used on the Project. The sample wall(s) will be inspected and approved by the County and shall be maintained by the Contractor throughout the length of the project for use as the "standard of quality" for comparative purposes with masonry walls constructed on the Project. Sample wall section(s) shall be removed by the Contractor upon substantial completion of the Project.

1.03 SUBMITTALS

- A. Submit shop drawings, product data, mixes, etc., in accordance with Section 01300.
- B. Submit complete shop drawings, including bar lists and placement drawings Comply with ACI 315 "Details and Detailing Concrete Reinforcement". Include elevations of all reinforced walls showing reinforcement.

- C. Submit manufacturer's certifications that all masonry units meet or exceed all specified standards.
- D. Product data for split-face CMU types indicating composition, shape, surfaces, and dimensions.
- E. Submit 3 color samples for integral colored split-faced concrete masonry units and colored mortar mixers.
- F. Submit catalog data for metal ties and anchors, joint reinforcement, and control joint material.
- G. Samples of split-face CMU illustrating face profile, color range, surface, and texture.
- H. Installation instructions.

PART 2 PRODUCTS

- 2.01 MASONRY UNITS
 - A. Split-Face concrete masonry units
 - 1. Standard and lightweight CMU shall conform to ASTM C90, Grade N, Type I, as shown on the Drawings.
 - 2. CMU shall be free from substances that will cause staining or pop-outs and shall be fine, even textured with straight and true edges. All units shall have been wet steam cured for at least 18-hours and then air cured in covered storage for not less than 28-days before delivery. Units shall have a maximum linear drying shrinkage of 0.25% (percent) (ASTM C426) and have a moisture content at time of delivery not exceeding 30% (percent) of total absorption.
 - 3. Split-face CMU's for interior and exterior walls where indicated on the Drawings, shall be as manufactured by DeMaco Corporation, Rockblock, Inc., or approved equal. Units shall have 8-inch by 16-inch nominal face size. Matching end and corner units shall be selected from samples provided by the block manufacturer. Split-face units shall be high strength units having a minimum compressive strength of 1,900-psi for any 1-unit. Minimum acceptable water absorption rate shall be 6% of the oven dry weight of the masonry unit in pounds per cubic feet. Split-face CMU's shall be factory prefinished with an integral coloring agent that is added during the mixing process. The coloring agent used for this project shall be from the same lot and batch numbers. The color for the split-face CMU's shall be selected by the County from the CMU manufacturer's standard color samples.

- 4. CMU noted as fire rated on the Drawings shall conform to Underwriters Laboratories, Inc. Standard for Concrete Masonry Units UL618, and shall have a 2-hour fire resistant rating.
- 5. All split rib CMU shall have a height minimum of 7-1/2-inch equally spaced 3/4-inch deep by 3/4-inch wide bevels. The projected face shall have a rough texture.
- 6. Units shall be obtained from 1 manufacturer to ensure even color and texture.
- 7. Provide special units required by the Drawings including solid, corner, pilaster, lintels, and jamb units.
- 8. Split-face CMU units shall be Dillon Company, Swords Creek Virginia or DeMaco Concrete Products, Sarasota Florida.
- B. Concrete Masonry Units
 - 1. CMU's for structures shall conform to ASTM C90, Grade N, Type II normal weight units with minimum compressive strength of 1,900-psi.
 - 2. Vertical Reinforcing: Provide as shown on the Drawings.
- C. Integral Water Repellent
 - 1. Provide units made with integral water repellant for exposed units. Integral water repellant to be a liquid polymeric admixture that does not reduce flexural bond strength. Integral water repellant shall be ACM Chemistries; Rainbloc, Grace Construction Products; Dry-Block or equal.

2.02 REINFORCEMENT

- A. Reinforcing Steel: ASTM Designation A615, Grade 60, unless otherwise specified. Single width reinforcement shall be ladder or truss type, fabricated with a single pair of galvanized 9-gauge side rods and continuous 9-gauge cross-rods spaced not more than 16-inches on center.
- B. Galvanized dovetailed anchor slots shall be Heavy Filled, Catalog Number 8334 by Vulcan Metal Products, Inc. or equal, and shall be 5-inches long, 16-gauge galvanized.
- C. Dovetail anchors shall be placed at 16-inches on center for anchorage to concrete framework or walls.
- D. Corrugated non-ferrous 16-gauge metal ties manufactured for use with the anchor slots provided shall be spaced at a maximum of 8-inches on center vertically and 16-inches on center horizontally.

- E. The Contractor shall provide and install miscellaneous anchors and attachment members required both for the anchorage of his own work and that of other trades requiring attachment to masonry, which are not specifically provided under separate sections.
- F. Control joints shall be factory extruded preformed styrene-butadiene-rubber compound, conforming to ASTM D2000 2AA805 and shall be as manufactured by Dur-O-Wal, Hohmann and Bernard, Inc., AA Wire Products or equal. Control joints shall be installed as shown on the Drawings.
- G. Weep holes shall be 1/4-inch outside diameter by 4-inches long, clear plastic tubing that will not strain brickwork, by Hohmann and Bernard, Inc., or equal.
- H. Cleaning compound shall be mild, non-caustic detergent solution such as 801 Super Real Clean by Superior Manufacturing Co., or 600 Sureclean by Process Solvent Co., Inc., or equal.

2.03 MASONRY LINTELS

- A. General: Provide precast or built-in-place masonry lintels in compliance with the requirements below.
- B. Built-in-place masonry lintels:
 - 1. Built-in-place lintel to be made from lintel and bond beam concrete masonry units with reinforcing bars places ad indicated and filled with grout.
 - 2. Lintels shall be of length sufficient to bear 8" on either side of opening.
 - 3. Temporarily support all built-in-place lintels until cured.
- C. Pre-cast concrete lintels:
 - 1. U-Lintel units, minimum compressive strength: 3500 psi at 28 days.
 - 2. All units shall have sand block finish
 - 3. Manufacture and tolerances shall be in compliance with PCI MNL-116, "Manual for Quality Control for Precast and Prestressed Concrete."
 - 4. Manufacturer shall rate U-lintel units for gravity, uplift, and lateral loads in units of pounds per linear foot, and provide load vs. deflection data.
 - 5. Lintels shall be of length sufficient to bear 8" on either side of opening.

2.04 MORTAR AND GROUT MATERIALS

- A. Portland Cement shall conform to ASTM C150 Type II requiring only sand and water for mixing. Masonry cements may be used for colored mortar when specifically accepted.
- B. Lime for masonry mortar shall be hydrated, conforming to ASTM C207, Type S.
- C. Sand shall be clean, durable particles, free from detrimental amounts of organic matter. The sand shall conform to the limits of ASTM C14. Sand for grout shall conform to ASTM C144 or C33 as required.
- D. Water shall be potable, free from detrimental amounts of oils, acids, alkalis, or organic matter, and shall be clean and fresh.
- E. Masonry cements used for integral colored CMU's shall be specifically approved for colored mortar. Colored mortar mixers shall be factory premixed with color pigments and Portland cement, requiring only sand and water for mixing. Colored mortar for the project shall be from the same factory lot and batch numbers. Color of the mortar mix shall be selected by the Owner from the mortar manufacturer's standard color samples.
- F. Water repellent admixture added to mortar shall match water repellent used in manufacture of split-face CMU.
- G. Strength of mortars shall exceed 1,800-pounds per square inch, when tested with 2-inch cubes at the end of a 28-day aging period.
- H. Grout for setting bearing plates, machinery, or any other non-masonry use shall be as specified in Section 03600 "Grouting."
- I. Grout
 - 1. Portland cement shall conform to ASTM C150, Type I.
 - 2. Aggregates shall conform to ASTM C144.
 - 3. Grout for constructing CMU lintel blocks and for grouting cores to receive embedded anchors or reinforcing shall conform to ASTM C476, fine or coarse grout. Strength shall be 2,500-psi minimum at 28-days. Grout will have a slump of 10-inches, plus or minus 1-inch, at time of placement.
 - 4. Concrete grout for filling structural CMU cells shall use 3/8-inch pea rock mix with a minimum compressive strength of 3,000-psi.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide formwork and shores as required for temporary support of reinforced masonry elements. Design, erection, support, bracing, and maintenance of formwork are the Contractor's responsibility.
- B. Construct formwork to conform to shape, line, and dimensions shown and sufficiently tight to prevent leakage of mortar grout or concrete.
- C. Do not remove forms and shoring until reinforced masonry member has hardened sufficiently to carry its own weight and all other reasonable temporary loads that may be placed on it during construction. Do not remove forms and shoring supporting the weight of concrete in beams, slabs, and other members until concrete has attained its specified 28-day compressive strength.

3.02 MORTAR

- A. Mortar shall be machine mixed in an approved type of mixer in which the quantity of water can be accurately and uniformly controlled. The mixing time shall not be less than 5-minutes, approximately 2-minutes of which shall be for mixing the dry materials and not less than 3-minutes for continuing the mixing after the water has been added. Where hydrated lime is used for mortar requiring lime content, the Contractor will have the option of using the dry-mix method or first converting the hydrated lime into putty.
- B. Where the dry-mix method is employed, the materials for each batch shall be well turned over together until the even color of the mixed, dry materials indicates that the cementitious material has been distributed throughout the mass, after which the water shall be gradually added until a thoroughly mixed mortar of the required plasticity is obtained.
- C. Mortar that has begun to set shall not be used.
- D. Mortar shall be used and placed in final position within 1-1/2 hours after mixing.
- E. Mortar boards and boxes shall be cleaned at the end of each days work, and all tools shall be kept clean.

3.03 LAYING CONCRETE BLOCK

- A. Do not wet concrete masonry units (CMU).
- B. Masonry shall not be laid at temperatures below 40°F, without the approval of the Owner, and all work shall be done in such a manner as to insure the proper and normal hardening of all mortar. All masonry work shall be so protected and heated that the temperature at the surface will not fall below 50°F for a period of

72-hours after placing. Any completed work found to be affected by cold weather shall be taken down and rebuilt by the Contractor at his expense.

- C. 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 be 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. Split-face CMU's shall be laid with the horizontal stringline control to the inside face of block in a full bed of mortar on all 4 sides.
- D. Masonry units shall be laid in a running bond unless otherwise shown.
- E. Sizes shall be as specified and called for on the Drawings and where "Soaps" and "Splits" are used, the space between these members and the backup material shall be slushed full of mortar.
- F. Masonry joints which are exposed to view shall be tooled in accordance with the following:
 - 1. Wait until unit mortar is thumbprint hard before tooling joint.
 - 2. Both vertical and horizontal joint spacing shall be uniform.
 - 3. Joints for CMU shall be 3/8-inch.
 - 4. Joints for structural block shall be 1/4-inch.
 - 5. Joints shall be tooled slightly concave.
 - 6. Joints for standard CMU shall be rubbed with a sponge to provide a flush, neat, rubbed joint.
 - 7. Exterior joints for split-face CMU shall be rubbed with a sponge, paddle, or Styrofoam tool to cause the joint to blend with the masonry unit's exterior split-face. Interior face joints of split-face CMU shall match standard CMU joints.
- G. Install all frames required to be set in masonry. Set masonry tightly against frames, build in and mortar in all frame anchors and fill frames solid with mortar.
- H. Control joints shall be installed at the intersection of masonry walls with structural concrete members and elsewhere as detailed on the Drawings. Joints shall be raked out to a depth of 3/4-inch for the full height or full width of the wall suitable for caulking. The maximum length, horizontally, between vertical control joints shall be 40-feet, but joints shall be located only as directed or shown. Joints shall be equal in width to the standard mortar joint.

- I. All masonry slots, chases, or openings required for the proper installation of the work of other sections shall be constructed as indicated on the Drawings or in accordance with information furnished before the work is started at the points affected. No chase shall be cut into any wall constructed of hollow units after it is built, except as directed by the County.
- J. Field cut split-face CMU with power tools to provide straight true edge and avoid damage to split-face. Do not install chipped or broken units.
- K. Exercise care that wet mortar is not splashed onto split-face during installation. Excess or splashed mortar shall be cleaned from face with a burlap wipe.
- L. During grouting, placement of foamed-in-place insulation, and application of sealants, ensures that materials are not smeared onto split-faces of CMU. Remove smeared materials as recommended by manufacturer.
- M. Surfaces shall be brushed as work progresses and maintained as clean as practical. Unfinished work shall be raked back where possible, and toothed only where absolutely necessary. Before leaving fresh or unfinished work, walls shall be fully covered and protected against rain and wind, and before continuing work, previously laid surfaces shall be swept clean. The tops of walls or other unfinished work shall be protected against all damage by frost or the elements by means of waterproof paper, tarpaulins, boards, or other means reviewed by the County.
- N. The Contractor shall build in all miscellaneous items to be set in masonry for which placement is not specifically provided under separate Divisions, including reglets, lintels, ties, electrical panel boxes, sleeves, vents, grilles, anchors, grounds and exterior electrical conduits, and fixtures, and shall cooperate with other trades whose work is to be coordinated with the work under this Section.
- O. All anchorage, attachment, and bonding devices shall be set so as to prevent slippage and shall be completely covered with mortar or grout.
- P. All ties and reinforcing for masonry shall be furnished and installed by the Contractor.
- Q. Loose lintels shall be set in a full bed of mortar and supported by solid or mortar filled hollow concrete blocks as detailed on the Drawings.
- R. Bed and grout all items coming in contact with masonry where grouting is required, including door bucks and frames set in masonry. The Contractor shall install all anchor bolts, base plates, and seats in masonry walls, and build in all items required for the completion of the building as they apply to masonry.
- S. Block work shall be laid plumb, level, and true to line and grade. Lay block within the following tolerances from specified dimensions:
 - 1. Mortar joint thickness: Bed-1/8 inch; Head- ¹/₄ inch, +3/8 inch

- 2. Variation from plumb, level, and line: $\frac{1}{4}$ inch in 10 feet, $\frac{3}{8}$ inch total
- T. Where solid CMU units are shown, lay units with full mortar head and bed joints.
- U. Walls
 - 1. Pattern Bond: Lay CMU wall units as specified in Section 04050 "Masonry." Bond and interlock each course at corners and intersections and use special-shaped units where shown, and as required for corners, jambs, sash, control joints, lintels, bond beams, and other special conditions.
 - 2. Maintain vertical continuity of core or cell cavities, which are to be reinforced and grouted, to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
 - 3. Where horizontal reinforced beams (bond beams) are shown, use special units or modify regular units to allow for placement of continuous horizontal reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells of non-reinforced vertical cells, or provide units with solid bottoms.
 - 4. Option: Where all vertical cores are not shown to be grouted, Contractor may elect to fill all vertical cores with grout, in which case, requirements for mortar bedding of cross-webs and closing of core spaces below bond beams will not apply.
- V. Columns, Piers, and Pilasters
 - 1. Use CMU of the size, shape, and number of vertical core spaces shown. If not shown, provide units which provide minimum clearances and grout coverage for number and size of vertical reinforcement bars shown.
 - 2. Provide pattern bond as shown, or if not shown, provide alternate head joints in vertical alignment.
 - 3. Where bonded pilaster construction is shown, construct wall and pilaster units together to the maximum pour height specified.

3.04 PLACING REINFORCEMENT

- A. Clean reinforcement of loose rust, mill scale, earth or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on Drawings or final shop drawings, or bars with reduced cross-section due to excessive rusting or other causes.
- B. Place reinforcement straight, centered in cells, and tied at laps and intersection of bars. Horizontal reinforcement may be placed as the masonry work progresses.

Where vertical bars are shown in close proximity, provide a clear distance between bars of not less than the nominal bar diameter or 1 inch, whichever is greater.

- C. For columns, piers, and pilasters, provide a clear distance between vertical bars as shown, but not less than 1-1/2-times the nominal bar diameter or 1-1/2-inches, whichever is greater. Provide lateral ties as shown.
- D. Splice reinforcement bars only as shown. Do not splice at other points unless approved by the Engineer. Provide lapped splices, unless otherwise shown. In splicing vertical bars or attaching to dowels, tie splices with wire.
- E. Provide not less than the minimum lap shown, or if not shown, as required by governing code.
- F. Embed metal ties in mortar joints as work progresses, with a minimum mortar cover of 5/8 inch on exterior face of walls and 1/2 inch at other locations.
- G. Anchor reinforces masonry work to supporting structure as indicated.

3.05 GROUTING

- A. Use fine grout for filling spaces less than 4 inches in both horizontal directions.
- B. Use course grout for filling 4 inch spaces or larger in both horizontal directions.
- C. Place grout within 1.5 hours from introducing water in the mixture and prior to initial set.
- D. Grouting Technique: At the Contractor's option, use either low-lift or high-lift grouting techniques subject to the requirements which follow.
- E. Consolidate grout by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.
- F. Low-Lift Grouting:
 - 1. Provide a minimum clear dimension of 2 inches and clear area of 8 sq. in. in vertical cores to be grouted.
 - 2. Place vertical reinforcement prior to laying of CMU. Extend vertical reinforcement above elevation of maximum pour height as required to allow for splicing and support it in position at vertical intervals not exceeding 192 bar diameters nor 10 feet.
 - 3. Lay CMU to maximum pour height. Limit pour height to 5 feet. If bond beam occurs below the 5 feet height stop, pour at course below bond beam.
 - 4. Preparation of Grout Spaces: Prior to grouting, inspect and clean out the grout spaces. Remove dust, dirt, mortar droppings, loose pieces of

masonry and other foreign materials from grout spaces. Clean reinforcement and adjust to proper position. Clean top surface of structural members supporting masonry to ensure bond.

- 5. Pour grout using container with spout or by chute and rod or vibrate during placing. Place grout continuously. Do not interrupt pouring of grout for more than one hour. Terminate grout pours 1 1/2-inches below top course of pour.
- 6. Bond Beams: Terminate grout in vertical cells 1 1/2-inches below bond beam course. Place horizontal reinforcement in bond beams with corners and intersections lapped as shown. Place grout in bond beam course before filling vertical cores above bond beam.
- G. High-Lift Grouting:
 - 1. Do not use high-lift grouting technique for grouting of CMU unless minimum cavity dimension and area is 3 inches and 10 sq. in., respectively.
 - 2. Provide cleanout holes in first course at all vertical cells which are to be filled with grout. Use units with one face shell removed and provide temporary supports for units above, or use header units with concrete brick supports, or cut openings in one face shell. Openings shall have a minimum area of 12 square inches and a minimum opening dimension of 3 inches.
 - 3. Construct masonry to full height of maximum grout pour specified, prior to placing grout.
 - 4. Limit grout lifts to a maximum height of 5 feet and grout pour to a maximum height of 24 feet.
 - 5. Place vertical reinforcement before grouting. Tie vertical reinforcement to dowels at base of masonry where shown and thread CMU over or around reinforcement. Support vertical reinforcement at intervals not exceeding 192 bar diameters nor 10 feet.
 - 6. Where reinforcement is prefabricated into cage units before placing, fabricate the units with vertical reinforcement bars and lateral ties of the size and spacing shown.
 - 7. Place horizontal beam reinforcement as the masonry units are laid.
 - 8. Embed lateral tie reinforcement in mortar joints where shown as masonry units are laid.
 - 9. Where lateral ties are shown in contact with vertical reinforcement bars, embed additional lateral tie reinforcement in mortar joints. Place as

shown, or if not shown, provide as required to prevent grout blowout or rupture of CMU face shells, but provide not less than No. 2 bars or 8-gauge wire ties spaced 16-inches on center for members with 20-inches or less side dimensions, and 8-inches on center for members with side dimensions exceeding 20-inches.

- 10. Preparation of Grout Spaces: Prior to grouting, inspect and clean out the grout spaces. Remove dust, dirt, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcement and adjust to proper position. Clean top surface of structural members supporting masonry to ensure bond. After final cleaning and inspection, close cleanout holes and brace closures to resist grout pressures.
- 11. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist displacement of masonry units and breaking of mortar bond. Install shores and bracing, if required, before starting grouting operations.
- 12. Place grout by pumping into grout spaces unless alternate methods are acceptable to the Engineer.
- 13. Limit grout pours to sections which can be completed in one working day with not more than one hour interruption of pouring operation. Place grout in lifts which do not exceed 5 feet. Allow not less than 30 minutes, nor more than one hour between lifts of a given pour. Vibrate each grout lift during pouring operation.
- 14. Place grout in lintels or beams over openings in one continuous pour.
- 15. Where bond beam occurs more than 1 course below top of pour, fill bond beam course to within 1-inch of vertically reinforced cavities during construction of masonry.
- 16. When more than one pour is required to complete a given section of masonry, extend reinforcement beyond masonry as required for splicing. Pour grout to within 1 1/2 inches of top course of first pour. After grouted masonry is cured, lay masonry units and place reinforcement for second pour section before grouting. Repeat sequence if more pours are required.
- 17. Grout for filled cells shall be tested.

3.06 PROTECTION

A. During erection: Cover top of walls with waterproof sheeting at end of day. Cover partially completed walls when work is not in progress. Extend 24-inches minimum down both sides and hold securely in place.

- B. Protect face of walls, sills, and other projections from roof run-off, water, mud, grout, and mortar.
- C. Spread sand or straw at base of walls to minimize dirt and clay splashed.
- D. Without damaging completed work, provide protective boards at exposed external corners, which may be damaged by construction activities.
- E. Clean installed block at the end of each work day.

3.07 CLEANING

- A. All holes in exposed masonry shall be pointed, and defective joints shall be cut out and re-pointed with mortar of same color as that of the original and adjoining work.
- B. Exposed masonry shall be protected against staining by wall coverings, and excess mortar shall be wiped off the surface as the work progresses.
- C. All masonry shall be cleaned with approved detergent solution in accordance with manufacturer's printed directions. No acid or metal scrapers shall be used on masonry.
- D. Before applying any cleaning agent to the entire wall, it shall be applied to a sample wall area of approximately 20-square feet in a location reviewed by the County. No further cleaning work may proceed until the sample area has been reviewed by the County, after which time the same cleaning materials and method shall be used on the remaining wall area.
- E. After cleaning, treat exposed split-face CMU surfaces and mortar joint sealer applied in accordance with manufacturer's instructions. Verify surfaces are clean and thoroughly dry prior to application.

END OF SECTION

SECTION 05500

MISCELLANEOUS METAL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and cut, remove, repair or otherwise modify parts of existing concrete structures or appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Concrete joint accessories are included in Section 03350.
- B. Masonry reinforcement, ties and accessories are included in Division 4.
- C. Painting and Coating is included in Division 9.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Shop drawings, showing sizes of members, method of assembly, anchorage and connection to other members. Shop drawings shall depict all equipment and existing conditions relative to the members being installed to ensure no conflicts exist.
- B. Samples
 - 1. Submit samples as requested by the Engineer during the course of construction.
- C. Design Data
 - 1. Submit calculations sealed by a professional engineer registered in the State of Florida or submit load tables and test data demonstrating that the railing and their attachments will resist the loads specified in the 2017 Florida Building Code at the post spacing provided.
 - 2. Submit manufacturer's load and deflection tables for grating.
- D. Test Reports
 - 1. Certified copy of mill test reports on each aluminum proposed for use showing the physical properties and chemical analysis.

E. Certificates

- 1. Submit certification that the railing system is in compliance with OSHA requirements and the 2017 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. ABH-21 Aluminum Brazing Handbook
 - 2. ASD-1 Aluminum Standards and Data
 - 3. DAF-45 Designation System for Aluminum Finishes
 - 4. SAA-46 Standards for Anodized Architectural Aluminum
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM A36 Standard Specification for Carbon Structural Steel.
 - 2. ASTM A48 Standard Specification for Gray Iron Castings.
 - 3. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 4. ASTM A108 Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
 - 5. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 6. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 7. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
 - 8. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes.
 - 9. ASTM A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength.
 - 10. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

- 11. ASTM A366 Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.
- 12. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- 13. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
- 14. ASTM A536 Standard Specification for Ductile Iron Castings.
- 15. ASTM A570 Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
- 16. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- 17. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
- 18. ASTM B429 Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- 19. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Caps Screws, and Studs.
- 20. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- C. American Iron and Steel Institute (AISI).
 - 1. Specification for Structural Steel Buildings.
- D. American Welding Society (AWS)
 - 1. AWS D1.1 Structural Welding Code Steel.
 - 2. AWS D1.2 Structural Welding Code Aluminum.
 - 3. AWS D1.6 Structural Welding Code Stainless Steel.
- E. Occupational Safety and Health Administration (OSHA)
- F. 2017 Florida Building Code. (FBC)
- G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- 1.05 QUALITY ASSURANCE

- A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.
- B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.
- C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B. Repair items which have become damage or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

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

2.

- A. Unless otherwise noted, materials for miscellaneous metals shall conform to the following standards:
 - 1. Structural Steel

	a.	W Shapes:	ASTM A992, Gr.50
	b.	M Shapes:	ASTM A36
	c.	S, C and MC Shapes:	ASTM A36
	d.	L Shapes:	ASTM A36
	e.	Plates, rods and Bars:	ASTM A36
HSS		lectangular Shapes:	ASTM A500, Grade B, 42 ksi

3.	HSS R	ound Shapes	ASTM A500, Grade B, 35 ksi
4.	Welde	ed 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 S	bheets	ASTM A366
6.	Gray I	ron Castings	ASTM A48, Class 35
7.	Ductil	e Iron Castings	ASTM A536, Grade 65-45-12
8.	Alumi	num Extruded Pipe	ASTM B429, Alloy 6063 T6
9.	Alumi	num Extruded Shapes	ASTM B221, Alloy 6061 T6
10.	Alumi	num Sheet and Plate	ASTM B209, Alloy 6061 T6
11.	Stainless Steel Plates, Sheets, and Structural Shapes		
	a.	Exterior, Submerged or Industrial U	se ASTM A240, Type 316 (Type 316L for welded)
	b.	Interior and Architectural Use	ASTM A240, Type 304
12.	Stainle	ess Steel Bolts, Nuts, and Washers	ASTM A276, Type 316
13.	Carbon Steel Bolts and Studs		ASTM A307, Grade A or ASTM F1154, Gr. 36 (galvanized unless noted otherwise)
14.	High Strength Steel Bolts, Nuts and washers AST Galva Class		s ASTM A325 (mechanically Galvanized per ASTM B695, Class 50, where noted)
	a.	Elevated Temperature Exposure	Type I
	b.	General Application	Type I or Type II
15.	Galva	nizing	ASTM A123 Zn w/0.5 Percent minimum Ni
16.	Galva	nizing, hardware	ASTM A153, Zn w/0.5 percent minimum

2.03 ANCHORS, BOLTS AND FASTENING

- A. Furnish anchors, bolts, fasteners, etc., as necessary for installation of the work of this section or as specified for securing the work of other sections.
- B. Anchor bolt material shall be ASTM F1154, Grade 36, or ASTM A307, Grade A standard headed bolts with heavy hex nuts, Grade A washers, hot-dipped galvanized, unless noted otherwise on drawings.
- C. Unless otherwise noted, bolts for the connection of carbon steel or iron shall be steel bolts; bolts for the connection of galvanized steel or iron shall be galvanized steel or stainless steel bolts; and bolts for the connection of aluminum or stainless steel shall be stainless steel bolts.
- D. Unless otherwise noted, expansion anchors shall be zinc plated carbon steel wedge type anchors complete with nuts and washers. Type 316 stainless steel, wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are required. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least 1-in behind the concrete reinforcing steel. Expansion anchors shall be Hilti, Kwick-bolt III; ITW Ramset; Redhead trubolt, or equal.
- E. Unless otherwise noted, adhesive anchors shall be a two-component chemical resin anchoring system. Capsules shall be self-contained, exactly premeasured amounts of polyester or vinyl ester resin, aggregate and hardener. Stud assemblies shall consist of a stainless steel type 316 all-thread anchor rod with nut and washer. Provide manufacturer's recommended installation tools for installing anchor components. Install anchors in full compliance with the manufacturer's recommendations. Adhesive anchor system shall be Hilti, HIT-RE 500-SD; Simpson Strong Tie, SET-XP Epoxy-Tie or Acrylic Tie; or approved equal.
- F. Anchors used in masonry construction shall be as indicated in Section 2.03.C above where anchors are installed into solid grouted cells. Additional, Hilti, HIY-HY150 MAX adhesive anchoring system, or approved equal, may also be used in grouted masonry construction. When fastening to hollow concrete block or brick, adhesive anchors shall be a three-part stud, screen and chemical dispenser anchoring system. Adhesive cartridges shall contain premeasured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Stud assemblies shall consist of a stainless steel type 316 all-thread anchor rod with nut and washer. Anchors shall be Hilti, HIT HY-20 System or approved equal.
- G. Automatic end welded headed anchor studs shall be flux ended studs made from cold drawn steel, ASTM A108 Grades C-1010 through C-1020. Headed anchor studs shall be Nelson, H4L Headed Concrete Anchors or equal.

- H. Machine bolts and nuts shall conform to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.
- I. Connection bolts for wood members shall be ASTM A307, galvanized where specified.
- J. Toggle bolts shall be Hilti, Toggler Bolt or equal.

2.04 METAL GRATING

- A. Grating shall have rectangular, 3/16-in thick, bearing bars spaced 1-3/16-in on center with cross bars spaced at 4-in on center. All grating panels shall be banded with a bar the same size as the bearing bars.
 - 1. Grating shall not exceed the fabricator's maximum recommended span, and meet or exceed the following load and deflection criteria for the maximum span length at the opening being covered by the grating.
 - a. The grating shall produce a deflection of 1/360 of the span or less under a uniform live load of 100 lbs/sq ft on the maximum span.
 - b. The grating shall produce a deflection of 1/360 of the span or less under a concentrated live load of 300 lbs applied at the mid point of the maximum span.
 - 2. Openings 2-in or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing bars or cross bars shall be welded to the banding bar.
 - 3. Provide trench grating with symmetrical cross bar arrangement.
 - 4. Grating clamps, nuts, bolts, washers and other fastening devices for grating and grating supports shall be Type 316 stainless steel. All grating shall be anchored to the supporting system using saddle clips.
- B. Aluminum grating material shall be aluminum alloy 6061-T6 with an anodized class I finish. Cross bars shall be attached to the bearing bars with interlocked swaged joints. The grating shall be Type BS by IKG Borden, Houston, TX; Type 19 SG-4 by Ohio Gratings, Inc., Canton, OH; Type 19S4 by Seidelhuber Metal Products, San Carlos, CA or equal.
- C. Metal frames and supports for grating shall be of the same material as the grating unless otherwise shown on the Drawings. Where aluminum supports are used, they shall be fabricated from aluminum alloy 6061-T6.

2.05 RAILINGS

- A. Guardrails and railing systems shall comply with the requirements of OSHA and the FBC and shall be custom welded pipe aluminum railing systems. All materials including rails, posts, toeboards, etc. shall have an anodized class I finish.
- B. Rails and posts shall be 6061-T6, 6063-T6, 6063-T832 or 6105-T5. Splice and reinforcing sleeves, brackets, end caps, toeboards, etc, shall be aluminum alloy 6061-T6, 6063-T6 or 6105-T5 alloy. Railing system fastening hardware shall be Type 316 stainless steel. After welding, aluminum shall be anodized. All railing, posts, toeboards and exposed aluminum shall be anodized with a clear architectural Class I satin finish providing a minimum coating thickness of 0.7 mils and a minimum coating weight of 32 milligrams per square inch in compliance with AA M10C22A41.
- C. Railings shall be 2 rail welded railing systems, as shown on the Drawings, fabricated with 1-1/2-in nominal diameter pipe. Posts shall be Schedule 80 pipe, and railing shall be Schedule 40 pipe, minimum. Posts and top rails shall be continuous. The top surface of the top railing at all points, including corners and terminations, shall be smooth and shall not be interrupted by projected fittings or posts. Spacing of posts shall not exceed 5-ft on center and shall be uniformly spaced except as otherwise shown on the Drawings. Posts will be required on each side of structure expansion joints. All railing posts shall be vertical.
- D. 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. All rail 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. Field splices shall be used in all railing panels that cross over structure expansion joints.
 - 1. Field splices shall use internal splice sleeves located within 8-in of railing posts. The sleeve shall be welded to the rail on one side and fastened with a set screw to the rail on other side. The field splice shall be detailed to take the differential expansion between the railing system and the supporting structure.

- 2. When the field splice occurs in a railing panel crossing a structure expansion joint, the sleeve shall be welded to the rail on one side and be free to slide in the rail on other side. The field splice shall be detailed to take the same movement as the structure expansion joint.
- F. The bases or supports for railing posts and handrail shall be the types indicated on the Drawings.
 - 1. Where non-removable railing is set in concrete, the posts shall be placed in 2-1/2-in diameter formed concrete openings and firmly caulked with a nonsulphur compound, hydraulic cement equal to Por-Rok by Minwax Construction Products Division Sterling Drug, Montvale, NJ. Collars shall be placed around the post bases and fastened in place with set screws on the side of the post away from the walkway. Posts shall be placed with the centerline 4-in from the edge of the concrete except that posts shall be set at the centerline of concrete curbs.
 - 2. Aluminum railing posts, which may collect condensation, shall have a 3/16-in drain hole drilled immediately above the concrete encased area, the base flange, or supporting socket on the side away from the walking area. The bottom of the rail post between the drain hole and the bottom of the post shall be filled with an inert material such as a compressed closed cell neoprene rod.
- G. Toeboards shall be provided on all railing adjacent to a drop in elevation of 4-ft or more. Toeboards are not required on the inclined portion of stairway railings or where concrete or steel curbs, 4-in or more in height, are present. Toeboards shall be 4-in high channels of the same material as the railing. The channels shall have a minimum thickness of 1/8-in and have flanges of not less than 3/4-in nor more than 1-1/2-in in width. Toeboards shall be positioned with a maximum clearance of 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. Toeboards shall not be welded to the posts. Connection to post shall allow expansion and contracting movements.
- 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.
- I. Aluminum shapes, including mounting brackets, in contact with concrete or a different type of metal shall be separated by a 1/32" neoprene gasket or provided with a heavy coating of protective zinc chromate for separation of dissimilar materials.

- J. Safety gates, for railing openings, shall be fabricated of matching pipe and rail material and configuration. The gates shall be self-closing gates with approved stop, latch and stainless steel closure spring and hinges.
- K. Barrier chains, for railing openings, shall be fabricated of stainless steel chains. Chain shall be 1/4-in stainless steel links, with eleven links per foot as manufactured by Eastern Chain Works, Inc., NY; Lawrence Metal Products, Inc. or equal. Chains shall be fastened to the handrail posts at the elevation of each rail. One end of each chain shall be connected to one post with a 1/4-in diameter stainless steel eye bolt and the other end shall be connected to the other post by means of a heavy chromium plated bronze swivel eye slide harness snap and a similar eye bolt.

2.06 ACCESS HATCHES

А. Access hatches shall have single or double leaf doors as indicated by the Drawings. The doors shall be 1/4-in aluminum diamond pattern plate with welded stiffeners, as necessary, to withstand a live load of 300 lbs/sq ft with a maximum deflection of 1/150th of the span. Hatches shall have a 1/4-in aluminum channel frame with a perimeter anchor flange or strap anchors for concrete embedment around the perimeter. Where hatch is supported by steel framing members, these members shall be modified as needed to support the hatch chosen. This includes the addition of angles, tube members, etc. Unless otherwise noted on the Drawings, use pivot torsion bars for counterbalance or spring operators for easy operation along with automatic door hold open. Hardware shall be durable and corrosion resistant with Type 316 stainless steel hardware used throughout. Provide removable lock handle. Finish shall be the factory mill finish for aluminum doors and frames with bituminous coating on the exterior of the frames in contact with concrete. Hatches shall be watertight and have a 1-1/2-in drainage coupling to the channel frame. Access hatches shall be Types as indicated on the Drawings by Bilco Company, New Haven, CT or equal.

2.07 MISCELLANEOUS ALUMINUM

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed

surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

- C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosings, and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.
- D. Angle frames for hatches, beams, grates, etc, shall be complete with welded strap anchors attached.
- E. Aluminum diamond plate and floor plate shall have a minimum thickness of 3/8in. Frames and supports shall be of aluminum construction. Fastening devices and hardware shall be Type 304 stainless steel. Plates shall have a mill finish.
- F. Stair treads for aluminum stairs shall have abrasive non-slip nosing as approved.
- G. Aluminum nosing at concrete stairs shall be Wooster Products, Inc.; Alumogrit Treads, Type 116; similar by Barry Pattern and Foundry Co.; Andco or equal. Furnish with wing type anchors and flat head stainless steel machine screws, 12in on center. Nosing shall also be used at concrete ladder openings. Nosing shall a single piece for each step extending to within 3-in at each side of stair or full ladder width. Set nosing flush with stair tread finish at concrete stairs. Furnish treads with heavy duty protective tape cover.
- H. Miscellaneous aluminum items shall have a cleaned and anodized class I finish.

2.08 MISCELLANEOUS STEEL

- A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, holddown straps and lugs, door frames,

splice plates, subframing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.

- D. Structural steel angle and channel door frames shall be shop coated with primer. Frames shall be fabricated with not less than three anchors on each jamb.
- E. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.
- F. Lintels, relief angles or other steel supporting masonry or embedded in masonry shall be shop coated with primer.
- G. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.
- H. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface.
- 2.09 MISCELLANEOUS STAINLESS STEEL
 - A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
 - B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.
 - C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.
- B. Abrasions in the shop primer shall be touched up immediately after erection. Areas left unprimed for welding shall be painted with primer after welding.
- C. Zinc coating which has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damage area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.
- D. Specialty products shall be installed in accordance with the manufacturer's recommendations.
- E. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.
- F. Install adhesive capsule anchors using manufacture's recommended drive units and adapters and in compliance with the manufacturer's recommendations.
- G. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.
- H. All railings shall be erected to line and plumb with tightly fitted joints proving smooth transitions. For mechanically fastened systems provide gaps between connecting members no greater than 1/8" unless at designated expansion joints.
- I. All steel surfaces that come into contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.
- J. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zincchromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
- K. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.
- L. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

M. Between aluminum grating, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-in thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

END OF SECTION

SECTION 07920

JOINT SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: Caulking and sealants.

1.02 SUBMITTALS

A. Submit for approval product data, samples, guarantees, and certification of all materials specified, in accordance with Section 01300.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Materials shall be stored and handled so as to prevent the inclusion of foreign matter or the damage of materials by water, heat, sunlight or breaking, and shall be stored in original containers until ready for use. Material showing evidence of damage shall be rejected.

1.04 WARRANTY AND GUARANTEES

A. Submit a written two (2) year guarantee on sealant type caulking work against joint failure. Joint failure is defined as: leaks of air or water; evidence of loss of adhesion between sealant and joint edge; evidence of loss of cohesion, fading of sealant material; migration of sealant.

PART 2 - PRODUCTS

- 2.01 MATERIALS, GENERAL
 - A. General: Sealants of formulation and qualities indicated that are recommended for applications indicated and that accommodate indicated percentage change in joint width existing at time of installation without failing either adhesively or cohesively.
 - B. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 - C. Colors: Provide color of exposed joint sealants to comply with the following:
 - 1. Provide selections made by Architect from manufacturer's full range of standard colors for products of type indicated.

2.02 EXTERIOR BUILDING JOINT SEALANTS

A. Exterior Building Joints, General: One-part silicone sealant, FS-TT-S-00230C, Type II - non-sag, Class A; color as selected:

1.	Elongation Capability	±50%
2.	Service Temperature Range	-40 to 180°F
3.	Shore A Hardness Range	20 to 35

B. Glazing Joints - Non-Structural: One-part silicone sealant, FS-TT-S-00230C, Type II, non-sag, Class A; clear:

1.	Elongation Capacity	±50%
2.	Service Temperature Range	-40 to 180°F
3.	Shore A Hardness Range	20 to 35

C. Embedded Non-Exposed Joints, Sill Members, Splice Covers, Thresholds, Etc.: One-part butyl, polyurethane or polyisobutylene sealant, complying with FS TT-S-1657, Type 1:

1.	Elongation Capacity	±5%

- 2. Service Temperature Range 0 to 180°F
- D. Exposed Horizontal Expansion Joints Subject to Pedestrian and Light Vehicular Traffic: Multi-component polyurethane sealant, self-leveling, traffic grade.

1.	Elongation Capacity	±25%
2.	Service Temperature Range	-40 to 200°F

- 3. Shore A Hardness Range 20 to 35
- E. Exposed Horizontal Control Joints Subject to Vehicular and Wheeled Traffic: Multi-component epoxy sealant, pourable, non-primed.

1.	Elongation Capacity	±10%
2.	Service Temperature Range	-40 to 200°F

3. Shore A Hardness Range 70 to 90

2.03 INTERIOR BUILDING JOINT SEALANTS

A. Interior Building Joints, General: One-part, nonsag, mildew-resistant, paintable sealant of formulation indicated:
- 1. Silicone emulsion sealant complying with ASTM C 834 and, except for weight loss measured per ASTM C 792, with ASTM C 920 that accommodates joint movement of not more than 25 percent in both extension and compression for a total of 50 percent.
- B. Acoustical Sealant for Exposed Joints: Nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:
 - 1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies per ASTM E 90.
- C. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

2.04 TAPE SEALANTS

A. Tape Sealant: Solvent-free, butyl-based tape sealant with a solids content of 100 percent formulated to be nonstaining, paintable, and nonmigrating in contact with nonporous surfaces with or without reinforcement thread to prevent stretch and packaged on rolls with a release paper on one side.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Joints:
 - 1. All joints shall be thoroughly cleaned; loose particles shall be blown out or vacuumed from joints. Material to be contacted by sealant shall be dry, fully free of laitance, loose aggregate, form release agents, curing compounds, water repellents and other surface treatments.
 - 2. Joint packing shall be installed in all joints to receive sealant where required. Packing shall be sized to require 20 to 50 percent (20% 50%) compression upon insertion, and shall be placed so that sealant depth is approximately one-half (1/2) joint width. In joints not of sufficient depth to allow packing, polyethylene bondbreaking tape shall be installed at back of joint. Lengthwise stretching of packing materials shall be avoided.
 - 3. Masking tape shall be applied where required to protect adjacent surfaces. Tape shall be adhered in continuous strips in alignment with joint edge and removed immediately after joints have been sealed and tooled.
 - 4. Joints shall be primed where required by sealant manufacturer, to receive sealant in accordance with manufacturer's instructions. Primer shall be

brushed uniformly upon all surfaces of joint. Sufficient drying time shall be allowed before caulking.

3.02 APPLICATION

- A. Sealant:
 - 1. Mixing and application of sealant shall be as recommended by sealant manufacturer.
 - 2. Material which has exceeded the manufacturer's recommended potential open time (POT Life) shall not be used.
 - 3. Sealant and caulking material shall be applied under pressure to fill joints completely with prevention of air pockets or voids. Tooling shall be performed with solvent recommended by manufacturer. Joints shall be tooled concave.
- B. Locations:
 - 1. Sealants shall be applied around penetrations of floor slabs and walls for piping, conduits, ductwork and similar items, at top of slabs and exterior face of walls, around perimeter of door frames and windows, louvers and vents, and at other locations shown on the Drawings. Thresholds shall be set in full bed of sealant.
- C. Cleaning:
 - 1. Adjacent surfaces shall be cleaned free of sealant and soiling resulting from this work and as work progresses, using solvent or cleaning agent as recommended by the manufacturer. All finished work shall be left in a neat, clean condition. Where any sealant material will permanently stain surfaces, these surfaces shall be masked out to prevent such staining.

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

A.02 SUMMARY

- A. Aluminum overhead coiling doors for chain hoist operation.
- B. Provide operating door assemblies, door curtain, guides, hardware, operators, and installation of accessories.

1.03 DEFINITIONS

A. Operation Cycle: One complete cycle of a door begins with the door in the closed position. The door is then moved to the open position and back to the closed position.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide overhead coiling doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
 - 1. Wind Load: Uniform pressure (velocity pressure) of 32 lb/sq. ft., acting inward and outward.
- B. Operation-Cycle Requirements: Design overhead coiling door components and operator to operate for not less than 20,000 cycles.
 - 1. Include tamperproof cycle counter.

1.05 SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory include details of construction relative to materials, dimensions of individual components, profiles, and finishes in accordance with Section 01300. Provide roughing-in diagrams, operating instructions, and maintenance information. Include the following:
 - 1. Setting drawings, templates, and installation instructions for built-in or embedded anchor devices.

- B. Shop Drawings: For special components and installations not dimensioned or detailed in manufacturer's data sheets.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring and between components provided by door manufacturer and those provided by others.
- C. Samples for Verification: Of each type of exposed finish required, prepared on Samples of size indicated below and of same thickness and material indicated for Work. Where finishes involve normal color and texture variations, include Sample sets showing the full range of variations expected.
 - 1. Curtain Slats: 12-inch length.
- D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

1.06 QUALITY ASSURANCE

- A. Manufacturer: Rolling doors shall be manufactured by a firm with a minimum of five years experience in the fabrication and installation of rolling doors.
- B. Installer Qualifications: Engage an experienced installer who is an authorized representative of the overhead coiling door manufacturer for both installation and maintenance of units required for this Project.
- C. Source Limitations: Obtain overhead coiling doors through one source from a single manufacturer.
 - 1. Obtain operators and controls from the overhead coiling door manufacturer.
- D. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - 1. Atlas Door Corp.; Div. of Clopay Building Products Co.
 - 2. The Cookson Company.

- 3. Cornell Iron Works Inc.
- 4. McKeon Rolling Steel Door Company, Inc.
- 5. Overhead Door Corporation.
- 6. Raynor Garage Doors.
- 7. Wayne-Dalton Corp.

Exterior Doors: Series 625 with F-265I slat, powder coat finish with color selected by Owner, by Overhead Door Corporation, or approved equal.

2.02 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtain: Fabricate overhead coiling door curtain of interlocking slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of material thickness recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
 - 1. Aluminum Door Curtain Slats. ASTM B 209 or ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
 - a. Provide slats equal to those specified above
 - 2. Insulation: Fill slat with manufacturer's standard rigid cellular polystyrene or polyurethane-foam-type thermal insulation complying with maximum flame-spread and smoke-developed indices of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within aluminum slat faces.
 - 1. Inside Curtain Slat Face: To match material of outside metal curtain slat and as follows:
 - a. Aluminum Sheet Thickness: Same thickness as outside aluminum curtain face slat.
- B. Endlocks: Malleable-iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets, or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
- C. Windlocks: Malleable-iron castings secured to curtain slats with galvanized rivets or high-strength nylon, as required to comply with wind load.
- D. Bottom Bar: Consisting of 2 angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick, aluminum extrusion to suit type of curtain slats.

- 1. Astragal: Provide a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene, between angles or fitted to shape, as a cushion bumper for interior door.
- E. Curtain Jamb Guides: Fabricate curtain jamb guides of steel angles, or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Build up units with not less than 3/16-inch- thick, galvanized steel sections complying with ASTM A 36, and ASTM A 123. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain and a continuous bar for holding windlocks.

2.03 HOODS AND ACCESSORIES

- A. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head and act as weatherseal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and fascia for any portion of betweenjamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
 - 1. Fabricate aluminum hoods, complying with ASTM B 209, alloy and temper recommended by aluminum producer, and not less than 0.032 inch thick, for aluminum doors. Hood to be painted to match curtain slats.
 - 2. Shape: Round.
 - 3. Exterior Mounted Door: Fabricate hood with sealant-joint bead profile for applying joint sealant.
- B. Weatherseals: Provide replaceable, adjustable, continuous, compressible weather-stripping gaskets fitted to bottom and at top of exterior doors, unless otherwise indicated. At door head, use 1/8-inch- thick, replaceable, continuous sheet secured to inside of curtain coil hood.
 - 1. In addition, provide replaceable, adjustable, continuous, flexible, 1/8inch- thick seals of flexible vinyl, rubber, or neoprene at door jambs for a weathertight installation.
- C. Push/Pull Handles: For push-up-operated or emergency-operated doors, provide galvanized steel lifting handles on each side of door.
 - 1. Provide pull-down straps or pole hooks for doors more than 84 inches high.
- D. Fabricate locking device assembly with lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bar to engage through slots in tracks.

- 1. Locking Bars: Single-jamb side, operable from inside only.
- 2. Provide Lock cylinder for electric operation with interlock switch.
- E. Chain Lock Keeper: Suitable for padlock.

2.04 COUNTERBALANCING MECHANISM

- A. General: Counterbalance doors by means of adjustable-tension steel helical torsion spring, mounted around a steel shaft and contained in a spring barrel connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- B. Counterbalance Barrel: Fabricate spring barrel of hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.
- C. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast-steel barrel plugs to secure ends of springs to barrel and shaft.
- D. Fabricate torsion rod for counterbalance shaft of cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
- E. Brackets: Provide mounting brackets of manufacturer's standard design, either cast-iron or cold-rolled steel plate with bell-mouth guide groove for curtain.

2.05 MANUAL DOOR OPERATORS

A. Chain Hoist Operator: Provide manual chain hoist operator consisting of endless steel hand chain, chain pocket wheel and guard, and geared reduction unit with a maximum 35-lb pull for door operation. Furnish alloy steel hand chain with chain holder secured to operator guide.

2.06 FINISHES, GENERAL

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. 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. Where surfaces are not to be painted provide manufacturer's standard anodized class I finish.

PART 3 EXECUTION

3.01 PREPARATION

A. Coordination and Measurements: Measurements shall be taken at the building to assure proper erection of the work. Check all dimensions, whether or not shown on the Drawings, upon which the accurate fitting and installation of the door may depend, or which would affect the proper operation of the door.

3.02 INSTALLATION

- A. Install overhead coiling doors in accordance with the instructions and recommendations of the manufacturer and in such a manner that will prevent damage or deformation. Doors shall be stored at the job site before installation on platforms or pallets. During storage, doors shall be stored in a weathertight area, and shall be covered to protect the door from dust, dirt and damage.
- B. Doors shall be installed plumb, level and true to line in accordance with the details shown on the approved shop drawings. Hardware shall be applied and adjusted to achieve quiet and smooth operation.
- C. Install the doors securely in appropriate frames and adjusted for proper operation without sticking or binding.
- D. Install door and operating equipment complete with necessary hardware, jamb, and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with approved shop drawings, manufacturer's instructions, and as specified herein.
- E. Upon completion of installation including work by other trades, lubricate, test and adjust doors to operate easily, free from warp, twist or distortion and fitting weathertight for the entire perimeter.

3.03 PROTECTION

A. Protect door installation from damage until the date of final acceptance. Damaged work shall be repaired or replaced to the satisfaction of the Owner and the Engineer at no additional cost to the Owner.

TILE AND MARBLE WORK

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Description: This Section specifies the furnishing and installation of ceramic tile, associated thresholds, marble window sills, and setting and grouting materials.
- 1.02 QUALITY ASSURANCE
 - A. Source Quality Control: Tile shall be quality tested, certified and bear the Certification Mark of the Tile Council of America, Incorporated hereinafter known as TCA.
 - B. Reference Standards: The Contractor shall comply with the applicable requirements on the following standards as published by TCA.
 - C. Recommended Standard Specifications for Ceramic Tile, ANSI 137.1
 - D. American National Standard Specifications for the Installation of Ceramic Tile, ANSI A108.5 and ANSI A118.4

1.03 SUBMITTALS

- A. Manufacturer's data sheets for all materials shall be submitted to establish conformance to all Specification items. Shop drawings shall be submitted in accordance with Section 01300.
- B. Samples: Three (3) individual samples shall be submitted for each of the following:
 - 1. Sample Panel: Sample panels using the materials and setting methods specified for the finished work. Panels shall be approximately 12 inches square and shall indicate the color, texture and workmanship to be expected in the finished work.
 - 2. Trim Tile Units: Each type of trim tile unit, showing size, shape, color and texture.
 - 3. Thresholds: Six inch long samples of marble threshold, showing shape, coloration and texture.
- C. Certificates: Six (6) copies shall be submitted of the Master Grade Certificate for tile, signed by the tile and manufacturer and the installer.
- D. Maintenance Materials: Maintenance materials shall be provided equal to five (5) percent of the installed quantity. Maintenance materials shall be provided in

original, unopened containers with each container identified as to location in the project.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be delivered in manufacturer's original, unopened containers, clearly labeled with the manufacturer's name and address, type, color, grade conformance seal and statement of compliance with TCA 137.1
- B. Materials shall be stored in original, unopened containers, protected from direct contact with the ground and under protection from the elements.
- C. Materials shall be handled in a manner to prevent breakage and damage to the surfaces of the tiles.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Ceramic Tile Units: Ceramic tile shall comply with ANSI 137.1, Ceramic Tile, Standard Grade. Colors and patterns shall be selected by the Engineer.
 - 1. Flat tile units for walls shall be $4\frac{1}{4}$ " x $4\frac{1}{4}$ " glazed and floors shall be 2" x 2" unglazed ceramic mosaic tile units, by 1/4 inch thickness, plainbacked, cushioned-edge uniformly mounted and of the color to be selected from standard colors
 - 2. Trim tile units shall be unglazed ceramic mosaic tile units of the same thickness and color as flat tile units. Internal corners to be coved, external corners and edges to be bullnosed.
- B. Thresholds: Thresholds shall be sound Group A white marble with a fine sand textured finish and a hardness of not less than 10.0 when tested in accordance with ASTM C 241. Marble thresholds shall be equal to the Georgia Marble Company's, White Cherokee, size and shapes as shown on the Drawings.
- C. Mortar: Dry-set Portland cement mortar for ceramic mosaic floor tile where concrete floor slab is not recessed shall conform to ANSI A 118.1 and shall be Formula 759 manufactured under license by the Tile Council of America. Containers shall bear T.C.A.- trademark and each container shall be properly identified as "Floor Mix."
- D. Thin-set materials shall be in accordance with ANSI A118.4 and as manufactured by L & M - Surco Company; the Upco Company; Jamo, Inc.; or approved equal, modified with latex additive. Latex liquid additive shall be Laticrete 4237 or equal.
- E. Grout: Grout shall be prepackaged, precolored, commercial waterproof Portland cement grout; Acid-R Grout by L & M Surco Company; Hydroment Ceramic

Tile Grout by the Ipco Company; Star Brand Acid Resistant Grout by Jamo, Incorporated; or approved equal modified by a latex additive.

- 1. Latex liquid additive shall be Laticrete 3701 as manufactured by Uniroyal Incorporated for Laticrete International Incorporated, or approved equal.
- 2. Grout mix shall be a brand of mix as approved by the manufacturer of the latex additive.
- F. Sealant: Sealant for expansion joints in tile field shall be a single-component, synthetic-rubber-base type or a two-component, rubber-base type at the option of the Contractor. Color of sealant shall be as approved to match or blend with adjacent materials. It shall have a Shore A hardness of 25 for joints in horizontal surfaces. Single-component sealant shall be non-sag type complying with Fed. Spec. TT-S-00230. Two-component sealant shall comply with Fed. Spec. TT-S-227b, Type 1, self leveling.
 - 1. Back up material for joints to receive sealant shall be flexible and compressible type as recommended by manufacturer of the sealant. Material shall be furnished in sizes and shapes indicated by joint details or as recommended by the sealant manufacturer for the size of joint and type of materials. Materials shall be non-staining and compatible with the sealants used.
- G. Bond-breaker material where required for joints to receive sealant shall be strips of polyethylene tape, wax paper or aluminum foil the same width as the joint.
- H. Cementitious Backer Units: Provide cementitious backer units at all showers complying with ANSI A118.9, of thickness and width indicated below, and in maximum lengths available to minimize end-to-end butt joints.
 - 1. Thickness: $\frac{1}{2}$ inch (12.7), unless otherwise indicated.
 - 2. Width: Manufacturer's standard width, but not less than 32 inches (813 mm).
- I. Available Products: Subject to compliance with requirements, cementitious backer units that may be incorporated into the Work, include, but are not limited to, the following:
 - 1. DomCrete Cementitious Tile-Backer Board; Domtar Gypsum.
 - 2. Util-A-Crete Concrete Backer Board; FinPan, Inc.
 - 3. DUROCK Cement Board; United States Gypsum Co.
- J. Waterproof: Waterproof cleavage membrane shall be any of the following materials at the Contractor's option.

- 1. Waterproof building felt conforming to ASTM D226, 15 lb, asphaltsaturated or ASTM D227, 13 lb. coal-tar saturated.
- 2. Reinforced asphalt paper, duplex type conforming to Fed Spec. UU-B-790A.
- 3. Polyethylene sheeting at least nominal thickness of 0.004-inch and conforming to ASTM C 156.
- K. Anti-fracture Membrane: Laticrete 9235 Anti-fracture Membranes.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Substrate surfaces shall be examined for conditions that will adversely affect the quality of the installation. Do not proceed with the installation until all adverse conditions have been corrected and the following finishes and tolerances have been provided.
 - 1. Floor Finish and Tolerance: Concrete substrate shall have a steel trowel and fine broom finish and a maximum variation of 1/8-inch in 10 feet from the required plane.
 - 2. Wall Tolerance: Substrate shall have a maximum variation of 1/8-inch by eight feet from the required plane and be plumb and true with square corners.

3.02 PREPARATION

- A. Dust, dirt, debris and oily or waxy films shall be removed in advance of tile setting operations. Standing water shall be removed and surfaces shall be allowed to dry thoroughly before starting installation.
- B. Mixing Mortar and Grout:
 - 1. Latex-Portland cement mortar and grout shall be mixed in accordance with manufacturer's printed instructions.
 - 2. Dry mortar or grout mix shall be added to the amount of latex as specified by the manufacturer and mix thoroughly to obtain complete and visually uniform wetting of the dry mix.
 - 3. Mortar consistency shall be such that when applied with the notched trowel to the backing, the ridges formed in the mortar will not flow or slump.
 - 4. Grout consistency shall be adequate to firmly bond the compressed grout to the setting mortar and the tile units.

- 5. Mortar or grout shall be remixed occasionally during use. Additional material shall not be added after initial mixing, nor shall mortar or grout be used after initial set.
- 3.03 INSTALLATION:
 - A. Workmanship shall conform to the following:
 - 1. Tiles shall be smooth cut. All tiles having jagged or flaked edges shall be discarded.
 - 2. Tiles shall be carefully fitted to all items protruding through surface, in a manner to allow cut edges to be covered by escutcheons, plates or collars.
 - 3. Tile floors shall be slightly dished at floor drains.
 - 4. The finished tile installation shall be clean and free of cracked, chipped, broken and unbonded tiles.
 - B. Setting of tile shall conform to the following:
 - 1. Tile joints shall be straight, level, perpendicular and of even width not exceeding 1/16-inch for ceramic tile. Vertical joints shall be maintained plumb for the entire height of the tile work. Damaged or defective tile shall be replaced. All work shall conform to the best current practice of the industry and shall comply with ANSI standard installation specifications A108.1 through A108.7 and Tile Council of America "Handbook for Ceramic Tile Installation".
 - 2. Floor tile to be set in dry-set mortar shall be set dry. A 1/8-inch thick (minimum) layer of dry-set mortar shall be spread on the floor surface not more than 30 minutes before covering with tile. Dry set mortar shall be combed with a 1/4-inch square notched trowel not more than 5 minutes before tile is set. Tile shall be beaten-in and leveled with uniform joints as specified above.
 - 3. Wall tile shall be set with thinset materials. Tile shall be plumb and all joints shall be straight and true.
 - 4. Tile shall be placed symmetrically, starting at center of floor or wall. Eliminate tiles of less than half full size wherever possible. Cut tiles in both floors and walls shall be located in inconspicuous locations.
 - 5. All wall and floor joints shall be aligned to give uniform lines plumb and level.

- C. Grouting shall conform to the following:
 - 1. All ceramic tile shall be grouted with a commercial Portland cement grout mixed and applied in strict accordance with the grout manufacturer's instructions. Tile joints shall be tooled slightly concave, and the mortar shall be cut off and wiped from the face of the tile. Interstices or depressions left in the mortar joints after the grout has been cleaned from the surface shall be roughened at once and filled to the spring line of the cushion edge before the mortar begins to harden.
 - 2. Ceramic floor tile shall be grouted with a thick slurry of commercial Portland cement grout mixed with a minimum amount of water, and the slurry shall be brushed or squeegeed over the floor until all joints are thoroughly filled and excess slurry removed.
 - 3. Grout shall not be installed until ceramic tile has set for a minimum of 48 hours.
- D. At all showers install cementitious backer units and treat joints to comply with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.04 CLEANING

A. At completion of installation, finished tile surfaces shall be cleaned using materials and methods as recommended by the tile manufacturer.

3.05 PROTECTION

- A. The finished installation shall be covered with a non-staining, reinforced building paper taped in place. Protective paper shall be lapped not less than six inches at joints and continuously taped at all joints.
- B. One half inch thick plywood shall be laid over protective paper in all areas to be used as passageways during subsequent construction.
- C. All traffic shall be prohibited from using tiled floors for at least three days following completion of installation.
- D. Immediately prior to final acceptance, all protective coverings shall be removed and tile surfaces washed.

PAINTING AND COATING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work:
 - 1. The Contractor shall furnish all materials, labor, equipment, and incidentals required to provide a protective coating system for the surfaces listed herein and not otherwise excluded. All surfaces described, whether new or existing, shall be included within the scope of this Section.
 - 2. The work includes painting of exterior and interior architectural surfaces (floors, walls, etc.), unless otherwise specified herein or on the Drawings. The omission of minor items in the schedule of work shall not relieve the Contractor of his obligation to include such items where they come within the general intent of the Specifications as stated herein.
 - 3. "Paint" as used herein means all coating systems, materials, including primers, emulsions, enamels, epoxies, sealers and fillers, and other applied materials whether used as a prime, intermediate, or finish coats.
- B. Related Work
 - 1. Concrete is included in Division 3.
 - 2. Metals are included in Division 5.
 - 3. For painting and coating of structures and components not specified see JEA standards Sections 427, 429, 430, 446 and 447 along with other Drawings and Specifications.

1.02 QUALITY ASSURANCE

- A. Provide the best quality grade of the various types of coatings as regularly manufactured by approved paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard, best-grade product will not be acceptable.
- B. Provide undercoat paint produced by the same manufacturer as the finish coats. Undercoat and finish coat paints shall be compatible. Use only thinners approved by the paint manufacturer, and use only within recommended limits.

C. Painting shall be accomplished by experienced painters specializing in industrial painting familiar with all aspects of surface preparations and applications required for this project. Work shall be done in a safe and workmanlike manner.

1.03 SUBMITTALS

- A. Product literature, manufacturer's specifications, and data on the proposed paint systems including detailed surface preparation, application procedures and recommended dry film thicknesses (DFT) shall be submitted in accordance with Section 01300.
- B. Schedule
 - 1. The Contractor shall submit for approval a complete Schedule of Painting Operations within 21 days after the Notice to Proceed. This Schedule is imperative so that the various fabricators or suppliers may be notified of the proper ship prime coat to apply. It shall be the Contractor's responsibility to properly notify and coordinate the fabricators' or suppliers' surface preparation and painting operations with these specifications. This Schedule shall include for each surface to be painted, the brand name, generic type, solids by volume, application method, the coverage and the number of coats in order to achieve the specified dry film thickness, and color charts. When the Schedule has been approved, the Contractor shall apply all material in strict accordance with the approved Schedule and the manufacturer's instructions. Wet and dry paint film gauges may be utilized by the Owner or Engineer to verify the proper application while work is in progress.
- C. Color Samples: Manufacturer's standard color charts for color selection by Owner.
- D. Samples:
 - 1. Paint colors will be selected by Owner. Compliance with all other requirements is the exclusive responsibility of the Contractor.
 - 2. Samples of each finish and color shall be submitted to the Owner or Engineer for approval before any work is started.

1.04 DELIVERY, HANDLING AND STORAGE

- A. Deliver all materials to the job site in original, unopened packages and containers bearing manufacturer's name and label in accordance with Paragraph 2.02: Material and Equipment.
 - 1. Provide labels on each container with the following information:
 - a. Name or title of material.

- b. Fed. Spec. number if applicable.
- c. Manufacturer's stock number, date of manufacture and expiration date
- d. Manufacturer's formula or specification number.
- e. Manufacturer's batch number.
- f. Manufacturer's name.
- g. Generic type.
- h. Contents by volume, for major pigment and vehicle constituents.
- i. Application instructions: thinning, ambient conditions, etc.
- j. Color name and number.
- 2. Containers shall be clearly marked to indicate any hazards connected with the use of the paint and steps which should be taken to prevent injury to those handling the product.
- B. All containers shall be handled and stored in such a manner as to prevent damage or loss of labels or containers.
- C. The Contractor shall designate areas for storage and mixing of all painting materials. Store only acceptable product materials on project site. Restrict storage to paint materials and related equipment. Storage of paint materials and related equipment shall comply with the requirements or pertinent codes and fire regulations. In addition, all safety precautions noted on the manufacturer's Material Safety Data Sheets and other literature shall be strictly followed. Proper containers located outside of buildings shall be provided by the Contractor and used for painting wastes. No plumbing fixtures shall be used for this purpose.
- D. All paint and coatings materials shall be stored under cover and at a temperature within 10°F of the anticipated application temperature and at least 5°F above the dew point.
- E. Used rags shall be removed from the buildings every night and every precaution taken against spontaneous combustion.

1.05 WARRANTY AND GUARANTEES

- A. Warranty period shall be two (2) years after acceptance by the Owner.
- B. All paint and coatings work performed under these specifications shall be guaranteed by the coatings applicator for 100 percent of the total coated area for both materials and labor against failures during the warranty period.

C. Failure under this warranty shall include flaking, peeling, or delaminating of the coating due to aging, chemical attack, or poor workmanship; but it shall not include areas which have been damaged by unusual chemical, thermal, or mechanical abuse.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All paint systems shall be manufactured by Tnemec, Carboline, or an approved equal, and shall be their highest grades of paint.
- B. The following coating systems list a product by name to establish a standard of quality; other products of the same generic types may be submitted to the Engineer for approval as described in Paragraph 1.04., herein. When other than the specified coating system is proposed, the Contractor shall submit on a typewritten list giving the proposed coatings, brand, trade name, generic type and catalog number of the proposed system for the Engineer's approval.
- C. Paint used in successive field coats shall be produced by the same manufacturer. Paint used in the first field coat over shop painted or previously painted surfaces shall cause no wrinkling, lifting, or other damage to underlying paint. Shop paint shall be of the same type and manufacture as used for field painting by the Contractor.
- D. Emulsion and alkyd paints shall contain a mildewcide and both the paint and mildewcide shall conform to OSHA and Federal requirements, including Federal Specification TT-P- 19.
- E. Finish coats containing lead shall not be allowed. Oil shall be pure boiled linseed oil.
- F. Rags shall be clean painter's rags, completely sterilized.

2.02 MATERIALS AND EQUIPMENT

- A. Exterior Masonry, Concrete:
 - 1. Prepare surfaces to SSPC-SP13 (with cleaning and surface preparation) and as recommended by the painting system manufacturer.
 - 2. The prime coat shall be Tnemec S54 Fine Masonry Filler or equal epoxy applied at 75 to 100 square feet per gallon. Actual coverage may be less than the minimum stated depending on the porosity of the substrate to be coated.
 - 3. The intermediate and finish coat shall be Tnemec S180 W. B. Tneme-Crete high quality acrylic latex, 4.0 – 6.0 mils DFT per coat.

- 4. Total minimum system finish coating thickness shall be 8 mils DFT.
- B. Interior Masonry or Concrete:
 - 1. Prepare surfaces to SSPC-SP13 and as recommended by the painting system manufacturer.
 - 2. The prime coat for existing and new masonry walls shall be Tnemec S54 Fine Masonry Filler or equal epoxy applied at 75 to 100 square feet per gallon. Actual coverage may be less than the minimum stated depending on the porosity of the substrate to be coated.
 - 3. The intermediate and finish coat for concrete and masonry walls shall be Tnemec S66 high quality acrylic latex, 4.0 6.0 mils DFT per coat.
 - 4. Total minimum system finish coating thickness shall be 8 mils DFT.
- C. Interior Gypsum Board:
 - 1. The prime coat for gypsum board walls shall be Tnemec S51-792 , 1.0 1.5 mils DFT.
 - 2. The intermediate and finish coat for gypsum board walls shall be Tnemec S66 high quality acrylic latex, 4.0 6.0 mils DFT per coat.
 - 3. Total minimum system finish coating thickness shall be 8 mils DFT.
- D. Ferrous Metal:
 - 1. Prepare surfaces to SSPC-SP6, Commercial Blast Cleaning, 1.5-3 mils anchor profile.
 - 2. Prime coat shall be 1 coat of Corotech V155 Pre-primer by Benjamin Moore.
 - 3. Final coat shall be 1 coat of Corotech V440 waterborne amine epoxy with Corotech V630 aggregate by Benjamin Moore.
- E. Concrete Floor:
 - 1. Prepare surfaces to SSPC-SP13 and as recommended by the painting system manufacturer.
 - 2. Prime coat shall be 1 coat of Carbogaurd 60 at 4.0 to 6.0 mils DFT. Surface shall be prepared to SSPC-SP.
 - 3. Final coat shall be 2 coats of Carboguard 60 at 4.0 to 6.0 mils DFT each coat.

2.03 SPARE PAINT

A. Upon completion of painting, the Owner shall be furnished at no additional cost, unopened containers providing a minimum of one (1) gallon of each type and color of finish paint for touching up. Multi-component coatings shall have each component supplied in separate containers boxed together. Paint container labels shall be complete with manufacturer's name, generic type, number, color, and location where used.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Mix and prepare painting materials in strict accordance with manufacturer's recommendations and directions, stirring materials before and during application to maintain a mixture of uniform density, free of film, dirt and other foreign materials.
- B. No thinners shall be used except those specifically mentioned and only in such quantity as directed by the manufacturer in his instructions. If thinning is used, sufficient additional coats shall be applied to assure the required dry film thickness is achieved. The manufacturer's recommended thinner or cleanup solvent shall be used for all clean-up. Application by brush, spray, airless spray or roller shall be as recommended by the manufacturer for optimum performance and appearance.
- C. All dirt, rust, scale, splinters, loose particles, disintegrated paint, grease, oil, and other deleterious substances shall be removed from all surfaces which are to be coated.
- D. Hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items and surfaces not to be painted which are in contact with or nearby surfaces to be painted shall be removed, masked, or otherwise protected prior to surface preparation and painting operations. Refer to Paragraph 3.09B.
- E. Before commencing work, the painter must make certain that surfaces to be covered are in perfect condition and must obtain Engineer's approval to proceed. Should the painter find such surfaces impossible of acceptance, he shall report such fact to the Engineer. The application of paint shall be held as an acceptance of the surfaces and working conditions and the painter will be held responsible for the results reasonably expected from the materials and processes specified.
- F. Schedule the cleaning and painting so contaminants from the cleaning process will not fall onto wet, newly-painted surfaces.
- G. Mix and prepare painting materials in strict accordance with manufacturer's recommendations and directions, stirring materials before and during

application to maintain a mixture of uniform density, free of film, dirt, and other foreign materials.

H. Except where otherwise specified, thinning shall be done only if necessary for the workability of the coating material and then, only in accordance with the coating manufacturer's most recent printed Application instructions. Use only thinner provided by coating manufacturer. If thinning is used, sufficient additional coats shall be applied to assure the required dry film thickness is achieved. The manufacturer's recommended thinner or cleanup solvent shall be used for all clean-up. Application by brush, spray, airless spray or roller shall be as recommended by the manufacturer for optimum performance and appearance.

3.02 APPLICATION

- A. All painting shall be done by skilled and experienced craftsmen and shall be of highest quality workmanship. Coating systems shall be as specified herein.
- B. Apply paint in accordance with the manufacturer's directions. Use applicators and techniques best suited for the type of material being applied.
- C. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, until the paint film is of uniform finish, color, and appearance.
- D. Paint shall be applied in a neat manner with finished surfaces free of runs, sags, ridges, laps, and brush marks. Each coat shall be applied in a manner that will produce an even film of uniform and proper thickness.
- E. Paint back sides of access panels and removable or hinged covers to match the exposed surfaces.
- F. Equipment manufacturer or supplier shall provide touch-up paint for items with shop applied finish coats.
- G. Where specified in the individual sections, primer coat(s) shall be applied in the shop by the equipment manufacturer. The shop coats shall be as specified and shall be compatible with the field coat or coats.
- H. Paint all exposed surfaces in rooms scheduled for painting whether or not colors are designated in schedules, except where the natural finish of material is obviously intended and specifically noted as a surface not be painted. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas. If color of finish is not designated, the Engineer will select these from standard colors available for the materials systems as specified.
- I. The following items will not be painted unless otherwise noted:

- 1. Any code-requiring labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature plates.
- 2. Plastic switch plates and receptacle plates.
- 3. Signs and nameplates.
- 4. Finish hardware.
- J. Comply with manufacturer's recommendations and as indicated herein as to the environmental conditions under which coatings and coating systems can be applied. The conditions below shall be adhered to even if manufacturer's recommendations are less stringent. If manufacturer's recommendations are more stringent, they shall apply.
 - No coatings shall be applied when the air, surface, and material 1. temperature is below 55°F or above 95°F for 24 hours prior to and 24 hours after coating application. Surface temperature shall be at least 5°F above the dew point for 24 hours prior to and 24 hours after coating The dewpoint shall be determined by use of a sling application. psychrometer in conjunction with U.S. Weather Bureau psychometric tables. Do not apply coatings when the relative humidity exceeds 85 percent or to damp or wet surfaces, unless otherwise permitted by the coating manufacturer's printed instructions. No painting shall be done when the surfaces may become damaged by rain, fog or condensation or when it is anticipated that these conditions will prevail during the drying period, unless suitable enclosures to protect the surface are used. Where heat is necessary, it shall be supplied by the painting applicator and shall be of such type that it will maintain an air and coated surface temperature of 55°F minimum prior to and after the coating application as described above, and 90°F minimum during the cure stage if hot air forced curing is recommended by the coating manufacturer for special coatings. Further, this heater shall be of such type as not to contaminate the surface area to be or being coated with combustion products. The Contractor shall supply utilities to run electric or gas heaters. Any surface coating damaged by moisture or rain shall be removed and redone as directed by the Owner or Engineer.
 - 2. Do not apply finish in areas where dust is being or will be generated during application through full cure.
 - 3. All exterior painting shall be done only in dry weather.
 - 4. Spray application shall occur only when wind velocities, including gusts, are less that 10 miles per hour. All materials, equipment, etc. in the vicinity of spray application shall be protected from overspray.

- 5. Application of materials shall be done only on properly prepared surfaces as herein specified. Between any two coats of material, unless specifically covered in the coating manufacturer's most recent printed application instructions, if more than one (1) week passes between subsequent coats, the coating manufacturer will be contacted for his recommended preparation of the surface prior to application of the next coat. This preparation might include brush-off blasting, steam cleaning, or solvent wiping (with an indicated solvent) and shall be specified in writing by the material supplier and followed by the applicator. Any surface coating damaged by moisture or rain shall be removed and redone as directed by the Owner or Engineer.
- 6. In no case shall paint be applied to surfaces which show a moisture content greater than 14 percent. The presence of moisture shall be determined prior to coating by testing with a moisture detection device such as a Delmhorst Model DLM2E.
- K. The minimum coating thicknesses shall be as follows:
 - 1. Coating thickness shall meet or exceed the specified minimum dry film thickness (DFT) in all areas. The average coating thickness as determined by multiple representative DFT measurements shall meet or exceed the mid-point of DFT range. If below this DFT value, the surface shall be recoated with at least the minimum DFT until the total DFT meets or exceeds the mid-point DFT.
 - 2. Coverage rates are theoretical as calculated by the coating manufacturer and are, therefore, the maximum allowable.
 - 3. Apply a prime coat to material which is required to be painted or finished, and which has not been prime coated by others.
 - 4. 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.
 - 5. Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.

TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Extent of each type of toilet accessory as indicated on Schedules on Drawings.
- B. Types of toilet accessories required include:
 - 1. Waste receptacle unit.
 - 2. Grab bar.
 - 3. Soap dispenser.
 - 4. Miscellaneous accessories.
- C. Related Sections: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01300, covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Manufacturer's technical data and installation instructions for each toilet accessory.

1.03 QUALITY ASSURANCE

- A. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Toilet and Bath Accessories:
 - a. Bobrick Washroom Equipment, Inc.
 - b. A&J Washroom Accessories.
 - c. American Specialties, Inc.
 - d. Bradley Corporation.
 - e. Franklin Brass Manufacturing Co.
 - f. McKinney/Parker, Inc.

2.02 MATERIALS

- A. Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 22 gauge (0.034 inch) minimum, unless otherwise indicated.
- B. Chromium Plating: Nickel and chromium electro-deposited on base metal, ASTM B 456, Type SC 2.
- C. Mirror Glass: FS DD-G-451, Type I, Class 1, Quality q2, 1/4-inch thick, with silver coating, copper protective coating, and non-metallic paint coating complying with FS DD-M-411.
- D. Galvanized Steel Mounting Devices: ASTM A 153, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit or of galvanized steel where concealed.

2.03 WASTE RECEPTACLE UNITS

- A. Waste Receptacle: 18-8 S, type-304, 22-gauge (0.8mm) stainless steel with satin finish. Front and side edges of bottom and all top edges are hemmed for safe handling. Secured to cabinet with a tumbler lock keyed like other Bobrick washroom accessories. Capacity: 12-gal. (45.4-L).
- B. Location: Provide one in each toilet room unless otherwise indicated.

2.04 SURFACE MOUNTED ROLL TOWEL DISPENSER UNITS

- A. Surface Mounted Unit: Tork Elevation matic Model 5510282
- B. Location: Provide one in each toilet room unless otherwise indicated.

2.05 GRAB BARS

- A. Stainless Steel Type: The grab bars shall meet the requirements as set forth by the State of Michigan for making facilities accessible for the physically handicapped. Provide grab bars with wall thickness not less than 18 gauge (0.050-inch), 48 inches long, and as follows:
 - 1. Mounting: Concealed, manufacturer's standard flanges and anchorages.
 - 2. Clearance: 1-1/2-inch clearance between wall surface and inside face of bar.
 - 3. Gripping Surfaces: Smooth, satin finish.
- B. Location: Provide 3 at each ADA compliant toilet, and 1 at each ADA compliant shower unless otherwise indicated.

2.07 SOAP DISPENSERS

- A. Surface Mounted Soap Dispenser: GOJO FMX-12 Dispenser Black-SKU 5155-06.
- B. Location: Provide 1 at each sink in toilet room unless otherwise indicated.

2.08 TOILET PAPER DISPENSERS

- A. Surface Mounted toilet paper Dispenser: Tork Twin Jumbo Bath Tissue Roll Dispenser, Article 247549A, Color: Black, SCC: 10073286622393.
- B. Location: Provide 1 at each toilet in toilet room unless otherwise indicated.

2.08 FABRICATION

- A. Only an unobtrusive stamped logo of manufacturer, as approved by ENGINEER, is permitted on exposed face of toilet or bath accessory units. On either interior surface not exposed to view or back surface, provide additional identification by means of either a printed, waterproof label or a stamped nameplate indicating manufacturer's name and product model number.
- B. Surface Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints and exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.

C. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install toilet accessory units in accordance with manufacturer's instructions using fasteners which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

3.02 ADJUSTING AND CLEANING

- A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.
- B. Clean and polish all exposed surfaces after removing temporary labels and protective coatings.

SLUICE GATES

PART 1 GENERAL

1.01 SCOPE OF WORK:

A. The work to be performed under this Section shall include furnishing all labor, materials, tools and equipment necessary to install and test all sluice gates, consisting of, but not limited to frames, discs, seals, stems, operators, floor stands, stem guides, anchorage, and all other appurtenances, in place and complete, as manufactured by:

Alfa Laval, Inc., Houston, Texas. (800) 362-9041.

1.02 RELATED WORK:

- A. Concrete Work is included under Division 3
- B. Painting and Coatings are included under Section 09900

1.03 SUBMITTALS:

- A. Submittals shall be in accordance with Section 01300. In addition, the following specific information shall be provided.
- B. Materials and Shop Drawings:
 - 1. Copies of all materials required to establish compliance with the specifications shall be submitted to the Engineer. Submittals shall include the following:
 - a. Certified shop and erection drawings to scale based on laying schedule and data regarding sluice gates.
 - b. Literature on drawings describing the equipment and showing all-important details of construction and dimensions.
- C. Operating Instructions: Operating and maintenance instructions for each type of sluice gate shall be furnished to the Engineer.
- D. Installation: The manufacturer shall provide installation instructions. The installation and adjustment of gates, operators and all accessories shall be in full accordance with these instructions. The sluice gates shall be installed by the best practices and methods.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. All equipment shall be delivered in suitable packaging, cases, or crates and stored or placed in the appropriate manner. Each package shall have an identifying mark and a complete list showing contents.

1.04 APPLICABLE PUBLICATIONS:

- A. The following publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS.
- C. AMERICAN WATER WORKS ASSOCIATION (AWWA) C563 Standard for Composite Slide Gates.

1.05 WARRANTY AND GUARANTEE:

- A. The Manufacturer shall guarantee the sluice gates, when installed and operated as recommended by the Manufacturer, trouble-free operation for a period of ten (10) years. If the Owner or Engineer is not completely satisfied with the performance of the product, the Manufacturer shall remedy the problem at no cost or refund the materials and installation cost upon the return of the equipment The Manufacturer shall guarantee the following:
- B. Leakage shall be no more than that allowed by the AWWA C563 Standard during the guarantee period.
- C. Door (disc) shall be free of sticking or binding as judged by the Engineer (move freely via operator provided) with no exercising required. Gate operators are to be warranted by the operator manufacturer per their standard warranty.
- D. No exception or revision shall be taken to the warranty.
- 1.06 OTHER:
 - A. All gates shall be fully assembled in their frames except for operators, guides, stem-extension, and stem covers or concrete-mounted pedestals. Where required by shipping constraints or installation constraints, frame may be partially assembled such that the top may be easily mounted to the bottom containing the disc. In such cases, reassembly and installation shall be performed under the supervision of Manufacturer's representative and at no additional cost to OWNER.
 - B. Any seal that needs replacement in less than 20 years shall not be acceptable. No part of the seal attached to the Disc or mounted to the frame shall protrude into the clear opening.

C. All sluice gates shall be supplied by the same manufacturer, who shall be fully experienced, reputable and qualified in the manufacturing of the specified equipment. The manufacturer of the specified equipment will have built specified equipment and show installations of fully and partially assembled gates in the US both in excess of ten (10) years.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Sluice gates shall be designed for the seating and unseating heads as listed in the gate schedule below. Sluice gates shall exceed the standard of AWWA C563. Exceeding the conformance to AWWA C563 applies to discs and frames with a safety factor of five (5) with regard to tensile, compressive and shear strength and with the requirement that all gates will yield no more leakage than shown in Section 6.8 (AWWA) Field Leakage Test. Materials of construction shall be suitable for the environment in which the sluice gates shall be installed and operated.

	OPENING SIZE	DISC ELEV	MAX HEAD (FT)		PEDESTAL FLOOR ELEV	OPERATOR
ID	(INCHES)	(FT)	SEAT	UNSEAT	(FT)	TYPE
SG-001	36 x 36	-7.12	10.24	11.72	8.90	Hand Crank
SG-002	36 x 36	-7.12	10.245	11.72	8.90	Hand Crank

B. Sluice gate design criteria are in accordance with the following schedule:

- C. Frames: Frames shall be 316LSS with a 5/16" minimum metal thickness for all items. Frames are wall mounted against a 1" nominal grout base; no thimbles or flanges are needed or included.
- D. Slides (Discs): Slides shall be constructed with a reinforced rigid composite skin, having a minimum thickness of 1/8-inch on the outside. Slide (disc) shall have an internal matrix of carbon steel. The total minimum slide thickness should not be less than 2". The slide (disc) outer surface skins shall be an Aramid fiber from the KEVLAR family of fibers and shall be designed to limit the deflection to a maximum of 1/1000 of the span under design head conditions based upon horizontal support members only. Fiber Reinforced Plastic, Glass Reinforced Plastic, plastic coated steel or externally reinforced slide (disc) shall not be acceptable. All welds on the slide shall be continuously welded and no stitch welding to be allowed. Manufacturer shall submit drawings and comprehensive design criteria to substantiate that the required deflection figure for each door has been achieved. Safety factors shall be calculated for the disc under maximum head, and shear at the disc/seal interface. No substitute of fiber type will be acceptable.

- E. Fiber reinforced plastic (FRP), glass reinforced plastic (GRP), plastic-coated steel or externally-reinforced slide (disc) shall not be acceptable. All welds on the slide shall be continuously welded and no stitch welding shall be allowed.
- F. Rigid Polyurethane foam shall be used as filler between the steel grid reinforcing system and shall be a min. of 7 LB density/cu.ft.
- G. Seals: The sealing arrangement for the reinforced plastic sluice gates shall comprise of sealing faces and side guides constructed of ultra high molecular weight polyolefin having an extremely low coefficient of friction and a backing constructed of highly resilient expanded neoprene. Guides and seating of the gate shall be easily adjustable (min. 5/8-inch). All moving contact surfaces shall be compatible to each other thereby minimizing sticking/ jamming and making the operation easy. Leakage rates shall be one-half (1/2) of the rate allowed by AWWA C563.

Tensile Strength	15,400		
Young's Modulus	1,756,000 psi		
Flexural Strength	28,000 psi		
Flexural Modulus	1,497,000 psi		
Compressive Strength	30,200 psi		
Impact Strength	9.65 ft-lb/in		
Water Absorption	0.09 %		
Specific Gravity	1.72		
Coefficient of Thermal Expansion	1.6 x 10 ⁻⁵ per C		
Heat Distortion Point	80 degrees C ASTM D648		
Low Temperature Impact Strength	93% @ -20 C		
Notch Sensitivity	Not notch sensitive		
Weathering Properties	Excellent		
Fire Resistance	Class 1 Spread of Flame, Rating BS476: Part 1: 1953 self-extinguishing, ASTM D635 - 56R		
Chemical Resistance	Organics, Alkaline, Ozone (2 to 3 PPM)		

PROPERTIES TABLE

2.02 FASTENERS:

A. Shall be 316 stainless steel. All anchor bolts, assembly bolts, screws, nuts, etc. shall be of ample section to safely withstand the forces created by operation of the gate while subjected to the heads specified.

2.03 STEMS:

- A. All stems shall be the rising type. The entire stem, including extension stem, shall be Type 316 Stainless Steel solid bar. The sections of extension stems shall be joined together by solid couplings, threaded and keyed to the stems. All couplings of the same size shall be interchangeable.
- B. Stems shall be furnished with adjustable, stem guides, spaced as necessary to maintain a slenderness ratio L/R of less than 200. Stems shall be of ample cross section to prevent distortion and shall have stub acme threads. Stems shall be designed to withstand tensile and compressive loads that occur under maximum operating conditions. Design for compressive loading shall meet AISC code where K=1 with a minimum safety Factor of 2 to 1. These requirements exceed AWWA standards. Stems shall be cold-rolled or cut with a double-start stub acme thread and a finish of 32 microns or less.
- C. Stems shall be fixed to the disc by a threaded and keyed assembly into a lifting nut attached to the disc in a lifting bracket, which is bolted to the disc. The bolts securing the bracket shall be in tension and not in shear. Bolts in shear will not be acceptable as they will bind against the outer material causing stress.

2.04 MANUAL OPERATORS:

- A. The actuator shall be a yoke mounted, manual, geared, hand crank operator with rising Type 316 stainless steel stem, stem guide and clear plastic stem cover. Crank operators shall have a diameter such that the operator does not interfere with the existing wall and shall operate the gage under the specified operating head with not greater than 40 lbs of force on the crank.
- B. Operators shall be equipped with fracture-resistant clear butyrate plastic stem covers which shall not discolor or become opaque for a minimum of 5 years after installation. The top of the stem cover shall be closed. The bottom end of the stem cover shall be mounted in a housing or adapter plate for easy field mounting. Stem covers shall be complete with indicator markings to indicate gate position. An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the gate. The direction of rotation to open shall be clockwise.

PART 3 EXECUTION

3.01 INSTALLATION

A. All gates and guides shall be installed by CONTRACTOR in a manner acceptable to the Manufacturer and OWNER. It shall be the responsibility of CONTRACTOR to handle, store, and install the equipment specified in this Section in strict accordance with the Manufacturer's drawings and recommendations. Frames and guides shall be installed in a true vertical plane with 90-degree corners.

3.02 INSPECTION AND TESTING

- A. Furnish the services of a factory representative for one (1) day who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise a test run of the equipment.
- B. After installation, all sluice gates shall be field tested at maximum differential head to ensure that all items of equipment follow this section, including the leakage requirement of maximum allowable leakage for sluice gates of 0.1 gpm/ft of perimeter under the design seating head.
- C. If gates, operators, and appurtenances do not meet specified requirements, CONTRACTOR shall take corrective measures and the unit re-tested. Corrective measures may include, but are not limited to, adjustment of frame alignment, tightening of fasteners, etc., as deemed acceptable to and under the supervision of Manufacturer's representative and at no additional cost to OWNER.
- D. CONTRACTOR shall supply official test certificates upon completion of the equipment installation. If installed equipment remains unable to meet the test requirements to the satisfaction of the OWNER, it shall be removed and replaced with a satisfactory unit at no additional cost to OWNER.

VERTICAL DRY PIT SOLIDS-HANDLING PUMPS

PART 1 GENERAL

1.01 This specification includes the furnishing of service pumps for raw wastewater duty. The service pumps shall be vertical, single-stage, end-suction, centrifugal pumps with bases, extended shafts, couplings, coupling guards and drivers. The service pump accessories shall include all mechanical seals, seal water controllers, and an integrated seal water/wash water system as specified herein.

1.02 QUALITY ASSURANCE

- A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications, and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.
- B. Unit responsibility. Pump(s), complete with motor, base, shaft, coupling, necessary guards and all other accessories and appurtenances specified herein shall be furnished by the pump manufacturer to ensure compatibility and integrity of the individual components and to provide the specified warranty for all components.
- C. The vertical dry-pit solids-handling pump(s) specified in this section shall be furnished by and be the product of one manufacturer.
- D. Pumps are to be engineered and manufactured under a written Quality Assurance program. The Quality Assurance program is to be in effect for at least ten years, to include a written record of periodic internal and external audits to confirm compliance with such program.
- E. Pump(s) are to be manufactured under the certification of ISO-9001:2000.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with 01300.
- B. Submittals shall include, but not be limited to, the following:
 - 1. Equipment Submittals as specified in Section.
 - 2. Standard performance curves for each pump model furnished. Curves shall cover range from shutoff to 120% of design flow rate at the conditions specified, and shall be submitted for the following parameters as a function of pump capacity and speed at design temperature:
 - a. Total developed head.

- b. Required brake horsepower.
- c. Pump efficiency.
- d. Required NPSH.
- e. Minimum recommended submergence.
- 3. Mechanical details including impellers, bearings, couplings, and seals.
- 4. Layout, dimensional, and cross-section drawings for the complete pump and motor assembly, including shaft, pump and motor stands and associated components.
- 5. Detailed, dimensioned and to-scale layout drawings for the pump installation showing vertical setting dimensions and horizontal lay lengths for all components. The layout shall show the horizontal assembly of piping, valves, appurtenances and supports, beginning at the suction bell and ending at the vertical base elbow fitting.
- 6. Layout, dimensional, and cross-section drawings for the complete seal water/wash water system assembly, including storage tank, pump assemblies, piping, supports, controls and associated components.
- 7. Materials of construction.
- 8. Manufacturer's standard protective coating system.
- 9. Manufacturer's critical speed determinations, vibration and shaft runout tolerances.
- 10. Motor performance data and results of shop testing.
- 11. Equipment instruction books.
- 12. Nameplate data.
- 13. Submit shop test reports and performance data herein.
- 14. Base plate details.
- 15. Weights of the following components:
 - a. Total each unit.
 - b. Pump.
 - c. Motor.
 - d. Base plate.
 - e. Skid-mounted seal water/wash water system.
PART 2 PRODUCTS

2.01 SERVICE PUMP MANUFACTURERS

- A. Acceptable Manufacturers and Models
 - 1. Flygt Xylem (a.k.a., Allis-Chalmers) Model NSYV [Basis of Design]
 - 2. Grundfos/Chicago Pump (a.k.a., Yeomans) Model 2111
 - 3. Pentair (a.k.a., Fairbanks-Morse) Model B5711

2.02 SERVICE PUMP PERFORMANCE AND CONSTRUCTION

A. The pumps shall be designed for continuous operation under normal service conditions, with the following operation criteria:

Primary Design Capacity	2,414	gpm
Rated Head (at Primary Capacity)	32	ft
Secondary Design Capacity	4200	gpm
Rated Head (at Secondary Capacity)	34	ft
Minimum Head	24	ft
Minimum Shutoff Head	57	ft
Maximum Shutoff Head	78	ft
Minimum Available Submergence (to Pump Centerline)	1.68	ft
Maximum Motor Speed	1200	rpm
Minimum Motor Speed	620	rpm
Minimum Efficiency (at Design Capacity)	68	percent
Maximum Motor Size	50	hp
Minimum Suction Connection	10	inch
Maximum Suction Connection	12	inch
Minimum Discharge Connection	8	inch
Maximum Discharge Connection	12	inch

- B. NPSH available at the centerline of the pump impeller is 27 feet at 2,414 GPM.
- C. Pumped liquid is raw wastewater with a maximum temperature of 80 degrees F.
- D. Service Pump Design
 - 1. Rotation
 - a. The pump rotation will be clockwise when looking at the pump from the drive end.
 - 2. Impeller
 - a. The impeller shall be single-suction enclosed type with two vanes, made of 2% 3% Ni cast iron. Impeller be specifically designed with smooth water passages to prevent clogging by stringy or fibrous materials and shall be capable of passing solids having a maximum sphere size of 3 inches.
 - b. Impeller hardness shall be minimum 406 BHN.
 - c. The impeller is to be dynamically balanced and shall be keyed and secured to the shaft by a Type 316 stainless steel nut locked in place. It shall be readily removed without the use of special tools.
 - d. The impeller shall be of ample diameter to assure first critical speed will occur at no less than 150% of rated pump speed.
 - 3. Casing
 - a. The casing shall be close-grained cast iron conforming to ASTM A48 Class 30 of sufficient strength, weight and metal thickness to insure long life, accurate alignment, and reliable operation. The casing shall withstand up to 60 psi hydrostatic pressure. The volute shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller and provide smooth, unobstructed flow.
 - b. The casing shall be flanged tangential discharge and capable of rotation in 45-degree increments to accommodate piping orientation.
 - c. Casing shall be split perpendicular to the shaft, with lifting lugs, removable suction cover with hex-head bolts, and stuffing box cover. Machined fit for these parts shall be accurately aligned and identical so that casing may be installed for either clockwise or counterclockwise direction of rotation.
 - d. The casing shall be furnished with large cleanout openings located at the impeller centerline, to allow access to the impeller. The cleanout

cover shall be secured with four hex-head bolts. Priming, drain and 1/4-inch minimum gauge connections shall be provided. Flanges shall be 125 lb flat-faced flanges (ANSI B16.1) drilled and slotted for ease of assembly and disassembly.

- e. The casing shall be designed to permit the removal of the rotating assembly without disturbing the suction or discharge piping. The casing shall be hydrostatically tested to 1.25 times the shutoff head.
- 4. Wear Rings
 - a. Wear rings shall be provided on both the impeller and fronthead so that clearances can be maintained throughout the life of the rings and minimize recirculation.
 - b. Impeller wear rings shall be replaceable Type 316 stainless steel "L"-shaped axial or face-type and mounted on impeller to provide a renewable surface opposite the suction cover wear plate.
 - c. Wear ring hardness shall be minimum 300 BHN. Wear plate hardness shall be minimum 350 BHN.
 - d. Suction cover wear rings shall be replaceable 11.5-14% chrome steel and provide a minimum of 1/4-inch wear surface. It shall be installed with its wear surface parallel to the end of the impeller nut.
 - e. Wear rings shall be attached to the impeller and suction cover using an interference fit and Loctite.
 - f. Wear ring clearance adjustment shall have provisions for adjustment of axial clearance. This adjustment shall be made through the use of shims placed between the frame and outboard bearing housing.
- 5. Suction Cover
 - a. The Suction Cover shall be removable to allow access to the impeller. It shall be ASTM A48 Class 30 Cast Iron and drilled for 125 lb flanges (ANSI B16.1). The mounting holes shall be slotted for ease of assembly and disassembly.
 - b. Suction gauge connections shall be drilled and tapped next to the suction flange to accommodate a 1/4-inch IPS pipe fitting.
 - c. Clean-out Port: a large clean-out opening shall be provided in the suction nozzle. It shall have a removable cover to allow access to the suction for inspection and flushing, if required.

- d. Suction Flange: the suction flange shall be 125 lb (ANSI B16.1) flatfaced and slotted for ease of assembly and disassembly.
- 6. Stuffing Box Cover and Stuffing Box
 - a. Stuffing box cover shall be made of ASTM A48 Class 30 closegrained cast iron with integral stuffing box and shall be designed to accept either packing or mechanical seal.
 - b. Mechanical Seal: A John Crane Type 21 double mechanical seal with Silicon Carbide (rotating) and Tungsten Carbide (fixed) hard faces, or equal, shall be installed in the stuffing box. The mechanical seal stuffing box shall be provided with a tapped sealing liquid connection.
- 7. Bearing Frame Assembly and Shaft
 - a. The Bearing housing shall be one-piece, rigid cast iron construction. Frame shall be provided with cast iron bearing housing at the outboard end, and a cast iron end cover at the inboard end. Both ends of the frame shall be provided with lip type grease seals and labyrinth type deflectors to prevent the entrance of contaminants.
 - b. Bearing frame shall be designed so that complete rotating assembly can be removed from the casing without disconnecting suction or discharge piping.
 - c. Frame shall be provided with a 3/4-inch IPS pipe tapped hole, located as low as possible to drain the leakage from the packing gland. Coordinate with seal water system configuration.
 - d. Jacking bolts for external impeller adjustments are required.
 - e. Zerk-type grease fittings for bearing lubrication shall be supplied at the bearing housing.
 - f. The pump shaft shall be high-strength carbon steel, AISI #4140 minimum, accurately machined, tapered at the impeller end and sufficiently sized to transmit full driver output. It shall be protected from the pumped liquid by a shaft sleeve in the stuffing box area. A seal shall be provided, by a synthetic rubber "O"-ring, between the shaft and shaft sleeve to prevent leakage of pumped liquid out and/or air into the pump.
 - g. Shaft diameter between bearings shall be minimum 3-5/8 inch.

- h. Shaft diameter and keyways for other shaft sections shall be as per the manufacturer's recommendation and shall be compatible with connecting components such as impeller, sleeve, bearings and motor coupling.
- i. Shaft Sleeve for Mechanical Seal: a renewable shaft sleeve used for mechanical seals shall be 316 stainless steel. Positive adhesive, sealed to prevent leakage between the shaft and the sleeve, shall protect the shaft through the sealing box area. The sleeve provided shall extend through the stuffing box and under the gland.
- j. Inboard Bearing: inboard bearings shall be single-row, radial type suitable for all loads encountered in the service conditions.
- k. Outboard Bearing: outboard bearings shall be axial-thrust, angular contact, double-row ball suitable for thrust loads in two directions.
- 1. Bearings: bearings shall be designed for 100,000 hours minimum L10 life at 50% B.E.P. Radial inboard bearing shall be roller type for F8-H frames. They shall be suitable for all loads encountered in the service conditions. Axial thrust outboard bearing shall be deep-groove, angular contact double-row or duplex type for F8-H frames.
- m. Bearing Lubrication: bearings shall be grease lubricated with provisions for the addition and relief of grease. Provide oil lubrication at top of pump motor and grease fittings at bottom of motor.
- n. Bearing Locking: the outboard bearing shall be locked to the shaft with a nut and lock washer. The lock washer shall have a key seat tab on its ID to prevent it from turning and a set of tabs on its OD, one of which will align with a notch in the nut to prevent it from loosening.
- 8. Pedestal Base, Suction Elbows, Coupling and Coupling Guard
 - a. Pedestal Base: Pump shall be supported by a cast iron suction head with clean-out handhole. Base shall be designed to support the weight of the pump and shafting. Base shall safely withstand all stresses imposed thereon by vibration, shock and all possible direct and eccentric loads. Base shall have adequate horizontal dimensions, foundation contact area, anchorage facilities and shall be sufficient height so the suction elbow will not touch the floor or foundation upon which the pump is mounted.

- b. Intermediate Shafting: Intermediate line shafting of the flexible type shall be of the size (diameter, length, number of and joint) as recommended by the shaft manufacturer to provide continuous 24-hour duty at any speed within the range specified and max. torque. Couplings shall be universal joint type to permit removal of the pump rotating element without dismantling other sections of shafting, any intermediate bearing, and without removing driver. One slip spline, to allow for endwise movement, and the necessary steady bearings shall also be provided for each shaft.
- c. Suction Elbow: Each pump shall be provided with a clean-out type cast iron suction elbow which is bolted directly to the pump suction flange. A 4-inch minimum handhole clean-out shall be provided with a removable cover. The inner surface shall generally conform to the curvature and radius of the suction elbow. A 1/4-inch tapped hole for gauge connection shall be provided in the elbow near the suction flange. A 2-inch tapped hole shall be provided in the side of the elbow for use in applying water pressure to unclog the pump in case of blockage.
- d. Coupling: Couplings shall be of the manufacturer's choice and of flexible type. Coupling hubs shall be secured to the driver and driven shafts by a set screw located over the key.
- e. Coupling Guard: Guard shall be all-metal completely enclosing the coupling.
- f. The coupling shall be a standard-flexible type and secured to the driver and driven shafts by a setscrew located over the keyway.
- 9. Fits and Hardware
 - a. The volute/casing, suction cover, stuffing box cover, and frame shall be manufactured with concentric shoulder fits to assure accurate alignment. All machined bolts, nuts, and capscrews shall be of the hex-head type and will not require the use of any special tools.
- 10. Factory Painting
 - a. Prior to paint: blast and clean per SSPC-SP10.
 - b. Primer: primer paint with one coat of ICI Devoe Bar-Rust 233H for a minimum DFT of 6 mils.
 - c. Top Coat: Apply top coat with ICI Devoe Bar-Rust 235 Epoxy for a minimum DFT of 8 mils.

- d. Color Custom Grey. Total minimum DFT of 12 mils.
- 11. Vibration Limitations (Field)
 - a. The limits of vibration as set forth in the standards of the Hydraulic Institute shall govern.

2.03 SEAL WATER / WASH WATER SYSTEM

A. Seal Water System

- 1. An integrated seal water system shall be supplied by the service pump manufacturer as a coordinated part of the overall service pump package. The seal water system shall be functionally complete and designed for the specific sealing needs of the service pump components. The system shall be fully automatic, capable of continuous duty operation.
- 2. Refer to the Contract Drawings for a schematic of the seal water system components and seal water pump operating conditions. Deviations from the basis of design equipment or operating requirements shall be listed by the Bidder on their proposal as exceptions, with all required remedial measures to be reviewed by OWNER. Bids not meeting specifications will be rejected in their entirety. Any costs associated with remedial measures will be the responsibility of the supplier and should be included in their bid price.
- 3. The seal water components generally include the following:
 - a. One (1) 360-gallon, HDPE, covered seal water storage tank with 110% secondary containment, float valve, and level element.
 - b. Two (2) vertical, in-line, multi-stage seal water pumps. Seal water pumps shall be variable speed with VFD controllers.
 - c. All seal water supply and return piping, fittings, valves, strainers and supports as shown in the Drawings.
 - d. Seal water pump control panel with power, control and alarm functions, to be coordinated with the pump station's power, control and communication systems as shown in the piping and instrumentation (P&ID) diagrams and process loop descriptions in the Contract Documents. All control panels shall meet the requirements of Specification 16910.
 - e. Custom base skid assembly, as per manufacturer's standard offering for the service location and conditions. Skid shall be designed and fabricated to facilitate installation as shown on the

Contract Drawings, including access through any required doorways and past other structures or equipment.

- f. Seal water controller devices for the control and monitoring of seal water flow and pressure shall be provided separately for each service pump. The system shall include John Crane Safeunit Type SFD devices with 3/8-inch NPT seal water connections and mounting brackets. Provide all fittings and components as required for a complete and functional installation, including recirculation of seal water and alarm features as shown in the drawings.
- B. Wash Water System
 - 1. An integrated wash water system shall be supplied by the service pump manufacturer as a coordinated part of the overall service pump package. The wash water system shall be functionally complete and designed for the purpose of station washdown operations. The system shall be fully automatic, capable of continuous duty operation. This system may be provided separately from or integrated with the seal water system of Paragraph 2.03.A. of this Section.
 - 2. Refer to the Contract Drawings for a schematic of the wash water system components and wash water pump operating conditions.
 - 3. The wash water components generally include the following:
 - a. Shared use of the seal water storage tank described in Paragraph 2.03.A above.
 - b. One (1) horizontal, end-suction centrifugal wash water pump. Wash water pump shall be constant speed with soft starters.
 - c. All wash water supply piping, fittings, valves, bladder tank and supports as shown in the Drawings.
 - d. Wash water pump control panel with power, control and alarm functions, to be coordinated with the pump station's power, control and communication systems as shown in the piping and instrumentation (P&ID) diagrams and process loop descriptions in the Contract Documents. This may be a shared panel with the seal water system. All control panels shall meet the requirements of Specification 16910.
 - e. Custom base skid assembly, as per manufacturer's standard offering for the service location and conditions. Skid shall be designed and fabricated to facilitate installation as shown on the Contract Drawings, including access through any required

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doorways and past other structures or equipment. This may be a shared skid assembly with the seal water system.

PART 3 EXECUTION

3.01 MANUFACTURER'S SERVICES

- A. Factory Testing
 - 1. A certified factory performance test shall be performed on each pumping unit in accordance with Hydraulic Institute Standards, latest edition. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition.
- B. Field Start-up and Training
 - 1. The manufacturer shall furnish the services of a competent factory representative for the following services, travel time excluded:
 - a. 1 day (minimum) for installation and start-up assistance, inspection and certification of the installation. Certification shall include statements that the alignment and vibration of the pumps and shafts are within the manufacturer's allowable tolerances.
 - b. 1/2 day (minimum) of operation and maintenance training for the OWNER'S operating personnel.

3.02 FIELD PAINTING

- A. Contractor shall prepare surfaces and shall touch up coatings damaged during shipment and installation. Touch-up coatings shall be the same as the original shop coatings.
- 3.03 SPARE PARTS AND MANUALS
 - A. The manufacturer shall furnish the OWNER with the following:
 - 1. A recommended list of spare parts.
 - 2. An Operations and Maintenance manual.

3.04 WARRANTY

A. The manufacturer shall furnish to the OWNER a one-year Parts and Labor Warranty issued by the manufacturer on all equipment furnished under this specification section. The warranty period shall commence on the date of

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issuance of the Certificate of Substantial Completion and shall run concurrently with the CONTRACTOR'S warranty period. CONTRACTOR shall coordinate with OWNER to conduct a warranty inspection of the Work on or about thirty (30) days prior to the warranty period expiration.

END OF SECTION

SECTION 11810

SUBMERSIBLE MIXERS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Work necessary to furnish and install, complete, the mixing equipment specified herein.

1.02 GENERAL

- A. See CONDITIONS OF THE CONTRACT and Section GENERAL REQUIREMENTS, for information and requirements that apply to the work specified herein and are mandatory for this project.
- B. Like items of equipment provided hereunder shall be the end products of one manufacturer to achieve standardization.

1.03 RELATED WORK

- A. Concrete Work is included in Division 3
- B. Painting is included in Section 09900
- C. Electrical Work is included in Division 16

1.04 MANUFACTURERS' SERVICES

- A. A manufacturer's representative for the equipment specified herein shall be present at the job site and/or classroom designated by the Owner for the minimum days listed for the services hereinunder, travel time excluded:
 - 1. 1/2 day for installation assistance, inspection and certification of the installation.
 - 2. 1/2 day for testing and training.

1.05 SUBMITTALS

- A. Submittals shall be made in accordance with Section 01300. In addition, the following specific information shall be provided:
 - 1. Complete manufacturer's drawings for the mixer, including drawings showing attachment of the mixer base and the supporting structure.
- B. Provide Manufacturer's Operation and Maintenance Manuals in accordance with Section 01300.

PART 2 PRODUCTS

2.01 GENERAL

- A. The mixing equipment shall be capable of mixing and maintaining a uniform suspension of the liquids described herein.
- B. Equipment furnished and installed under this section shall be assembled and placed in proper operating condition by the Contractor in full conformity with the specifications, drawings, engineering data, and instructions and recommendations of the equipment manufacturer as approved by the Engineer.
- C. The Contractor shall furnish and install each mixer complete with:
 - 1. All supports, anchor bolts and mounting hardware required to mount the mixers to the existing wetwell basin.
 - 2. All mechanical equipment required for proper operation.
 - 3. All steel, iron and other materials of construction indicated in this section.
 - 4. All electrical equipment, including starters, controls, etc.
 - 5. Any additional materials of construction required by the manufacturer's design.

2.02 MIXING CONDITIONS

- A. Raw Municipal Sewage:
 - 1. Working Basin Volume = 31,400 gal
 - 2. Maximum Depth = 8.5 ft
 - 3. Basin Length = 46 ft (approximate)
 - 4. Basin Width = 17 ft (approximate)

2.03 MANUFACTURERS

- A. KSB Amamix Model C 3225/06 XDG [Basis of Design]
- B. Xylem Flygt
- C. Wilo (a.k.a., EMU)

2.04 EQUIPMENT

- A. Scope: Furnish and install one submersible mixer. Each mixer shall be equipped with a 2.8 HP, LSPM (line-started permanent-magnet) submersible electric motor connected for operation on 460 Volts, 3 Phase, 60 Hertz, 4 wire service, with a 50-feet Subcab cable. All cables shall be oil-resistant, chlorinated polyethylene rubber-jacketed. Each unit shall be fitted with lifting cable of adequate strength to permit raising and lowering the mixer. Mixers specified herein shall be capable of a nominal thrust of 130 N with a propeller speed of 1675 rpm, a propeller diameter of 8.27 inches, and a shaft horsepower not to exceed 2.8 BHP in clear water. Total input power shall not exceed 2.3 kW. The mixer shall be designed for continuous duty under the specified service conditions.
- B. Mixer Design: The mixer shall be mounted on the floor using a 4-inch floor socket.
- C. Mixer Construction: Each mixer shall be of the integral design, close-coupled, submersible type. All components of the mixer, including motor, shall be capable of continuous underwater operation. Major mixer components like the propeller, motor shaft, mast mounting brackets, motor housing etc. shall be of 316L Stainless Steel construction. All metal surfaces in contact with the mixed media, other than stainless steel, shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer with an epoxy finish coat on the exterior of the mixer. All exposed cast iron and ferrous surfaces shall be cleaned of dirt and grease, sandblasted to near white finish, and coated (dipped) with an anticorrosion iron oxide primer. The mixer shall then be painted with two-component epoxy coating, having at minimum 83% solids by volume. This coating shall be non-toxic and approved for both wastewater and water applications.
- D. Motor (Explosion Proof): The motor shall be directly connected to the propeller (gearbox designs are not acceptable) to produce a propeller speed of 1675 RPM. The mixer motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator winding shall be insulated with moisture resistant Class F insulation which will resist a temperature of 155°C (311°F). The stator shall be insulated by the trickle impregnation method resulting in a winding fill factor of at least 95%. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least thirty (30) evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal switches embedded in the end coils of the stator winding and set for 284°F (140°C). These shall be used in conjunction with, and supplemental to, external motor overload protection, and must be wired to the control panel as required by FM regulations.

E. Elastomers: All mating surfaces where watertight sealing is required shall be machined and fitted with a double set of Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used

- F. Propeller: The propeller shall be of 316 stainless steel dynamically balanced, nonclogging backward curved design. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced. The propeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications. The propeller shall have two vanes 8.27 inches in diameter with a blade angle of 7 degrees.
- G. Jet-Ring Assembly: The mixer assembly shall incorporate a jet ring assembly, configured for a full 360 degrees around the propeller.
- H. Cable Entry: The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets to ensure a redundant system in the event of a cable entry failure. Single-sealing systems will not be acceptable. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak-proof seal at the cable entrance without the need for specific torque requirements. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top. Connection shall be made between the threaded compressed type binder posts thus securely affixing the cable wires to the terminal board. The use of the terminal compressed type post and a terminal board O-ring shall render the motor compartment leak proof from any liquid which may enter the terminal compartment. Epoxies, silicones, or other secondary sealing systems shall not be acceptable.
- I. Bearings: All bearings shall have a minimum B-10 or L-10 rated life of 100,000 hours and shall have inner and outer races of metal construction. Bearings with races made of nonmetallic construction will not be deemed acceptable for meeting the load handling and environmental requirements of this application. The outboard propeller bearing shall be an angular-contact bearing. The motor shaft end shall be supported by two bearings. A roller and an angular-contact ball bearing shall take up the axial and radial loads while an angular-contact ball bearing shall take up the axial loads. The bearings shall be pre-loaded by a bearing loading nut located on the motor end of the shaft to reduce shaft deflection and increase bearing life and seal life. Mixers without pre-loaded bearings will not be considered acceptable or equal
- J. Oil Housing: The oil housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate oil flow. If the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of a simple gravity process. Mixers which require propeller removal for oil change shall not be acceptable. Separate fill and drain plugs shall be provided to facilitate oil replacement.

- K. Mechanical Seals: Each mixer shall be provided with two sets of lapped end face type mechanical seals running in oil reservoirs for cooling and lubrication. The inner mechanical seal is corrosion-resistant Silicon Carbide/Tungsten Carbide. The outer seal faces are Silicon Carbide/ Tungsten Carbide. One face of the inner seal ring pair shall have spiral grooves laser etched in it, to provide a pumping action to move leakage from the stator housing back into the oil chamber. To avoid seal failure due to sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the oil housing.
- L. Factory Testing: The mixer manufacturer shall perform the following inspections and tests on each mixer before shipment from the factory:
 - 1. Propeller, motor rating, and electrical connections shall first be checked for compliance to the customer's purchase order.
 - 2. A dielectric test shall be carried out in accordance to IEC 60034-1 (two times rated voltage plus 1000 V). This test shall be done after assembly but before any performance tests. No records shall normally be provided.
 - 3. Prior to shipment, the mixer shall be run dry to establish correct rotation and mechanical integrity.
 - 4. A written report stating the foregoing steps have been done may be supplied with each mixer at the time of shipment (upon request).
- M. In addition to the requirements listed above, for the installations which are in hazardous locations as defined by the National Electrical Code (NEC), only mixers certified by Factory Mutual for use in such locations shall be used.

Specifically, the mixers used shall be certified for use in all Class I, Divisions 1 and 2, Groups C and D, Class II, Divisions 1 and 2, Groups E, and G and Class III locations as outlined in Articles 500-502 inclusive of the NEC code.

PART 3 EXECUTION

3.01 SHIPPING, HANDLING, AND INSTALLATION REQUIREMENTS

- A. Each mixer unit, including motor and propeller, shall be completely factory assembled, aligned, and securely crated for shipment. Accessory equipment which cannot be shipped assembled to the unit, such as guide rails and brackets, baseplates, anchorage materials, spare parts, etc., shall be separately crated, clearly marked as to the contents, and shipped with the mixer units.
- B. The equipment shall be installed in strict accordance with the manufacturer's instructions.

3.02 FIELD TEST

A. Prior to startup, inspect all components for proper alignment, proper connection(s), and quiet and satisfactory operation. The manufacturer's representative(s) shall inspect the installation and provide certification that all components have been correctly and completely installed and are ready for operation. Any mixer which fails to meet any of the contract specifications will be modified, repaired or replaced by the contractor at no additional cost to the owner.

3.03 WARRANTY

A. The mixer manufacturer shall warrant the mixer and motor to the Owner against defects in workmanship and materials for a period of one (1) year from date of first beneficial use or eighteen (18) months from shipment (whichever occurs first). The manufacturer's warranty shall be in published form and shall apply to all similar units. A copy of the warranty shall be provided to the Owner at startup.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Grout.
 - 8. Mechanical demolition.
 - 9. Equipment installation requirements common to equipment sections.
 - 10. Painting and finishing.
 - 11. Concrete bases.
 - 12. Supports and anchorages.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, and unexcavated spaces.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.

- 2. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. NBR: Acrylonitrile-butadiene rubber (BUNA-N).

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. All equipment and material stored outside must be kept elevated to prevent damage.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.

- f. Viking Johnson.
- 2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
- 3. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Eslon Thermoplastics.
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solderjoint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F .
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.

- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
 - 1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM, NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Plastic, Carbon steel, Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Stainless Steel: Stainless steel or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 PLUMBING PLATES

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated, Polished chrome-plated and rough brass.
- C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated, Polished chrome-plated and rough brass.
- D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chromeplated finish.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, castbrass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or Splitcasting, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.

- M. Sleeves are not required for core-drilled holes. Coordinate core drilling location with all other trades including the structure.
- N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 2. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

- 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
- 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, repair or replacement of components and meet the NEC access clearances. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

- 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 15050

SECTION 15055

MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed motors.

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices and features that comply with the following:
 - 1. Compatible with the following:
 - a. Magnetic controllers.
 - b. Multispeed controllers.
 - c. Reduced-voltage controllers.
 - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of the load.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed motors except as follows:
 - 1. Different ratings, performance, or characteristics for motor are specified in another Section.
 - 2. Motorized-equipment manufacturer requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

- A. Frequency Rating: 60 Hz.
- B. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- C. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
- D. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
- E. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- F. Enclosure: Open dripproof.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium, as defined in NEMA MG 1.
- C. Stator: Copper windings, unless otherwise indicated.
 - 1. Multispeed motors shall have separate winding for each speed.
- D. Rotor: Squirrel cage, unless otherwise indicated.
- E. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating, unless otherwise indicated.
- G. Insulation: Class F, unless otherwise indicated.
- H. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- I. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
 - 1. Finish: Gray enamel.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Designed with critical vibration frequencies outside operating range of controller output.
 - 2. Temperature Rise: Matched to rating for Class B insulation.
 - 3. Insulation: Class H.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Rugged-Duty Motors: Totally enclosed, with 1.25 minimum Service Factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with non-hygroscopic material.
 - 1. Finish: Chemical-resistant paint over corrosion-resistant primer.

2.5 SINGLE-PHASE MOTORS

- A. Type: One of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split-phase start, capacitor run.
 - 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive field-installed motors for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before motor installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIELD-INSTALLED MOTOR INSTALLATION

- A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.
- B. Install motors on concrete bases.
- C. Comply with mounting and anchoring requirements specified in other sections of these specifications.

3.3 FIELD QUALITY CONTROL FOR FIELD-INSTALLED MOTORS

- A. Prepare for acceptance tests.
 - 1. Align motors, bases, shafts, pulleys, and belts. Tension belts according to manufacturer's written instructions.
 - 2. Verify bearing lubrication.
 - 3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 - 4. Test interlocks and control and safety features for proper operation.
 - 5. Verify that current and voltage for each phase comply with nameplate rating and NEMA MG 1 tolerances.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform electrical tests and visual and mechanical inspections except optional tests and inspections stated in NETA ATS on factory- and field-installed motors. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.4 FIELD-INSTALLED MOTOR DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain field-installed motors.

END OF SECTION 15055

SECTION 15060

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following hangers and supports for mechanical system piping and equipment:
 - 1. Stainless steel pipe hangers and supports.
 - 2. Stainless steel trapeze pipe hangers.
 - 3. Stainless steel metal framing systems.
 - 4. Stainless steel thermal-hanger shield inserts.
 - 5. Stainless steel fastener systems.
 - 6. Stainless steel equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Stainless steel pipe hangers and supports.
 - 2. Stainless steel thermal-hanger shield inserts.
 - 3. Stainless steel powder-actuated fastener systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

- 1. Stainless steel trapeze pipe hangers. Include Product Data for components.
- 2. Stainless steel metal framing systems. Include Product Data for components.
- 3. Stainless steel equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." AWS D1.3, "Structural Welding Code--Sheet Steel." AWS D1.4, "Structural Welding Code--Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 STAINLESS STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Bergen-Power Pipe Supports.
 - 3. B-Line Systems, Inc.; a division of Cooper Industries.
 - 4. Carpenter & Paterson, Inc.
 - 5. Empire Industries, Inc.
 - 6. ERICO/Michigan Hanger Co.
 - 7. Globe Pipe Hanger Products, Inc.
 - 8. Grinnell Corp.
 - 9. GS Metals Corp.
 - 10. National Pipe Hanger Corporation.
 - 11. PHD Manufacturing, Inc.
 - 12. PHS Industries, Inc.
 - 13. Piping Technology & Products, Inc.
 - 14. Tolco Inc.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.
- E. Isolation Pads: Dissimilar metals

2.3 STAINLESS STEEL TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated stainless steel pipe-support assembly made from structural-stainless steel shapes with MSS SP-58 hanger rods, stainless steel nuts, stainless steel saddles, and stainless steel U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated stainless steel pipe-support assembly made of stainless steel channels and other components.
- B. Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. GS Metals Corp.
 - 4. Power-Strut Div.; Tyco International, Ltd.
 - 5. Thomas & Betts Corporation.
 - 6. Tolco Inc.
 - 7. Unistrut Corp.; Tyco International, Ltd.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 STAINLESS STEEL THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in stainless steel shield.
- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. ERICO/Michigan Hanger Co.
 - 3. PHS Industries, Inc.
 - 4. Pipe Shields, Inc.
 - 5. Rilco Manufacturing Company, Inc.
 - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- 2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-stainless steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - d. MKT Fastening, LLC.
 - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated stainless steel equipment support made from structural- stainless steel I shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi , 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use stainless steel hangers and supports for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Stainless Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Stainless Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
 - 3. Adjustable, Stainless Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
 - 4. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
 - 5. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 7. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with stainless steel pipe base stanchion support and stainless steel floor flange.
 - 8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with stainless steel pipe base stanchion support and stainless floor flange and with U-bolt to retain pipe.
 - 9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with stainless steel pipe base stanchion support and stainless steel floor flange.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Stainless Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Stainless Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Stainless Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Stainless Steel Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 2. Stainless Steel Thermal-Hanger Shield Inserts: For supporting insulated pipe.

- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches .
 - 2. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 - 3. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Stainless Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, stainless steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-stainless steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural stainless steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- M. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include stainless steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 : 12 inches long and 0.048 inch thick.
 - b. NPS 4 : 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6 : 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14 : 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24 : 24 inches long and 0.105 inch thick.
 - 4. Pipes NPS 8 and Larger: Include wood inserts.
 - 5. Insert Material: Length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-stainless steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils .

END OF SECTION 15060

SECTION 15074

VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Restrained elastomeric isolation mounts.
 - 3. Freestanding and restrained spring isolators.
 - 4. Housed spring mounts.
 - 5. Elastomeric hangers.
 - 6. Spring hangers.
 - 7. Spring hangers with vertical-limit stops.
 - 8. Restraining braces and cables.
 - 9. Steel vibration isolation equipment bases.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code Steel."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation.
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control.
 - 6. Mason Industries.
 - 7. Vibration Eliminator Co., Inc.

- 8. Vibration Isolation.
- 9. Vibration Mountings & Controls, Inc.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
 - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: Limit stop as required for equipment.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- E. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.
- F. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

- 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- G. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation.
 - 3. Isolation Technology, Inc.
 - 4. Kinetics Noise Control.
 - 5. Mason Industries.
 - 6. Vibration Eliminator Co., Inc.
 - 7. Vibration Isolation.
 - 8. Vibration Mountings & Controls, Inc.
- B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Stainless Steel: Stainless Steel shapes, plates, and bars. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded stainless steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

- 1. Powder coating on springs and housings.
- 2. All hardware shall be stainless steel.
- 3. Baked enamel or powder coat for metal components on isolators for interior use.
- 4. Color-code or otherwise mark vibration isolation control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

- A. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
- B. Attachment to Structure: Anchor bracing to structure at concrete members.
- C. Drilled-in Anchors:
 - Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 15074

SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment nameplates.
 - 2. Equipment markers.
 - 3. Equipment signs.
 - 4. Access panel and door markers.
 - 5. Pipe markers.
 - 6. Valve tags.
 - 7. Valve schedules.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Valve numbering scheme.
- C. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

- A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
 - 1. Data:
 - a. Manufacturer, product name, model number, and serial number.
 - b. Capacity, operating and power characteristics, and essential data.
 - c. Labels of tested compliances.
 - 2. Location: Accessible and visible.
 - 3. Fasteners: As required to mount on equipment.
- B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Data:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 - d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
 - 3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.
- C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Data: Instructions for operation of equipment and for safety procedures.
 - 2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.
 - 3. Thickness: 1/16 inch for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.
 - 4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.
- D. Access Panel and Door Markers: 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.
 - 1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

- 1. Colors: Comply with ASME A13.1, unless otherwise indicated.
- 2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
- 3. Pipes with OD, Including Insulation, Less Than 6 Inches : Full-band pipe markers extending 360 degrees around pipe at each location.
- 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
- 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.
- C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.
- D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches : 3/4 inch minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2inch numbers, with numbering scheme approved by Architect. Provide 5/32-inch hole for fastener.
 - 1. Material: 0.032-inch- thick [316 stainless steel].
 - 2. Valve-Tag Fasteners: 316 stainless steel wire-link or beaded chain; or S-hook.

2.4 VALVE SCHEDULES

- A. Valve Schedules: For each piping system, on standard-size bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
 - 2. Frame: 316 stainless steel.
 - 3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

- A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
 - 1. Fuel-burning units, including boilers.
 - 2. Pumps, compressors, condensers, and similar motor-driven units.
 - 3. Heat exchangers, coils, evaporators, heat recovery units, and similar equipment.
 - 4. Fans, blowers, balancing and control dampers, and mixing boxes.
 - 5. Packaged HVAC central-station and zone-type units.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fire department hose valves.
 - c. Meters, gages, thermometers, and similar units.
 - d. Fuel-burning units, including boilers.
 - e. Pumps, compressors, condensers, and similar motor-driven units.
 - f. Heat exchangers, coils, evaporators, heat recovery units, and similar equipment.
 - g. Fans, blowers, balancing and control dampers, and mixing boxes.
 - h. Packaged HVAC central-station and zone-type units.
 - i. Tanks and pressure vessels.
 - j. Strainers, filters, and similar equipment.
- C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.
 - 1. Identify mechanical equipment with equipment markers in the following color codes:
 - a. Green: For cooling equipment and components.
 - b. Yellow: For heating equipment and components.
 - c. Green and Yellow or Orange: For combination cooling and heating equipment and components.
 - d. Brown: For energy-reclamation equipment and components.

- 2. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
- 4. Include signs for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. Fuel-burning units, including boilers.
 - c. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - d. Heat exchangers, coils, evaporators, heat recovery units, and similar equipment.
 - e. Fans, blowers, balancing and control dampers, and mixing boxes.
 - f. Packaged HVAC central-station and zone-type units.
 - g. Tanks and pressure vessels.
 - h. Strainers, filters, water-treatment systems, and similar equipment.
- D. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
 - 2. Pipes with OD, Including Insulation, Less Than 6 Inches : Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 3. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
 - 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches or 2 inches, round.
 - b. Hot Water: 1-1/2 inches or 2 inches, round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - 3. Letter Color:
 - a. Cold Water: Black or White.
 - b. Hot Water: Black or White.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.7 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 15075

SECTION 15082

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Mineral fiber.
 - 2. Adhesives.
 - 3. Mastics.
 - 4. Lagging adhesives.
 - 5. Sealants.
 - 6. Factory-applied jackets.
 - 7. Field-applied fabric-reinforcing mesh.
 - 8. Field-applied jackets.
 - 9. Corner angles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at pipe expansion joints for each type of insulation.
 - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 5. Detail application of field-applied jackets.
 - 6. Detail field application for each equipment type.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation

materials, sealers, attachments, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-testresponse characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000(Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ, ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
- C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.

- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. ITW TACC, Division of Illinois Tool Works; CB-25.
 - d. Marathon Industries, Inc.; 501.
 - e. Mon-Eco Industries, Inc.; 55-10.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 - d. Mon-Eco Industries, Inc.; 55-70.

- 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
- 3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
- 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
- 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-10.
 - b. Foster Products Corporation, H. B. Fuller Company; 35-00.
 - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
 - d. Marathon Industries, Inc.; 550.
 - e. Mon-Eco Industries, Inc.; 55-50.
 - f. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
 - 4. Solids Content: 63 percent by volume and 73 percent by weight.
 - 5. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Mon-Eco Industries, Inc.; 11-30.
 - e. Vimasco Corporation; 136.
 - 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fireresistant lagging cloths over equipment and pipe insulation.
 - 3. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
 - 4. Color: White.

2.5 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.

- d. Mon-Eco Industries, Inc.; 44-05.
- e. Vimasco Corporation; 750.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
- 5. Color: Aluminum.

2.6 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Anodized Class I Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 - 2. Width: 3 inches (75 mm).
 - 3. Thickness: 6.5 mils (0.16 mm).
 - 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - 5. Elongation: 2 percent.
 - 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 - 2. Width: 2 inches (50 mm).
 - 3. Thickness: 3.7 mils (0.093 mm).
 - 4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 - 5. Elongation: 5 percent.
 - 6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.9 SECUREMENTS

- A. Bands:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 - Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) or 3/4 inch (19 mm) wide with wing or closed seal.

2.10 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.

- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies.

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts.

- 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
- 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
- 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- 8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, and switches on insulated pipes and tanks. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Finish exposed surfaces with a metal jacket.

3.6 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

- 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
 - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 4. Install insulation to flanges as specified for flange insulation application.
- 3.7 FIELD-APPLIED JACKET INSTALLATION
 - A. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
 - B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.8 FINISHES

A. Equipment and Pipe Insulation with Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 9 painting Sections.

- 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect field-insulated equipment, randomly selected by Architect, by removing fieldapplied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 - 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate equipment in paragraphs below that is not factory insulated.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water subject to freezing:
 - 1. NPS 1 (DN 25) and Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch (13 mm) thick.
 - 2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the fieldapplied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. None.
- D. Piping, Exposed:
 - 1. Aluminum, Corrugated: 0.040 inch (1.0 mm) thick.
 - 2. Painted Aluminum, Corrugated 0.032 inch (0.81 mm) thick.
- 3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
 - A. Install jacket over insulation material. For insulation with factory-applied jacket, install the fieldapplied jacket over the factory-applied jacket.
 - B. If more than one material is listed, selection from materials listed is Contractor's option.
 - C. Piping, Concealed:
 - 1. None.
 - D. Piping, Exposed:
 - 1. Painted Aluminum, Corrugated with Z-Shaped Locking Seam: 0.040 inch (1.0 mm) thick.

END OF SECTION 15082

SECTION 15110

VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This Section includes the following general-duty valves:1. 316 stainless steel ball valves.

1.3 DEFINITIONS

- A. The following are standard abbreviations for valves:
 - 1. CWP: Cold working pressure.
 - 2. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: ASME B31.9 for building services piping valves.
 - 1. Exceptions: Domestic hot- and cold-waterpiping valves unless referenced.
- B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.

- 3. Set angle, gate, and globe valves closed to prevent rattling.
- 4. Set ball and plug valves open to minimize exposure of functional surfaces.
- 5. Set butterfly valves closed or slightly open.
- 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 VALVES, GENERAL

- A. Refer to Part 3 "Valve Applications" Article for applications of valves.
- B. 316 Stainless Steel Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
- C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- E. Valve Actuators:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. Lever Handle: For quarter-turn valves NPS 2 and smaller, except plug valves.
- F. Extended Valve Stems: On insulated valves.
- G. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves, and ASME B16.24 for bronze valves.
- H. Valve Grooved Ends: AWWA C606.
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.

- 2. Threaded: With threads according to ASME B1.20.1.
- I. Valve Bypass and Drain Connections: MSS SP-45.

2.3 STAINLESS STEEL BALL VALVES

- A. Available Manufacturers:
 - 1. Three-Piece, Stainless Steel Ball Valves:
 - a. Conbraco Industries, Inc.; Apollo Div.
 - b. DynaQuip Controls.
 - c. Grinnell Corporation.
 - d. Hammond Valve.
 - e. Jamesbury, Inc.
 - f. Kitz Corporation of America.
 - g. NIBCO INC.
 - h. PBM, Inc.
 - i. Red-White Valve Corp.
 - j. Worcester Controls.

2.4 VALVE APPLICATIONS

- A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball valves.
 - 2. Throttling Service: Ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- C. Domestic Water Piping: Use the following types of valves:
 1. Ball Valves, NPS 2 and Smaller: Three-piece, 600-psig CWP rating, stainless steel.
- D. Select valves, except wafer and flangeless types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Solder-joint.
 - 2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 3. For Grooved-End, Copper Tubing and Steel Piping: Valve ends may be grooved.

2.5 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

2.6 JOINT CONSTRUCTION

- A. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

2.7 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 15110

SECTION 15126

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. Section Includes:1. Gages.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.
- C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

- A. 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:
 1. Trerice, H. O. Co. 700 series
- B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 - 1. Case: Liquid-filled type, drawn 316 stainless steel 4-1/2-inch diameter.
 - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 - 3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
 - 4. Movement: Mechanical, with link to pressure element and connection to pointer.

- 5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- 6. Pointer: Red or another dark-color metal.
- 7. Window: Glass.
- 8. Ring: 316 stainless steel.
- 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
- 10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
- 11. Range for Fluids under Pressure: Two times operating pressure.
- C. Pressure-Gage Fittings:
 - 1. Valves: NPS 1/4 316 stainless-steel needle type.
 - 2. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

PART 3 - EXECUTION

3.1 GAGE APPLICATIONS

A. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.2 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install thermowells with socket extending a minimum of 2 inches into fluid, or to center of pipe, and in vertical position in piping tees where thermometers are indicated.
- C. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- D. Install needle-valve and snubber fitting in piping for each pressure gage.
- E. Install test plugs in tees in piping.
- F. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
- G. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION 15126

SECTION 15140

HOT AND COLD WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This Section includes domestic water piping inside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- 2.2 CPVC PIPING
- A. CPVC Schedule 80 Pipe: ASTM F 441/F 441M.

- 1. CPVC Schedule 80 Fittings: ASTM F 439, socket type or ASTM F 437, threaded type.
- B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.
- 2.3 VALVES
- A. CPVC Union Ball Valves: MSS SP-122, with full-port ball, socket or threaded detachable end connectors, and pressure rating not less than 150 psig (1035 kPa) at 73 deg F (23 deg C).
- B. CPVC Non-Union Ball Valves: MSS SP-122, with full- or reduced-port ball, socket or threaded ends, and pressure rating not less than 150 psig (1035 kPa) at 73 deg F (23 deg C).
- C. CPVC Check Valves: Swing or ball-check design and pressure rating not less than 150 psig (1035 kPa) at 73 deg F (23 deg C).

PART 3 - EXECUTION

- 3.1 PIPE AND FITTING APPLICATIONS
- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.
- C. Grooved joints may be used on aboveground grooved-end piping.
- D. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- E. Aboveground Domestic Water Piping: Use any of the following piping materials for each size range:
 - 1. NPS 1(DN 25) and Smaller: CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
 - 2. NPS 1 (DN 25) and Smaller: CPVC, Schedule 80 pipe; CPVC, Schedule 80 socket fittings; and solvent-cemented joints.
 - 3. NPS 1-1/4 and NPS 1-1/2 (DN 32 and DN 40): CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
 - 4. NPS 1-1/4 and NPS 1-1/2 (DN 32 and DN 40): CPVC, Schedule 80 pipe; CPVC, Schedule 80 socket fittings; and solvent-cemented joints.
 - 5. NPS 2 (DN 50): CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
 - 6. NPS 2 (DN 50): CPVC, Schedule 80; CPVC, Schedule 80 socket fittings; and solventcemented joints.
 - 7. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
 - 8. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): CPVC, Schedule 80 pipe; CPVC, Schedule 80 socket fittings; and solvent-cemented joints.
 - 9. NPS 4 to NPS 6 (DN 100 to DN 150): CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
10. NPS 4 to NPS 6 (DN 100 to DN 150): CPVC, Schedule 80 pipe; CPVC, Schedule 80 socket fittings; and solvent-cemented joints.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 and smaller. Use castiron butterfly valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water-Piping, Balancing Duty: Memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use gate valves for piping NPS 2-1/2 and larger.
- C. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install stainless steel sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section 15050, 3.1, N, "Basic Mechanical Materials and Methods."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 15 Section "Meters and Gages," and drain valves and strainers are specified in Division 15 Section "Plumbing Specialties."
- D. Install water-pressure regulators downstream from shutoff valves. Water-pressure regulators are specified in Division 15 Section "Plumbing Specialties."
- E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
 - 1. Plumbing Fixtures: Cold-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section 15410 "Plumbing Fixtures."
 - 2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.7 ADJUSTING

- A. Perform the following adjustments before operation:
 - 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 - 5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 15140

SECTION 15145

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Backflow preventers.
 - 2. Hose bibbs.
 - 3. Water hammer arresters.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Wilkens.
 - b. Apollo.
 - c. Watts Industries, Inc.
 - 2. The backflow prevention device shall be the type listed in the JEA's "Rules and Regulations for Water and Wastewater Services" manual.
 - 3. Backflow prevention devices shall have freeze valves and stainless steel valve handles.
 - 4. JEA's approved Freeze Protection Device is Dole SP35 or Dole SP45.
 - 5. Standard: ASSE 1013.
 - 6. Operation: Continuous-pressure applications.
 - 7. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
 - 8. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550, or steel with interior lining complying with AWWA C550 for NPS 2-1/2 and larger.
 - 9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 10. Configuration: Designed for horizontal, straight through flow.
 - 11. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.2 HOSE BIBBS

- A. Hose Bibbs
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Woodford Manufacturing Company.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.

- 2. Standard: ASME A112.18.1 for sediment faucets.
- 3. Body Material: Bronze.
- 4. Seat: Bronze, replaceable.
- 5. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
- 6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
- 7. Pressure Rating: 125 psig.
- 8. Vacuum Breaker: Integral, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
- 9. Finish for Service Areas: Chrome or nickel plated.
- 10. Operation for Service Areas: Wheel handle.
- 11. Include wall flange with each chrome- or nickel-plated hose bibb.

2.3 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. PPP Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Metal bellows.
 - 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15050 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.

- C. Install water hammer arresters in water piping according to PDI-WH 201.
- D. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 16 Section 16060 "Grounding and Bonding."
- C. Connect wiring according to Division 16 Section 16120 "Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Backflow preventers.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section 15075 "Mechanical Identification."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION 15145

SECTION 15150

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

2.4 SPECIAL PIPE FITTINGS

- A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco, Inc.
 - c. Logan Clay Products Company (The).
 - d. Mission Rubber Co.
 - e. NDS, Inc.
 - f. Plastic Oddities, Inc.
 - 2. Sleeve Materials:
 - a. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with fulllength, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Mission Rubber Co.
- C. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

- 1. Manufacturers:
 - a. SIGMA Corp.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground soil, waste, vent, and storm drainage piping in the two story office space shall be:
 - 1. Shielded, stainless-steel couplings; and hubless-coupling joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
- C. Underground, soil, waste, and vent piping shall be:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.2 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section 15050 "Basic Mechanical Materials and Methods."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Installations involving back-to-back blow-out water closets must be made with sanitary waste fittings that prevent cross flow. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- D. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- E. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for NPS 2 piping; 1 percent downward in direction of flow for piping NPS 3 and larger.
 - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

- F. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- G. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section 15050 "Basic Mechanical Materials and Methods."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 15 Section "Valves."
- B. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
 - 1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 - 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
 - 3. Install backwater valves in accessible locations.
 - 4. Backwater valve are specified in Division 15 Section "Domestic Water Piping Specialties."

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water . From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 15150

SECTION 15155

DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Roof flashing assemblies.
 - 4. Through-penetration firestop assemblies.
 - 5. Miscellaneous drainage piping specialties.
 - 6. Flashing materials.

1.3 SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.

- e. Watts Drainage Products Inc.
- f. Zurn Plumbing Products Group; Specification Drainage Operation.
- g. Josam Company; Blucher-Josam Div.
- 2. Standard: ASME A112.36.2M for cast iron, ASME A112.3.1 for stainless steel for cleanout test tee.
- 3. Size: Same as connected drainage piping
- 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch, Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk or raised-head, brass or cast-iron plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Light Commercial Operation.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
 - 3. Size: Same as connected branch.
 - 4. Type: Heavy-duty, adjustable housing.
 - 5. Body or Ferrule: Cast iron.
 - 6. Outlet Connection: Inside calk, Spigot, or Threaded.
 - 7. Closure: Brass plug with straight threads and gasket, or Brass plug with tapered threads.
 - 8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
 - 9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy; Polished bronze; Rough bronze.
 - 10. Frame and Cover Shape: Round or Square.
 - 11. Top Loading Classification: Heavy Duty.
 - 12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- C. Cast-Iron Wall Cleanouts :
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M. Include wall access.
 - 3. Size: Same as connected drainage piping.

- 4. Body: Hub-and-spigot, cast-iron soil pipe T-branch, Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk or raised-head, brass plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 7. Wall Access: Round, stainless-steel cover plate with screw. Provide security screw where wall access is exposed.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Commercial Enameling Co.
 - b. Josam Company; Josam Div.
 - c. MIFAB, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Light Commercial Operation.
 - h. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.6.3[with backwater valve].
 - 3. Body Material: Gray iron.
 - 4. Seepage Flange: As required.
 - 5. Anchor Flange: As required.
 - 6. Clamping Device: As required.
 - 7. Outlet: Bottom or Side.
 - 8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
 - 9. Top or Strainer Material: Bronze, Gray iron, Nickel bronze, or Stainless steel.
 - 10. Top of Body and Strainer Finish: Nickel bronze, Polished bronze, Rough bronze, or Stainless steel.
 - 11. Top Shape: Round or Square.
 - 12. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - 13. Trap Material: Cast iron.
 - 14. Trap Pattern: Deep-seal P-trap, or Standard P-trap.
 - 15. Trap Features: Trap-seal primer valve drain connection.

2.3 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

- A. Deep-Seal Traps:
 - 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - 2. Size: Same as connected waste piping.
 - a. NPS 2 : 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- B. Floor-Drain, Trap-Seal Primer Fittings:

- 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
- 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.
- C. Air-Gap Fittings:
 - 1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - 2. Body: Bronze or cast iron.
 - 3. Inlet: Opening in top of body.
 - 4. Outlet: Larger than inlet.
 - 5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- D. Vent Caps:
 - 1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
 - 2. Size: Same as connected stack vent or vent stack.
- E. Expansion Joints:
 - 1. Standard: ASME A112.21.2M.
 - 2. Body: Cast iron with bronze sleeve, packing, and gland.
 - 3. End Connections: Matching connected piping.
 - 4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

- 1. Position floor drains for easy access and maintenance.
- 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
- 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
- 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- L. Install vent caps on each vent pipe passing through roof.
- M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- 3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 15 Section "Mechanical Identification."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15155

SECTION 15410

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories, showers and sinks.
 - 2. Toilet seats.
 - 3. Protective shielding guards.
 - 4. Fixture supports.
 - 5. Water closets.
 - 6. Lavatories.
 - 7. Service sinks.

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
- C. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
 - 2. Vitreous-China Fixtures: ASME A112.19.2M.
 - 3. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
- G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Faucets: ASME A112.18.1.
 - 2. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 3. NSF Potable-Water Materials: NSF 61.
 - 4. Pipe Threads: ASME B1.20.1.
 - 5. Supply Fittings: ASME A112.18.1.
 - 6. Brass Waste Fittings: ASME A112.18.2.
- H. Comply with the following applicable standards and other requirements specified for shower faucets:
 - 1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 - 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - 3. Faucets: ASME A112.18.1.
 - 4. Hand-Held Showers: ASSE 1014.
 - 5. Hose-Coupling Threads: ASME B1.20.7.
 - 6. Pipe Threads: ASME B1.20.1.
 - 7. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.

- 2. Brass and Copper Supplies: ASME A112.18.1.
- 3. Brass Waste Fittings: ASME A112.18.2.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Flexible Water Connectors: ASME A112.18.6.
 - 2. Floor Drains: ASME A112.6.3.
 - 3. Grab Bars: ASTM F 446.
 - 4. Hose-Coupling Threads: ASME B1.20.7.
 - 5. Off-Floor Fixture Supports: ASME A112.6.1M.
 - 6. Pipe Threads: ASME B1.20.1.
 - 7. Plastic Toilet Seats: ANSI Z124.5.
 - 8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period for Commercial Applications: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

- A. Lavatory Faucets:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Chicago Faucets.

2.2 TOILET SEATS

- A. Toilet Seats:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard Companies, Inc.

b. Zurn Plumbing Products Group.

2.3 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Engineered Brass Co.
 - b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing Co., Inc.
 - d. Plumberex Specialty Products Inc.
 - e. TCI Products.
 - f. TRUEBRO, Inc.
 - g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and coldwater supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. TRUEBRO, Inc.
 - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and coldwater supplies and trap and drain piping. Comply with ADA requirements.

2.4 FIXTURE SUPPORTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Company.
 - 2. MIFAB Manufacturing Inc.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Tyler Pipe; Wade Div.
 - 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- C. Lavatory Supports:
 - 1. Description: Type I, lavatory carrier with exposed arms and tie rods. Type II, lavatory carrier with concealed arms and tie rod. Type III, lavatory carrier with hanger plate and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

2. Accessible-Fixture Support: Include rectangular steel uprights.

2.5 WATER CLOSETS

- A. Water Closets:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard Companies, Inc.- Champion 4; Model 2002.014
 - b. Zurn. Z-HPT; Model Z5551-K
 - c. Kohler Co. Cimarron; Model K-3589

2.6 LAVATORIES

- A. Lavatories:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard Companies, Inc.
 - b. Zurn
 - c. Kohler Co.

2.7 SERVICE SINKS

- A. Service Sinks:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Standard companies, Inc.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Precast Terrazzo Enterprises, Inc.
 - d. Stern-Williams Co., Inc.
 - e. Mustee, E. L. & Sons, Inc.
 - f. Swan Corporation (The).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 15 Section "Valves."
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- K. Install toilet seats on water closets.
- L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- M. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- N. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- O. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- P. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

- Q. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section 15050 "Basic Mechanical Materials and Methods."
- R. Set service sinks in leveling bed of cement grout. Grout is specified in Division 15 Section "Basic Mechanical Materials and Methods."
- S. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

- 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
- 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15410

SECTION 15815

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa). Metal ducts include the following:
 - 1. Rectangular ducts and fittings.
 - 2. Single-wall, round spiral-seam ducts and formed fittings.
 - 3.
- B. Related Sections include the following:
 - 1. Division 15 Section "Duct Accessories" for dampers, sound-control devices, ductmounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 SUBMITTALS

- A. Shop Drawings: 1/4 inch equals 1 foot (1:50) scale. Show fabrication and installation details for metal ducts.
 - 1. IFabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Duct layout indicating sizes and pressure classes.
 - 3. Elevations of top and bottom of ducts.
 - 4. Dimensions of main duct runs from building grid lines.

- 5. Fittings.
- 6. Reinforcement and spacing.
- 7. Seam and joint construction.
- 8. Penetrations through fire-rated and other partitions.
- 9. Equipment installation based on equipment being used on Project.
- 10. Duct accessories, including access doors and panels.
- 11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.
- B. Coordination Drawings: Drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Other systems installed in same space as ducts.
 - 2. Access doors and panels required to provide access to dampers and other operating devices.
 - 3. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- C. Welding certificates.
- D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.6, "Structural Welding Code—Stainless Steel," for hangers and supports, AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. NFPA Compliance:
 - 1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Aluminum Sheets: ASTM B 209 (ASTM B 209M), alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- C. Reinforcement Shapes and Plates: Stainless steel reinforcement where installed on aluminum sheet metal ducts.
- D. Tie Rods: Stainless steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 SEALANT MATERIALS

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
- B. Joint and Seam Tape: 2 inches (50 mm) wide; glass-fiber-reinforced fabric.
- C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.
- E. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.
- F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
- G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
 - 1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 - 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
 - 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Nexus Inc.
 - c. Ward Industries, Inc.

- C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
 - 1. Available Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Lockformer.
 - 2. Duct Size: Maximum 30 inches (750 mm) wide and up to 2-inch wg (500-Pa) pressure class.
 - 3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.
- D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of nonbraced panel area unless ducts are lined.

2.5 ROUND DUCT AND FITTING FABRICATION

- A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.
- B. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- C. Duct Joints:
 - 1. Ducts up to 20 Inches (500 mm) in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
 - 2. Ducts 21 to 72 Inches (535 to 1830 mm) in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
 - 3. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
 - a. Available Manufacturers:
 - 1) Ductmate Industries, Inc.
 - 2) Lindab Inc.
- D. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.
- E. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- F. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of dieformed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:
 - 1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

- 2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa):
 - a. Ducts 3 to 36 Inches (75 to 915 mm) in Diameter: 0.034 inch (0.85 mm).
- 3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg (500 to 2500 Pa):
 - a. Ducts 3 to 26 Inches (75 to 660 mm) in Diameter: 0.034 inch (0.85 mm).
- 4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for materialhandling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
- 5. Round Elbows 8 Inches (200 mm) and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
- 6. Round Elbows 9 through 14 Inches (225 through 355 mm) in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
- 7. Round Elbows Larger Than 14 Inches (355 mm) in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.
- 8. Die-Formed Elbows for Sizes through 8 Inches (200 mm) in Diameter and All Pressures 0.040 inch (1.0 mm) thick with 2-piece welded construction.
- 9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
- 10. Pleated Elbows for Sizes through 14 Inches (355 mm) in Diameter and Pressures through 10-Inch wg (2500 Pa): 0.022 inch (0.55 mm).

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

- A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Supply Ducts: 2-inch wg (500 Pa).
 - 2. Exhaust Ducts (Negative Pressure): 2-inch wg (500 Pa).
- B. All ducts shall be Aluminum.

3.2 DUCT INSTALLATION

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Install round ducts in lengths not less than 12 feet (3.7 m) unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install fabricated fittings for changes in directions, size, and shape and for connections.

- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches (300 mm), with a minimum of 3 screws in each coupling.
- F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
- I. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- J. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- K. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- L. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches (38 mm).
- M. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories."
- N. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

3.3 SEAM AND JOINT SEALING

- A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.
 - 1. For pressure classes lower than 2-inch wg (500 Pa), seal transverse joints.
- B. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

- A. Support horizontal ducts within 24 inches (600 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- B. Support vertical ducts at maximum intervals of 16 feet (5 m) and at each floor.
- C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

- D. Install concrete inserts before placing concrete.
- E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (500 Pa) (both positive and negative pressures).
 - 4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

3.7 CLEANING NEW SYSTEMS

- A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- B. Use service openings, as required, for physical and mechanical entry and for inspection.
 - 1. Create other openings to comply with duct standards.
 - 2. Disconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling sections to gain access during the cleaning process.
- C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
- D. Clean the following metal duct systems by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).

- 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
- 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, filters and filter sections, and condensate collectors and drains.
- 4. Coils and related components.
- 5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
- 6. Supply-air ducts, dampers, actuators, and turning vanes.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct accessories.
 - 4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
- F. Cleanliness Verification:
 - 1. Visually inspect metal ducts for contaminants.
 - 2. Where contaminants are discovered, re-clean and reinspect ducts.

3.8 CLEANING EXISTING SYSTEMS

- A. Use service openings, as required, for physical and mechanical entry and for inspection.
 - 1. Use existing service openings where possible.
 - 2. Create other openings to comply with duct standards.
 - 3. Disconnect flexible ducts as needed for cleaning and inspection.
 - 4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
 - 5. Remove and reinstall ceiling sections to gain access during the cleaning process.
- B. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.
- C. Particulate Collection and Odor Control:
 - 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or larger) particles.
 - 2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.
- D. Clean the following metal duct systems by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
- 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
- 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
- 4. Coils and related components.
- 5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
- 6. Supply-air ducts, dampers, actuators, and turning vanes.
- 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 - 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 - 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct accessories.
 - 4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
 - 5. Provide operative drainage system for washdown procedures.
 - 6. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.
- F. Cleanliness Verification:
 - 1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
 - 2. Visually inspect metal ducts for contaminants.
 - 3. Where contaminants are discovered, re-clean and reinspect ducts.
- G. Gravimetric Analysis: At discretion and expense of Owner, sections of metal duct system, chosen randomly by Owner, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.
 - 1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
 - 2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal duct system shall be re-cleaned and re-verified.
- H. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

END OF SECTION 15815

SECTION 15820

DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Volume dampers.
 - 2. Turning vanes.
 - 3. Duct-mounting access doors.
 - 4. Flexible connectors.
 - 5. Duct accessory hardware.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Volume dampers.
 - 2. Turning vanes.
 - 3. Duct-mounting access doors.
 - 4. Flexible connectors.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Special fittings.
 - 2. Manual-volume damper installations.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. 316 Stainless Steel: ASTM A 480/A 480M.
- C. Anodized Class I Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Anodized Class I Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- E. Tie Rods: Stainless steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches .

2.3 VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance, Inc.
 - 2. American Warming and Ventilating.
 - 3. Flexmaster U.S.A., Inc.
 - 4. McGill AirFlow Corporation.
 - 5. METALAIRE, Inc.
 - 6. Nailor Industries Inc.
 - 7. Penn Ventilation Company, Inc.
 - 8. Ruskin Company.
 - 9. Vent Products Company, Inc.
 - 10. Lindab, Inc.
 - 11. Eastern Sheet Metal
- B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
 - 1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications.

- 1. Steel Frames: Hat-shaped, 316 stainless sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
- 2. Roll-Formed Steel Blades: 0.064-inch- thick, 316 stainless sheet steel.
- 3. Blade Axles: 316 Stainless steel.
- 4. Bearings: 316 Stainless-steel sleeve.
- 5. Tie Bars and Brackets: 316 stainless steel.
- D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat, U, or Angle-shaped, 316 stainless sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 - 2. Roll-Formed Steel Blades: 0.064-inch- thick, 316 stainless sheet steel.
 - 3. Blade Axles: 316 stainless steel.
 - 4. Bearings: 316 stainless steel sleeve thrust or ball.
 - 5. Blade Seals: Felt, Vinyl, or Neoprene.
 - 6. Jamb Seals: Cambered 316 stainless steel or anodized class I aluminum.
 - 7. Tie Bars and Brackets: 316 stainless steel or anodized class I aluminum.
- E. Jackshaft: 1-inch- diameter, 316 stainless steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick 316 stainless steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, double-vane, curved blades of 316 stainless sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Duro Dyne Corp.
 - c. METALAIRE, Inc.
 - d. Ward Industries, Inc.
- C. Acoustic Turning Vanes: Fabricate airfoil-shaped anodized class I aluminum extrusions with perforated faces and fibrous-glass fill.

2.5 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

- B. Door: Double wall, duct mounting, and rectangular; fabricated of anodized class I aluminum sheet metal with insulation fill and thickness as indicated for duct pressure class. Include 1-by-1-inch butt or piano hinge and cam latches.
 - 1. Manufacturers:
 - a. American Warming and Ventilating.
 - b. CESCO Products.
 - c. Ductmate Industries, Inc.
 - d. Flexmaster U.S.A., Inc.
 - e. Greenheck.
 - f. McGill AirFlow Corporation.
 - g. Nailor Industries Inc.
 - h. Ventfabrics, Inc.
 - i. Ward Industries, Inc.
 - 2. Frame: Anodized class I aluminum, with bend-over tabs and foam gaskets.
 - 3. Provide number of hinges and locks as follows:
 - a. Less Than 12 Inches Square: Secure with two sash locks.
 - b. Up to 18 Inches Square: Two hinges and two sash locks.
 - c. Up to 24 by 48 Inches : Three hinges and two compression latches.
 - d. Sizes 24 by 48 Inches and Larger: One additional hinge.
- C. Door: Double wall, duct mounting, and round; fabricated of anodized class I aluminum sheet metal with insulation fill and 1-inch thickness. Include cam latches.
 - 1. Manufacturers:
 - a. Ductmate Industries, Inc.
 - b. Flexmaster U.S.A., Inc.
 - 2. Frame: Anodized class I aluminum, with spin-in notched frame.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.6 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Corp.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.
- B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- C. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd. .
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.

3. Service Temperature: Minus 67 to plus 500 deg F .

2.7 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: anodized class I cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts.
- C. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- D. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- E. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Downstream from volume dampers, turning vanes, and equipment.
 - 3. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
 - 4. On sides of ducts where adequate clearance is available.
- F. Install the following sizes for duct-mounting, rectangular access doors:
 - 1. Two-Hand Access: 12 by 6 inches .
- G. Install the following sizes for duct-mounting, round access doors:
 - 1. Two-Hand Access: 10 inches in diameter.
- H. Label access doors according to Division 15 Section 15075 "Mechanical Identification."
- I. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- J. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Division 15 Section 15950 "Testing, Adjusting, and Balancing."

END OF SECTION 15820

SECTION 15838

POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators.
 - 2. Hooded Propeller Supply fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators for designing vibration isolation bases.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

- C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Size and location of initial access modules for acoustical tile.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Greenheck.
 - 2. Loren Cook Company.
 - 3. Penn Ventilation.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Where fiberglass construction is specified, all FRP surfaces shall be ground smooth prior to top coating to ensure there are no exposed glass fibers. All hardware located within the airstream shall be made of stainless steel and encapsulated in FRP. Finish color shall be gray. No exposed metal parts in the airstream will be allowed.
- D. Where fiberglass construction is specified, the housings shall be made using fire retardant resins. All interior surfaces of the housing exposed to the airstream shall be resin rich and contain no more than 20% of "C" grade glass veil. The exterior surfaces of the housing shall be resin rich and use a paraffinated resin stabilized against ultraviolet degradation. No exposed metal parts will be allowed within the airstream. The finish color shall be gray. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings bearings and coated with enamel or epoxy to prevent corrosion.
- E. Where fiberglass construction is specified, fan wheel shall be manufactured from a FRP encapsulated steel hub and backplate with FRP blades strapped in for added strength. The wheels will be made using a non-fire retardant resin chosen for strength characteristics. Finish color shall be gray. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency. The shaft shall be 304 stainless steel.
- F. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 4. Fan and motor isolated from exhaust airstream.
- G. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, anodized class I aluminum wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

- H. Roof Curbs: Polymer coated aluminum; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
 - 2. Overall Height: 12 inches (300 mm).
 - 3. Pitch Mounting: Manufacture curb for roof slope.
 - 4. Metal Liner: Anodized class I aluminum sheet metal.

HOODED PROPELLER SUPPLY FANS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Penn Ventilation.
 - 2. Greenheck.
 - 3. Loren Cook Company.
- B. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.
- C. Housing: Polymer coated aluminum with flanged edges and integral orifice ring with bakedenamel finish coat applied after assembly.
- D. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- E. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- F. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: L₁₀ of 100,000 hours.
 - 3. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Belt Guards: Fabricate of 316 stainless steel for motors mounted on outside of fan cabinet.
- G. Accessories:
 - 1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
 - 2. Motor-Side Back Guard: Aluminum, complying with OSHA specifications, removable for maintenance.
 - 3. Wall Sleeve: Aluminum to match fan and accessory size.
 - 4. Weathershield Hood: Aluminum to match fan and accessory size.
 - 5. Weathershield Front Guard: Aluminum with expanded metal screen.

- 6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
- 7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.3 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch (25 mm).
- C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware.
- D. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.

- 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
- 5. Adjust belt tension.
- 6. Adjust damper linkages for proper damper operation.
- 7. Verify lubrication for bearings and other moving parts.
- 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
- 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
- 10. Shut unit down and reconnect automatic temperature-control operators.
- 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

END OF SECTION 15838

SECTION 15950

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-air volume systems.
 - 2. HVAC equipment quantitative-performance settings.
 - 3. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- F. Report Forms: Test data sheets for recording test data in logical order.
- G. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- H. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- I. TAB: Testing, adjusting, and balancing.

- J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- K. Test: A procedure to determine quantitative performance of systems or equipment.
- L. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- E. Sample Report Forms: Submit two sets of sample TAB report forms.
- F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

- 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
- E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
- B. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

- 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
- 2. Systems are balanced to optimum performance capabilities within design and installation limits.
- PART 2 PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
 - 2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flowcontrol devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine equipment for installation and for properly operating safety interlocks and controls.
- L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Equipment and duct access doors are securely closed.
 - 3. Balance dampers are open.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut ducts and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

- D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, and heat recovery equipment, under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fanmotor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
- 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.7 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.

3.8 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to

HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.9 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB firm who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer, type size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports varies from indicated values.
 - 15. Test conditions for fans performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.

- c. Fan drive settings including settings and percentage of maximum pitch diameter.
- d. Settings for supply-air, static-pressure controller.
- e. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outside, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.
 - 3. Balancing stations.
 - 4. Position of balancing devices.
- F. Air-Handling Unit Test Reports: For Fans and air-handling units, include the following:
 - 1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches (mm), and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Airflow in cfm (L/s).
 - g. Damper position.
- G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.

- d. Capacity in Btuh (kW).
- e. Number of stages.
- f. Connected volts, phase, and hertz.
- g. Rated amperage.
- h. Airflow rate in cfm (L/s).
- i. Face area in sq. ft. (sq. m).
- j. Minimum face velocity in fpm (m/s).
- 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btuh (kW).
 - b. Airflow rate in cfm (L/s).
 - c. Air velocity in fpm (m/s).
 - d. Entering-air temperature in deg F (deg C).
 - e. Leaving-air temperature in deg F (deg C).
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches (mm), and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches (mm), and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
 - g. Number of belts, make, and size.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).
- I. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling unit number.

- b. Location and zone.
- c. Traverse air temperature in deg F (deg C).
- d. Duct static pressure in inches wg (Pa).
- e. Duct size in inches (mm).
- f. Duct area in sq. ft. (sq. m).
- g. Indicated airflow rate in cfm (L/s).
- h. Indicated velocity in fpm (m/s).
- i. Actual airflow rate in cfm (L/s).
- j. Actual average velocity in fpm (m/s).
- k. Barometric pressure in psig (Pa).
- J. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft. (sq. m).
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary airflow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final airflow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).
- K. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.10 INSPECTIONS

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
 - 2. Randomly check the following for each system:

- a. Measure airflow of at least 10 percent of air outlets.
- b. Measure water flow of at least 5 percent of terminals.
- c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
- d. Measure sound levels at two locations.
- e. Measure space pressure of at least 10 percent of locations.
- f. Verify that balancing devices are marked with final balance position.
- g. Note deviations to the Contract Documents in the Final Report.
- B. Final Inspection:
 - 1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report.

3.11 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 15950

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to Division 16 Sections, in addition to Division 1 - General Requirements.

1.02 SCOPE

- A. This scope covers the furnishing, installation, testing, adjusting and placing in operation all electrical equipment, devices, facilities, materials, and auxiliary items necessary for the complete and successful operation of all electrical equipment as herein described, shown on the plans, or deemed necessary for the completion of the electrical portion of the project. It is the intent of DIVISION 16 to outline the electrical requirements of the contract in order to provide the information necessary for the construction of a fully operational system as shown on the plans and as herein described. A comprehensive electrical scope of work is as follows:
 - 1. Electrical Demolition as Shown on the Drawings
 - 2. Power/Electrical System
 - 3. Lighting System
 - 4. Control System
 - 5. Utility Work
 - 6. Connection of Electrically Powered Mechanical Equipment
 - 7. Temporary Construction Power
 - 8. All Incidentals Necessary for a Complete and Fully Operational Electrical System.

1.03 WORKING CLEARANCES

- A. Working clearances around equipment requiring electrical services shall be verified by Contractor to comply with Code requirements. Should there be apparent violations of clearances; the Contractor shall notify the Engineer before proceeding with connection or placing of equipment.
- B. In the case of panelboards, safety switches and other equipment requiring wire and cable terminations, the Contractor shall ascertain that lug sizes and wiring

gutters or space allowed for proper accommodation and termination of the wires and cables are adequate.

1.04 WORKMANSHIP

A. Workmanship under this Division shall be accomplished by persons skilled in the performance of the required task. All work shall be done in keeping with conventions of the trade. Work of this Division shall be closely coordinated with work of other trades to avoid conflict and interference.

1.05 PROTECTION OF ELECTRICAL EQUIPMENT

A. Electrical equipment shall be protected by the weather, especially from water dripping or splashing upon it, at all times during shipment, storage and after installation. Should any apparatus be subjected to possible injury by water, it shall be thoroughly dried out and put through a dielectric test, at the expense of the contractor, to ascertain the suitability of this apparatus. The results of the test shall be submitted to the Engineer and if the apparatus is found to be unsuitable, the contractor shall replace it without additional cost to the Owner.

1.06 UTILITIES

- A. The electrical contractor shall install a fully operational electrical service as described in the plans.
- B. Arrange with the utility company for the services and install the services in accordance with their requirements, regulations and recommendations.

1.07 GUARANTEE

- A. Contractor shall guarantee all light bulbs. Fluorescent and HID lamps, starters, and ballasts shall be guaranteed for a period of one (1) year after the building is occupied. Incandescent bulbs shall be guaranteed for a period of 30 days after occupancy. Guarantee shall include material and labor for re-lamping.
- B. The Contractor shall guarantee all other electrical systems, materials and workmanship to be free from defects for a period of one (1) year from the date of final acceptance. He shall correct all defects arising within this period upon notification by the Owner or Engineer, without additional compensation.
- C. It is understood that the rights and benefits given the Owner by the guarantees found in the technical specifications are in addition to and not in derogation of any rights or benefits found in the special and general provisions of the contract.

1.08 TEMPORARY LIGHTS DURING CONSTRUCTION

A. It shall be the responsibility of the Contractor to provide and maintain adequate temporary lighting at all times during construction, so that the various other

trades can accomplish their work in a flawless manner. Particular attention will be given to lighting for masonry, drywall, painting, tile work and any other finish work.

1.09 MATERIAL STANDARDS

A. Material shall be new and comply with standards of Underwriters' Laboratories, Inc., where standards have been established for the particular product and the various NEMA, ANSI, ASTM, IEEE, AEIC, IPCEA or other publications referenced.

1.10 TEST EQUIPMENT

A. The contractor shall provide all test equipment and supplies deemed necessary by the Engineer at no extra cost to the Owner. These supplies shall include but not be limited to the following: volt meters, amp meters, light meters, fuel, generator load banks, watt meters, harmonic distortion test equipment, thermal image camera, high pot test equipment, power quality analyzers, and oscilloscopes.

1.11 REFERENCES

- A. ANSI/NFPA 70 National Electrical Code.
- B. ANSIC2 National Electrical Safety Code.
- C. NEMA National Electrical Manufacturer's Assoc.
- D. UL Underwriters Laboratories
- E. NFPA National Fire Protection Assoc.
- F. IEEE The Institute of Electrical and Electronics Engineers
- G. IESNA The Illuminating Engineering Society of North America
- H. NETA International Electrical Testing Association
- I. Recommended Standards for Water Works and Wastewater Facilities as published by Great Lakes – Upper Mississippi River Board of State Public Health and Environmental Managers.
- 1.12 SUBMITTAL
 - A. Submit under provisions of the General Provisions.

- 1. The Contractor installing all Electrical work shall review and approve all electrical shop drawings prior to submittal to the Engineer for review. As part of the review, the installer shall certify the following:
 - a. I hereby certify that the (equipment) (material) (article) shown and marked in this submittal is in compliance with the contract drawing and specifications, can be installed in the allocated space, will be stored in accordance with the manufacturers recommendation, will be installed per NEC, and is submitted for approval.

Certified by: _____ Date: _____

- B. Submit shop drawings and product data grouped to include complete submittal of related systems, products, and accessories in a single submittal. No electrical work may be performed until shop drawings are approved. Submit Shop Drawings on the Following Systems as Grouped Below:
 - 1. Power/Electrical System
 - a. Conduit and Conduit Fittings
 - b. Wire
 - c. Pull Boxes
 - d. Panelboards
 - e. Panelboard Layouts
 - f. Circuit Breakers
 - g. Disconnects
 - h. Fuses
 - i. Conduit Support Systems
 - j. Wiring Devices
 - k. Switchboards
 - 1. Transformers
 - m. Surge Protection Equipment
 - n. Motor Control Centers
 - o. Breaker Coordination Study

- 2. Generator Equipment
 - a. Generator
 - b. Fuel System
 - c. Generator Enclosure
 - d. Low Voltage Transfer Switches
- 3. Lighting System
 - a. All Light Fixtures
 - 1) Computer Printout of Lighting Layout
 - 2) Sample Fixture (as directed by Engineer)
 - 3) IES Photometric Files
- 4. Control System
 - a. PLC
 - b. Software
 - c. I/O Racks
 - d. Field Instruments
 - e. HMI Software
 - f. Control Point-to-Point Drawings
- 5. Miscellaneous Electrical Equipment
 - a. Miscellaneous Electrical Parts
- 6. Drawings
 - a. Coordination drawing of All Electrical Room
 - b. Conduit layout drawings
 - c. Duct drawings
 - d. As-Built Drawings

C. Mark dimensions and values in units to match those specified.

1.13 REGULATORY REQUIREMENTS

- A. Conform to applicable sections of the Building Code and all local rules, regulations and ordinances.
- B. Electrical: Conform to NFPA 70 & National Electric Safety Code
- C. Obtain permits, and request inspections from authority having jurisdiction.
- D. References listed in Paragraph 1.11, this section.
- 1.14 FINAL INSPECTION AND TESTING
 - A. After the electrical installation is complete, the Contractor shall deliver to the Engineer the following information with his request for final inspection.
 - 1. One set of contract drawings marked to show all significant changes in equipment ratings and locations, alterations in locations of conduit runs, or of any data differing from the contract drawings. This shall include revised or changed panelboard and switchgear schedules.
 - 2. Certificates of final inspection from local authority.
 - 3. A tabulation of all motors listing their respective manufacturer, horsepower, nameplate voltage and current, actual running current after installation and overload heater rating.
 - B. The electrical work shall be thoroughly tested to demonstrate that the entire system is in proper working order and in accordance with the plans and specifications. Each motor with its control shall be run as nearly as possible under operating conditions for a sufficient length of time to demonstrate correct alignment, wiring capacity, speed and satisfactory operation. All main switches and circuit breakers shall be operated, but not necessarily at full load. Contractor may be required during final inspection, at the request of the Engineer to furnish test instruments for use during the testing.
 - C. All wiring shall be given a megger test using a 1000 Volt megger. This test shall be performed after conductors are pulled, but before final connections are made. The Engineer shall be given two (2) days' written notice of the anticipated test date so that he may witness the test if so desired. In any event, the Contractor shall record the circuit designation and the megger reading on each phase. This written record shall be submitted to the Engineer. The cost of this test or any retest caused by insufficient megger readings shall be the responsibility of the Contractor (All tests shall be done in accordance with NETA Standards).

1.15 STAFFING

- A. The electrical contractor shall provide a "Master Electrician" who has been deemed a "Master Electrician" by exam through the State, or any other Local Permitting Authority as the Electrical Superintendent for the project. The Electrical Superintendent shall be on the project site any time any electrical work is performed by the contractor.
- B. Submit daily reports from the Master Electrician to the owner and Engineer showing electrical work in progress.

1.16 PROCESS EQUIPMENT

- A. The electrical contractor is required and expected to read all other equipment specifications contained in these documents and provide all required power and control conductors required by said equipment to allow them to function as described.
- B. All equipment for which power is not specifically indicated on the plans shall be provided with power per the NEC to the nearest panelboard, MCC, or switchboard with adequate capacity to serve said equipment as calculated by the NEC.

1.17 AS-BUILT DRAWINGS

- A. The contractor shall provide detailed as-built drawings for the project indicating all power wiring. (All Drawings shall be delivered to the Owner in an AutoCAD 2007 Format.)
- B. The As-Built drawings shall include detailed drawings of all duct banks, underground conduit, above ground conduit, motor control centers, PLC control panels, control drawings. These drawings shall indicate exact location of all underground electrical wiring and fiber optic cable.
- C. The Engineer shall provide electronic copies of all drawings in the bid plans set for use by the contractor.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.
 - 1. Underground distribution grounding.
 - 2. Common ground bonding with lightning protection system.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
 - 1. Ground rods.
 - 2. Ground rings.
 - 3. Grounding arrangements and connections for separately derived systems.
 - 4. Grounding for sensitive electronic equipment.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for periodic testing and inspection of grounding features at ground rings grounding connections for separately derived systems based on NFPA 70.

- a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
- b. Include recommended testing intervals.

1.04 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.02 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type, 1 inch in diameter (length as required to achieve resistance to ground as specified in 3.5, B).

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: All conductors shall be stranded.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus
- E. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

3.03 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air

cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.04 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
 Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode.

Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

- H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building area or item indicated.
 - 1. Install copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches from building foundation.

3.05 FIEVLD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- B. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 5 ohms.
 - 2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
 - 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm.

- 5. Substations and Pad-Mounted Equipment: 5 ohms.
- 6. Manhole Grounds: 10 ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 16073

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.03 DEFINITIONS

- A. IMC: Intermediate metal conduit.
- B. RMC: Rigid metal conduit.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.

- 3. Nonmetallic slotted channel systems. Include Product Data for components.
- 4. Equipment supports.
- 1.06 QUALITY ASSURANCE
 - A. Comply with NFPA 70.
- 1.07 COORDINATION
 - A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
 - B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Stainless Steel Slotted Support Systems: Comply with MFMA-4, factoryfabricated components for field assembly.

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Cooper B-Line, Inc.; a division of Cooper Industries.
- b. Thomas & Betts Corporation.
- c. Unistrut; Tyco International, Ltd.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glassfiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Cooper B-Line, Inc.; a division of Cooper Industries.
- b. Unistrut; Tyco International, Ltd.

Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

Fitting and Accessory Materials: Same as channels and angles, except metal items shall be stainless steel.

Rated Strength: Selected to suit applicable load criteria.

- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Stainless Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-stainless steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Hilti Inc.

ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

MKT Fastening, LLC.

Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

- 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Cooper B-Line, Inc.; a division of Cooper Industries.

Hilti Inc.

ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

MKT Fastening, LLC.

- 3. Clamps for Attachment to Steel Structural Elements: Stainless Steel, type suitable for attached structural element.
- 4. Through Bolts: Stainless Steel Structural type, hex head, and high strength.
- 5. Hanger Rods: Threaded stainless steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-stainless steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for conduit per NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables (All spaces except chemical feed areas): Install trapeze-type supports fabricated with stainless steel slotted system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps
- D. Multiple Raceways or Cables **(All chemical feed areas)**: Install trapeze-type supports fabricated with slotted nonmetallic system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt nonmetallic conduit clamps

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To New Concrete: Expansion anchor fasteners.
 - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 3. To Existing Concrete: Expansion anchor fasteners.
 - 4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standardweight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slottedchannel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete".
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

A. Touchup: Comply with requirements in Division 9 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.03 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.04 QUALITY ASSURANCE

- A. Comply with ANSI A13.1, ANSI C2, and ANSI Z635.4.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.05 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.
- E. Install all signs and labels horizontal (level) and consistent for similar equipment and panels.

PART 2 - PRODUCTS

2.01 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use
- 2.02 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS
 - A. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb, minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with snap-around label.
 - 1. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands:
 - 1. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
 - 2. Fire Alarm System: Red.
 - 3. Fire-Suppression Supervisory and Control System: Red and yellow.
 - 4. Combined Fire Alarm and Security System: Red and blue.
 - 5. Security System: Blue and yellow.
 - 6. Mechanical and Electrical Supervisory System: Green and blue.
 - 7. Telecommunication System: Green and yellow.
 - 8. Control Wiring: Green and red.

- C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
 - 1. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.
 - 1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
 - 1. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
 - 4. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway. During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches above duct. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

- 1. Description:
 - a. Permanent, bright-colored, continuous-printed, polyethylene tape.
 - b. Not less than 6 inches wide by 4 mils thick.
 - c. Compounded for permanent direct-burial service.
 - d. Embedded continuous metallic strip or core.
 - e. Printed legend shall indicate type of underground line.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - 1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
 - 2. Comply with NFPA 70 and 29 CFR 1910.145.
 - 3. Self-Adhesive Warning Labels: Factory printed, multicolor, pressuresensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
 - 4. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
 - 5. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
 - 6. Warning label and sign shall include, but are not limited to, the following legends:

- a. Multiple Power Source Warning: "DANGER ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- b. Workspace Clearance Warning: "WARNING OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- I. Instruction Signs:
 - 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with ENGINEER/OWNER APPROVED instructions where needed for system or equipment operation. Instructions are needed for all equipment unless otherwise noted.
 - a. Signs shall be engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - b. The engraved legend shall be ½" White letters on Brown face, and punched or drilled for mechanical fasteners.
 - c. The signs shall be installed with stainless hardware.
 - 2. Emergency Operating Instructions: Install emergency operating instruction signs at equipment used for power transfer, safety shutdown, or any other locations requiring operation in an emergency.
 - a. Signs shall be engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - b. The engraved legend shall be $\frac{1}{2}$ " White letters on Red face, and punched or drilled for mechanical fasteners.
 - c. The signs shall be installed with stainless hardware.
- J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:

- a. Indoor and Outdoor Equipment: Use engraved, laminated acrylic or melamine labels, punched or drilled for screw mounting Identification labels shall have white letters on a dark-gray background. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high. Mount labels with stainless hardware.
- b. Elevated Components: Increase the size of the labels and letters to those appropriate for viewing from the floor.
- 2. Equipment to Be Labeled:
 - a. Identification labeling of some items listed below may be required by individual Sections or by NFPA 70.
 - b. Panelboards, electrical cabinets, and enclosures.
 - c. Access doors and panels for concealed electrical items.
 - d. Electrical switchgear and switchboards.
 - e. Transformers.
 - f. Electrical substations.
 - g. Emergency system boxes and enclosures.
 - h. Motor-control centers.
 - i. Disconnect switches.
 - j. Enclosed circuit breakers.
 - k. Motor starters.
 - 1. Push-button stations.
 - m. Power transfer equipment.
 - n. Contactors.
 - o. Battery inverter units.
 - p. Battery racks.
 - q. Power-generating units.
 - r. Voice and data cable terminal equipment.

- s. Television/audio components, racks, and controls.
- t. Fire-alarm control panel and annunciators.
- u. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
- v. Monitoring and control equipment.
- w. Uninterruptible power supply equipment.
- x. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
- y. Control systems
- z. Field mounted control devices
- aa. Field mounted instruments

3.02 INSTALLATION PRACTICES

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- D. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or, for sizes LARGER than No. 10 AWG if authorities having jurisdiction permit, field applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.

- 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
- 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- E. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- F. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION

SECTION 16120

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Wires and cables rated 600 V and less.
 - 2. Connectors and terminations rated 600 V and less.
 - 3. Sleeves and sleeve seals for cables.

B. Restrictions

1. All wire/cable runs of any type must be continuous. Splices are expressly prohibited.

1.03 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.06 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. Beldon CDT Inc.
 - 4. General Cable Corporation.
 - 5. Senator Wire & Cable Company.
 - 6. Southwire Company.
- C. Copper Conductors: Comply with NEMA WC 70.
- D. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Types THHN-2-THWN-2, Type XHHW-2, RHW-2 Low Smoke, SOW and Type SO.
- E. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metalclad cable, Type MC and Type SO with ground wire.
- F. VFD Rated Cable: VFD power cables shall be shielded, flexible motor supply cable for variable speed drives subject to non-linear power distortions. VFD cable shall be used to interconnect AC variable frequency drives or control systems, to compatible AC motors. VFD cables shall be 1000V rated UL flexible motor supply cable, 3 stranded tinned copper circuit conductors with XLPE insulation, 1 stranded tinned copper ground wire with PVC insulation, overall combination tinned copper braid and foil shield, and black PVC jacket.

2.02 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. AFC Cable Systems, Inc.
- 2. Hubbell Power Systems, Inc.
- 3. O-Z/Gedney; EGS Electrical Group LLC.
- 4. 3M; Electrical Products Division.
- 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- 2.03 SLEEVES FOR CABLES
 - A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
 - B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
 - C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052or 0.138-inch thickness as indicated and of length to suit application.
 - D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.04 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

- 2. Pressure Plates: Stainless steel. Include two for each sealing element.
- 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper, stranded.
- B. Branch Circuits: Copper, stranded.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type XHHW-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type XHHW-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type XHHW-2, single conductors in raceway.
- F. Feeders in Cable Tray: Type XHHW-2, single conductors in raceway.
- G. Exposed Branch Circuits, Including in Crawlspaces: Type XHHW-2, single conductors in raceway.
- H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW-2, single conductors in raceway.
- I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- J. Branch Circuits Installed below Raised Flooring: Metal-clad cable, Type MC.
- K. Branch Circuits in Cable Tray: Type TC.
- L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

M. All control cables between the PLCs / MMCs and field instruments: 2 # 18 AWG, twisted shielded pair, UL Instrument Cable, XLPE conductor insulation, PVC outer jacket.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.

- 2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both wall surfaces.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to local codes and the manufacturer's written instructions.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to local codes and the manufacturer's written instructions.
- L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.06 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to local codes and the manufacturer's written instructions.

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
 - a. All Process Equipment.
 - b. Panels/Switchboards/Transformers/Transfer Switches
 - c. Pumps
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. All megger readings using a 1000 V dc megger shall be greater than 50 mega ohms.
 - 4. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test Reports: Prepare a written report to record the following:

- 1. Test procedures used.
- 2. Test results that comply with requirements.
- 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following: 16135

1.03 DEFINITIONS

- A. ARC: Aluminum rigid conduit
- B. EMT: Electrical metallic tubing
- C. FMC: Flexible metal conduit
- D. GRC: Galvanized rigid steel conduit
- E. IMC: Intermediate metal conduit
- F. LFNC: Liquidtight flexible nonmetallic conduit
- G. RNC: Rigid nonmetallic conduit
- H. SS: Stainless steel

1.04 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. For handholes and boxes for underground wiring, including the following:
 - a. Duct entry provisions, including locations and duct sizes.

- b. Frame and cover design.
- c. Grounding details.
- d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- e. Joint details.
- C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members in the paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and other features in the paths of conduit groups with common supports.
- D. Source quality-control test reports.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.
- C. For each type of conduit, all fittings shall be of one manufacturer.

PART 2 - PRODUCTS

- 2.01 METAL CONDUIT AND TUBING
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 5. Electri-Flex Co.
 - 6. Manhattan/CDT/Cole-Flex.

- 7. Maverick Tube Corporation.
- 8. O-Z Gedney; a unit of General Signal.
- 9. Wheatland Tube Company.
- B. ARC: ANSI C80.5 and UL 6A.
- C. EMT: Comply with ANSI C80.3 and UL 797.
- D. FMC: Comply with UL 1; Zinc coated steel or aluminum.
- E. GRC: Comply with ANSI C80.1 and UL 6.
- F. IMC: Comply with ANSU C80.6 and UL 1242.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360
- H. PVC Coated Rigid Steel Conduit: Comply with NEMA RN 1; Minimum coating thickness or 0.040 inch (1 mm).
- I. Fittings for Conduit and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

2.02 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arnco Corporation.
 - 4. CANTEX Inc.
 - 5. CertainTeed Corp.; Pipe & Plastics Group.
 - 6. Condux International, Inc.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.

- 10. Manhattan/CDT/Cole-Flex.
- 11. RACO; a Hubbell Company.
- 12. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.
- 2.03 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Arnco Corporation.
 - 2. Endot Industries Inc.
 - 3. IPEX Inc.
 - 4. Lamson & Sessions; Carlon Electrical Products.
 - B. Description: Comply with UL 2024; flexible type, approved for general-use installation.
- 2.04 NONMETALLIC WIREWAYS
 - A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Moulded Products, Inc.
 - 2. Hoffman
 - 3. Carlon Electrical Products
 - 4. Niedax-Kleinhuis USA, Inc.
 - 5. Or Approved Equal
 - B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant

gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.05 SURFACE RACEWAYS

- A. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Engineer from manufacturer's standard colors.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Butler Manufacturing Company; Walker Division.
 - b. Enduro Systems, Inc.; Composite Products Division.
 - c. Hubbell Incorporated; Wiring Device-Kellems Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.

2.06 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.

- 7. RACO; a Hubbell Company.
- 8. Robroy Industries, Inc.; Enclosure Division.
- 9. Scott Fetzer Co.; Adalet Division.
- 10. Spring City Electrical Manufacturing Company.
- 11. Thomas & Betts Corporation.
- 12. Walker Systems, Inc.; Wiremold Company (The).
- 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- E. Cabinets:
 - 1. NEMA 250, Type 1, stainless-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

2.07 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
 - 1. Color of Frame and Cover: Gray.
 - 2. Configuration: Units shall be designed for flush burial and have open bottoms with 8" of gravel fill below the bottom of the box.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- 5. Cover Legend: Molded lettering, as indicated for each service.
- 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- 7. Handholes 24 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. Hubble Power Systems, Quazite

2.08 SLEEVES FOR RACEWAYS

- A. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052or 0.138-inch thickness as indicated and of length to suit application.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.09 SLEEVE SEALS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.

- 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 2. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.010 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid aluminum conduit.
 - 2. Concealed Conduit, Aboveground: Rigid aluminum conduit.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X.
 - 6. Application of Handholes and Boxes for Underground Wiring:
 - a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.

- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Chemical Feed Areas: EPC-40 PVC
 - 2. Exposed: Rigid aluminum conduit.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC
 - 4. Damp or Wet Locations: Rigid aluminum conduit.
 - 5. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
 - 6. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: Riser-type, optical fiber/communications cable raceway.
 - 7. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: Plenum-type, optical fiber/communications cable raceway.
 - 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Aluminum Conduit: Use threaded aluminum conduit fittings, unless otherwise indicated.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. All aluminum conduit installed in contact with concrete or earth shall be protected with two coats of 3M Scotchrap Pipe Primer and then wrapped with one layer of 3M "Scotchrap –All Weather Corrosion Protection Tape" per the manufacturers recommendations.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- F. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.
- G. Raceways Embedded in Slabs:
 - 1. Run all conduits parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Change from Type EPC-40-PVC to rigid aluminum conduit, 3" before rising above the floor.
- H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- K. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size: Install raceways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

- L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
 - 1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg Ftemperature change.
 - 2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
 - 3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.
- N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
- O. Use LFNC in damp or wet locations not subject to severe physical damage.
- P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- Q. Set metal floor boxes level and flush with finished floor surface.

- R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- S. The use of LFNC to accomplish bends, turns, or otherwise ease of installation, and not detailed in Section 3.1.A.4, 3.1.B.5, or 3.2.N is expressly prohibited. Any exceptions will be at the sole discretion of the engineer and must be a written request with full justification.
- T. All underground conduits shall be spaced three times the trade size diameter apart.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
- B. Concrete Encased Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
 - 2. Install backfill as specified in Division 2 Section "Earthwork."
 - 3. Concrete shall be 3000 PSI, Fiber Reinforced with Red Dye added.
 - 4. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
 - 5. Conduit shall be provided with pre manufactured conduit spaces designed to provide 3" separation between conduits. Spaces shall be equal to Carlon Snap-Loc or approved equal.
 - 6. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
 - a. Couple conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For stub-ups at equipment mounted on outdoor concrete bases, extend conduit horizontally a minimum of 60 inches from edge of

equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line, below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

3.05 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.06 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

3.08 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 16135

UNDERGROUND DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for direct-buried and concreteencased duct banks, and in single duct runs.
 - 2. Handholes and boxes.
 - 3. Manholes.

1.03 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

- A. Product Data: For the following:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Warning tape.
 - 5. Warning planks.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.

- 3. Frame and cover design and manhole frame support rings.
- 4. Ladder/Step details.
- 5. Grounding details.
- 6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
- 7. Joint details.
- C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Cover design.
 - 3. Grounding details.
 - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.
- E. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- F. Qualification Data: For professional engineer and testing agency.
- G. Source quality-control test reports.
- H. Field quality-control test reports.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store non-metallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.07 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify the Engineer, Construction Manager, and Owner no fewer than 5 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without the Engineer's written permission.

1.08 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Engineer.

1.09 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 10% percent of quantity of each item installed.

PART 2 - PRODUCTS

2.01 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following or Engineer approved equal:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT; a division of Cable Design Technologies.
 - 11. Spiraduct/AFC Cable Systems, Inc.
- D. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

- E. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-80-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- F. Duct Accessories:
 - 1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
 - 2. Warning Tape: Underground-line warning tape specified in Division 16 Section "Electrical Identification."
 - 3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

2.03 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.
 - 4. Oldcastle Precast Group.
 - 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - 6. Utility Concrete Products, LLC.
 - 7. Utility Vault Co.
 - 8. Wausau Tile, Inc.
- C. Comply with ASTM C 858 for design and manufacturing processes.

- D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - 3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 - 4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 - 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 6. Cover Legend: Molded lettering, "ELECTRICAL." Or "CONTROL"
 - 7. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 - 9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

- a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
- b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
- c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
- 10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
- 11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
 - 1. Color: Gray.
 - 2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRICAL." Or "CONTROL."
 - 6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 - 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

- 8. Handholes 12 inches wide by 24 inches long and larger shall have factoryinstalled inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
 - e. Quazite
- C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.
- High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be plastic.
 - 4. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 5. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 6. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - a. Carson Industries LLC.
 - b. Nordic Fiberglass, Inc.
 - c. PenCell Plastics.

2.05 PRECAST MANHOLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Carder Concrete Products.
- 2. Christy Concrete Products.
- 3. Oldcastle Precast Group.
- 4. Riverton Concrete Products; a division of Cretex Companies, Inc.
- 5. Utility Vault Co.
- C. Coordinate first paragraph below with Drawings.
- D. Comply with ASTM C 858[, and with interlocking mating sections, complete with accessories, hardware, and features.
 - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
 - 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- E. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- F. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.06 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C 858 and with Division 3 Section "Cast-in Place Concrete."
- C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.07 UTILITY STRUCTURE ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bilco Company (The).
 - 2. Campbell Foundry Company.
 - 3. Carder Concrete Products.
 - 4. Christy Concrete Products.
 - 5. East Jordan Iron Works, Inc.
 - 6. Elmhurst-Chicago Stone Co.
 - 7. McKinley Iron Works, Inc.
 - 8. Neenah Foundry Company.
 - 9. NewBasis.
 - 10. Oldcastle Precast Group.
 - 11. Osburn Associates, Inc.
 - 12. Pennsylvania Insert Corporation.
 - 13. Riverton Concrete Products; a division of Cretex Companies, Inc..
 - 14. Strongwell Corporation; Lenoir City Division.

- 15. Underground Devices, Inc.
- 16. Utility Concrete Products, LLC.
- 17. Utility Vault Co.
- 18. Wausau Tile, Inc.
- C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 - 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 - 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
 - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
- D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2inch- diameter eye, and 1-by-4-inch bolt.
 - 1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

- F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4inch- diameter eye, rated 2500-lbf minimum tension.
- G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbonsteel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- J. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.
 - 1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
 - 2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
 - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 - Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
 - Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.
- L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35

degrees F. Capable of withstanding temperature of 300 degrees F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

- M. Fixed Manhole Ladders: Arranged for attachment to wall, and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
- N. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length shall be equal to distance from deepest manhole floor to grade plus 36 inches. One required.
- O. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.08 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by a independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in directburied duct bank, unless otherwise indicated.

- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC installed in direct-buried duct bank, unless otherwise indicated.
- G. Underground Ducts Crossing Paved Paths, Walks, and Driveways, Roadways, and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.02 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglassreinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
- B. Manholes: Precast concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.03 EARTHWORK

- A. Excavation and Backfill: Comply with Division 2 Section "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Sections "Lawns and Grasses" and "Exterior Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 1 Section "Cutting and Patching."

3.04 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Coordinate design of concrete-encased duct banks approaching building wall penetrations with building structural design to support ducts at wall, without reducing structural or watertight integrity of building. Do not use steel conduit in highly corrosive soils. Coordinate with Drawings.
- F. Sleeves and sleeve seals for conduits penetrating building walls below grade are specified in Division 16 Section "Basic Electrical Materials and Methods."
- G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use

fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 16 Section "Basic Electrical Materials and Methods."

- H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- I. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- J. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
 - 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

- 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
- 6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
- 7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
- 8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
- 9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
- 10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- K. Direct-Buried Duct Banks:
 - 1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 - 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

- 3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 2 Section "Earthwork" for pipes less than 6 inches in nominal diameter.
- 4. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
- 5. Delete subparagraph below if dimensioned duct sections are shown on Drawings.
- 6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
- 7. Requirements in first subparagraph below exceed NFPA 70. Retain for conservative design.
- 8. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
- 9. Set elevation of bottom of duct bank below the frost line.
- 10. Direct-buried, PVC duct elbows in first subparagraph below are particularly vulnerable to damage by pulling lines when cable pulling tensions are high. Rigid steel conduit elbows are sometimes specified for these stub-ups to prevent such damage. However, concrete encasement of PVC duct elbows, together with reduced pulling tensions, is also used in these situations. Pulling tensions can be reduced by making duct runs from the closest manhole or handhole as short as possible and arranging duct banks so stub-up elbows have the longest possible radius. 5-inch (125-mm) duct elbows are available in standard radii of 24, 36, 48, and 60 inches (300, 900, 1200, and 1500 mm) and greater. Coordinate with Drawings and see Editing Instruction No. 3 in the Evaluations.
- 11. Retain one of first two subparagraphs and associated subparagraphs below to specify type of stub-ups for direct-buried ducts in Project.
- 12. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

- 13. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
- 14. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.05 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Cast-in-Place Manhole Installation:
 - 1. Finish interior surfaces with a smooth-troweled finish.
 - 2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
 - 3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 3 Section "Cast-in-Place Concrete."
- B. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C 891, unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevations:

Manhole Roof: Install with rooftop at least 15 inches below finished grade.

Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.

Install handholes with bottom below the frost line.

Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

Where indicated, cast handhole cover frame integrally with handhole structure.

- D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- E. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 7 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- H. Coordinate paragraph below with Drawings. Delete second option if nonmetallic cable racks are specified.
- I. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- J. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- K. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- L. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and traffic ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Division 3 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep.

3.07 GROUNDING

A. Ground underground ducts and utility structures according to Division 16 Section "Grounding and Bonding."

3.08 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

- 2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
- 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 16 Section "Grounding and Bonding."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.09 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECITON

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Receptacles with integral surge suppression units.
 - 4. Isolated-ground receptacles.
 - 5. Snap switches and wall-box dimmers.
 - 6. Wall-switch and exterior occupancy sensors.
 - 7. Communications outlets.
 - 8. Pendant cord-connector devices.
 - 9. Cord and plug sets.

1.03 DEFINITIONS

- A. Retain term and abbreviations that remain after this Section has been edited.
- B. EMI: Electromagnetic interference.
- C. GFCI: Ground-fault circuit interrupter.
- D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- E. RFI: Radio-frequency interference.
- F. TVSS: Transient voltage surge suppressor.
- G. UTP: Unshielded twisted pair.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Retain first paragraph below if products have critical features needing hands-on appraisal.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain all wiring devices and associated wall plates from a single manufacturer and one source. (No deviation without written permission from the owner and engineer.)
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.06 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Retain subparagraph below if cord and plug sets are specified in Part 2.
 - 2. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).
- B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; CR 5253IG.
 - b. Leviton; 5362-IG.
 - c. Pass & Seymour; IG6300.
 - 2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; TR8300.
 - b. Hubbell; HBL8300SG.

- c. Leviton; 8300-SGG.
- d. Pass & Seymour; 63H.
- e. <Insert manufacturer's name; catalog number.>
- 3. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.03 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Cooper; GF20.
 - 2. Pass & Seymour; 2084.

2.04 TVSS RECEPTACLES

- A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 - 1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
 - 2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
- B. Duplex TVSS Convenience Receptacles:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5362BLS.
 - b. Hubbell; HBL5362SA.
 - c. Leviton; 5380.
 - 2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

- C. Isolated-Ground, Duplex Convenience Receptacles:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; IG5362BLS.
 - b. Hubbell; IG5362SA.
 - c. Leviton; 5380-IG.
 - 2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.05 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

- A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper Crouse-Hinds.
 - b. EGS/Appleton Electric.
 - c. Killark; a division of Hubbell Inc.

2.06 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.
- B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:

- 1. Products: Subject to compliance with requirements, provide one of the following:
- 2. Hubbell; IG2310.
 - a. Leviton; 2310-IG.
- 3. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.07 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 - 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.08 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 - 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.09 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).

- b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
- c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
- d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
 - 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.

- d. Pass & Seymour; 1251.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L.

2.010 OCCUPANCY SENSORS

- A. Each manufacturer's switch rating is different, but rated design values are generally not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- B. Retain one of two paragraphs and associated subparagraphs below. Adaptive technology includes the ability to sense and memorize usage patterns in the space and help eliminate false offs.
- C. Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 6111 for 120 V, 6117 for 277 V.
 - b. Hubbell; WS1277.
 - c. Leviton; ODS 10-ID.
 - d. Pass & Seymour; WS3000.
 - e. Watt Stopper (The); WS-200.
 - 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.
- D. Wall-Switch Sensors:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; AT120 for 120 V, AT277 for 277 V.
 - b. Leviton; ODS 15-ID.
- 2. Description: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft.
- E. Retain one of first two paragraphs and associated subparagraphs below for square and near-square rectangular rooms.
- F. Long-Range Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP1600WRP.
 - b. Leviton; ODWWV-IRW.
 - c. Pass & Seymour; WA1001.
 - d. Watt Stopper (The); CX-100.
 - 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, with a minimum coverage area of 1200 sq. ft.
- G. Long-Range Wall-Switch Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATD1600WRP.
 - b. Leviton; ODW12-MRW.
 - c. Watt Stopper (The); DT-200.
 - 2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft.
- H. Wide-Range Wall-Switch Sensors:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATP120HBRP.
 - b. Leviton; ODWHB-IRW.
 - c. Pass & Seymour; HS1001.
 - d. Watt Stopper (The); CX-100-3.
- 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 150-degree field of view, with a minimum coverage area of 1200 sq. ft.
- I. Exterior Occupancy Sensors:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton; PS200-10.
 - b. Watt Stopper (The); EW-100-120.
 - 2. Description: Passive-infrared type, 120/277 V, weatherproof, adjustable time delay up to 15 minutes, 180-degree field of view, and 110-foot detection range. Minimum switch rating: 1000-W incandescent, 500-VA fluorescent.

2.011 COMMUNICATIONS OUTLETS

- A. Telephone Outlet:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 3560-6.
 - b. Leviton; 40649.
 - 2. Description: Single RJ-45 jack for terminating 100-ohm, balanced, fourpair UTP; TIA/EIA-568-B.1; complying with Category 5e. Comply with UL 1863.
- B. Combination TV and Telephone Outlet:
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Cooper; 3562.
- b. Leviton; 40595.
- 2. Description: Single RJ-45 jack for 100-ohm, balanced, four-pair UTP; TIA/EIA-568-B.1; complying with Category 5e; and one Type F coaxial cable connector.

2.012 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.05-inch- thick anodized aluminum.
 - 3. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant die-cast aluminum with lockable cover.

2.013 MULTIOUTLET ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Incorporated; Wiring Device-Kellems.
 - 2. Wiremold Company (The).
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: PVC.
- D. Wire: No. 12 AWG.

2.014 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: As selected by Engineer, unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.

- 3. TVSS Devices: Blue.
- 4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
- F. Recommendation in subparagraph below is made in IEEE 602.
- G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- H. Coordinate two paragraphs below with Drawings.
- I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

J. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION

- A. Comply with Division 16 Section "Electrical Identification."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with [black] [white] [red]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
- B. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 16289

TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes SPDs for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Division 16 Section "Wiring Devices" for devices with integral SPDs.

1.03 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protection Device.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated, include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.
- B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:
 - 1. UL 1283.
 - 2. UL 1449.
- C. Coordinate paragraph below with qualification requirements in Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.
- D. Retain first paragraph and subparagraphs below if Contractor is responsible for field quality-control testing.

- E. Field quality-control test reports, including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- F. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.
- G. Warranties: Special warranties specified in this Section.
- 1.05 QUALITY ASSURANCE
 - A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
 - B. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
 - C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - D. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
 - E. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
 - F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.06 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Engineer's written permission.

- B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

1.07 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.
- B. Coordinate surge protection devices with Division 16 Section "Electrical Power Monitoring and Control."

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

1.09 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. See Editing Instruction No.1 in the Evaluations for cautions about naming manufacturers and products.
- B. Retain above for nonproprietary or below for semiproprietary specification. Refer to Division 1 Section "Product Requirements."
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Protection Technologies, Inc.

- 2. Current Technology, Inc.
- 3. Leviton Mfg. Company Inc.
- 4. Liebert Corporation; a division of Emerson.
- 5. Square D; Schneider Electric.
- 6. Surge Suppression Incorporated.
- 7. Cuttler-Hammer

2.02 SERVICE ENTRANCE SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts per phase rated at 5 A and 250-V ac, for remote monitoring of protection status. (Contacts shall be connected in either series or parallel as required to provide a single input to the plant control system.)
- B. Retain first option in first paragraph below for high exposure and cost, second option for medium exposure and cost, and third option for low exposure and cost.
- C. Peak Single-Impulse Surge Current Rating: 300 kA per phase.
- D. Connection Means: Permanently wired.
- E. Retain one of four paragraphs and associated subparagraphs below. Adjust clamping voltages to comply with Project conditions and verify compatibility of peak surge current rating and clamping voltage. Reference to UL 1449 is to the Second Edition.
- F. Protection modes and UL 1449 SVR for delta circuits with voltages of 480V, 3-phase, 3-wire circuits shall be as follows:
 - 1. Line to Line: 1500 V for 480V.
 - 2. Line to Ground: 1000 V for 480V.

2.03 PANELBOARD SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
- B. Retain first option in paragraph below for high exposure and cost, second option for medium exposure and cost, and third option for low exposure and cost.
- C. Peak Single-Impulse Surge Current Rating: 50 kA per phase.
- D. Retain one of four paragraphs and associated subparagraphs below. Adjust clamping voltages to comply with Project conditions and verify compatibility of peak surge current rating and clamping voltage. Reference to UL 1449 is to the Second Edition.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:
 - 1. Line to Neutral: 400 V for 208Y/120.
 - 2. Line to Ground: 400 V for 208Y/120.
 - 3. Neutral to Ground: 400 V for 208Y/120.
- F. Protection modes and UL 1449 SVR for delta circuits with voltages of 480V, 3-phase, 3-wire circuits shall be as follows:
 - 1. Line to Line: 1500 V for 480V.
 - 2. Line to Ground: 800 V for 480V.

2.04 PLUG-IN SURGE SUPPRESSORS

- A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. LED indicator lights for reverse polarity and open outlet ground.

- 3. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.
- B. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
- C. Protection modes and UL 1449 SVR shall be as follows:
 - 1. Line to Neutral: 475 V.
 - 2. Line to Ground: 475 V.
 - 3. Neutral to Ground: 475 V.

2.05 ENCLOSURES

- A. Interior enclosures to be NEMA 1.
- B. Exterior enclosures to be NEMA 4X, Stainless Steel.

PART 3 - EXECUTION

3.01 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Install devices at each service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for each panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Comply with manufacturer's written recommendation for conductor and circuit-breaker size for connecting SPD devices to distribution system. Match circuit-breaker size to conductor size. Coordinate with Drawings.
 - 2. Provide multipole, circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.02 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment, panelboards, control terminals, and data terminals to their sources until surge protection devices are installed and connected.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.

- 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. Testing: Perform the following field tests and inspections and prepare test reports:
 - 1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
- C. Remove and replace malfunctioning units and retest as specified above.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 1 for training requirements.

END OF SECTION

SECTION 16410

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Enclosures.

1.03 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.04 SUBMITTALS

- A. First two paragraphs below are defined in Division 1 Section "Submittal Procedures" as "Action Submittals."
- B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).

- 4. Retain first subparagraph below if using series rating of overcurrent protective devices.
- 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- 6. Retain subparagraph below if final system short-circuit and coordination studies will be performed by the designer or will be assigned to an independent consultant. These curves are also beneficial to Owner for future additions or reevaluations of settings of overcurrent protective devices. Although some manufacturers no longer offer curves on translucent graph paper, curves can normally be downloaded from manufacturers' Web sites or be obtained, in electronic form, from various coordination software vendors as part of a subscription service. Retain option in subparagraph below only if manufacturers selected offer curves on graph paper.
- 7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- C. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- D. Remaining paragraphs are defined in Division 1 Section "Submittal Procedures" as "Informational Submittals."
- E. Coordinate first paragraph below with qualification requirements in Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.
- F. Retain first paragraph below if retaining "Manufacturer's Field Service" Paragraph in "Field Quality Control" Article. Consider manufacturer's field services especially when retaining zone-selective interlocking because setting it to operate properly requires factory-trained expertise.
- G. Manufacturer's field service report.
- H. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

- 1.05 Retain option in subparagraph below only if manufacturers selected offer curves on graph paper.
- 1.06 QUALITY ASSURANCE
 - A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
 - B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
 - C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - D. Comply with NFPA 70.
- 1.07 PROJECT CONDITIONS
 - A. Specify unusual environmental or service conditions in first paragraph below. For equipment installed outdoors, indicate maximum and minimum ambient temperature and expected humidity range. For additional ambient compensation requirements for fuses, see Editing Instruction No.5 in the Evaluations.
 - B. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2010 m).
 - C. Retain paragraph below if interruption of existing electric service is required.
 - D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Engineer no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.

- 3. Do not proceed with interruption of electric service without Engineer's written permission.
- 4. Comply with NFPA 70E.

1.08 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.09 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Siemens
 - 2. Square D
 - 3. Allen-Bradley
 - 4. Cutler-Hammer
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate

indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 8. Service-Rated Switches: Labeled for use as service equipment.

2.02 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Siemens
 - 2. Square D
 - 3. Allen-Bradley
 - 4. Cutler-Hammer
- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- F. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.
- 2.03 Retain subparagraph below if retaining "Auxiliary Contact Kit" Subparagraph above and if remote-control power for remote indication is not specified in other Sections. See "Control Power Options" Article in the Evaluations for various sources available for control power. Although other voltages are available, the Section Text includes only those that are most frequently encountered and listed in manufacturers' literature. Integrally mounted control power is not available in safety switches.

2.04 RECEPTACLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Hubble
- B. Type 4, IP66 Rated, Twist lock, amp rated, combination safety switch and receptacle
- C. Receptacle: Twist lock, three-phase, four-wire or five-wire receptacle (one wire connected to enclosure ground lug).

2.05 If more than one type or rating of receptacle-switch combination is required, consider showing location of each on Drawings and deleting subparagraph below; otherwise, insert required information.

2.06 MOLDED-CASE CIRCUIT BREAKERS.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following (all switches to be manufactured by the same manufacturer as the motor control centers used on the project):
 - 1. Cutler-Hammer
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I²t response.
- F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and letthrough ratings less than NEMA FU 1, RK-5.
- G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- I. Features and Accessories:

- 1. Standard frame sizes, trip ratings, and number of poles.
- 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
- 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
- 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor. (Provide only when shown on the single line, or required by code)
- 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact. (Provide when indicated on drawing)
- 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay. (Provide when indicated on drawings)
- 7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts. (Provide when indicated on drawing)
- 8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped. (Provide when indicated on drawing)
- 9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position. (Provide when indicated on drawing)
- 2.07 Retain first option in first subparagraph below for solid-state trip units; retain second option for thermal-magnetic trip units.
- 2.08 Retain subparagraph below if retaining options requiring integral or remote-control power in subparagraphs above and if control power for remote indication or operation is not specified in other Sections. See "Control Power Options" Article in the Evaluations for various sources available for control power. Although other voltages are available, the Section Text includes only those that are most frequently encountered and listed in manufacturers' literature. First option below may not be available in all voltages; coordinate with manufacturers' literature.

2.09 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

- 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
- 2. Outdoor Locations: NEMA 250, Type 4X stainless steel.
- 3. Corrosion Areas: NEMA 250, Type 4X fiberglass.
- 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X stainless steel.
- 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 4X stainless steel

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with 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. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements in Division 16 Section "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 16 Section "Overcurrent Protective Device Coordination".

END OF SECTION

SECTION 16441

DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fusible switches
- B. Nonfusible switches
- C. Manual Disconnect Switches
- D. Fuses

1.02 REFERENCES

- A. NEMA KS 1 Enclosed Switches.
- B. NFPA 70 National Electrical Code.
- C. UL 198C High-Interrupting Capacity Fuses; Current Limiting Type.
- D. UL 198E Class R Fuses.

1.03 SUBMITTALS

- A. Product Data: Provide switch ratings and enclosure dimensions.
- B. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

1.05 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by UL as suitable for purpose specified and shown.

1.06 EXTRA MATERIALS

A. Provide three of each size and type fuse installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Square "D"
- B. Westinghouse
- C. General Electric
- D. Cutler Hammer

2.02 DISCONNECT SWITCHES

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses.
- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- C. Manual Toggle Disconnects: Equal to Square "D" Class 2510.
- D. Enclosures: NEMA KS 1.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

2.03 FUSES

- A. Description: Dual element, current limiting, time delay, one-time fuse, 250 or 600 volt, UL 198E, Class RK 5.
- B. Interrupting Rating: 200,000 rms amperes.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install disconnect switches where indicated.
- B. Install fuses in fusible disconnect switches.
- C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

END OF SECTION

SECTION 16442

PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Electronic-grade panelboards.

1.03 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.04 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.

- 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 6. Include wiring diagrams for power, signal, and control wiring.
- 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device (on project with emergency generators upstream of the panelboard, provide selective coordination for all panelboard circuit breakers).
- C. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.05 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NEMA PB 1.
E. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations (NEMA 1 and NEMA 12 Panelboards Only):
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Engineer no fewer than two days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Engineer's written permission.
 - 3. Comply with NFPA 70E.

1.08 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Per general conditions of the contract.

1.010 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
 - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 4X stainless steel.
 - c. Corrosion Areas: NEMA 250, Type 4X fibreglass.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 stainless steell.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

- 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- 3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
- 4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- 5. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized for NEMA 1 and NEMA12. Stainless steel for NEMA 4X..
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- 6. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and bottom.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads (see Drawings for requirements).
 - 4. Split Bus: Vertical buses divided into individual vertical sections.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

- 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device (see Drawings for requirements).
- 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.02 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.
- D. Mains: See panelboard schedules on Drawings.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in or Bolt-on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. Branch Overcurrent Protective Devices: Fused switches.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: See panelboard schedules on Drawings.
- D. Branch Overcurrent Protective Devices: Plug-in or Bolt-on circuit breakers, replaceable without disturbing adjacent units.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
- B. Coordinate two paragraphs below with Drawings. See the "Disconnecting and Overcurrent Protective Devices" Article in the Evaluations for guidance on making selections.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

- 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I2t response.
- 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; letthrough ratings less than NEMA FU 1, RK-5.
- 5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - f. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - g. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.

- h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- i. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- j. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.05 PANELBOARD SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Current Technology; a subsidiary of Danahar Corporation.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. Liebert Corporation.
- B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:
 - 1. Accessories:
 - a. LED indicator lights for power and protection status.
 - b. Audible alarm, with silencing switch, to indicate when protection has failed.
 - c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
 - 2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
 - 3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 70,000.
 - b. Line to Ground: 70,000.
 - c. Neutral to Ground: 50,000.

- 4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
- 5. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 and 208Y/120-V, three-phase, four-wire circuits shall be as follows:
 - a. Line to Neutral: 800 V for 480Y/277 or 400 V for 208Y/120.
 - b. Line to Ground: 800 V for 480Y/277 or 400 V for 208Y/120.
 - c. Neutral to Ground: 800 V for 480Y/277 or 400 V for 208Y/120.

2.06 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 3 Section "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

- 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- 4. Install anchor bolts to elevations required for proper attachment to panelboards.
- 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- J. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 16 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 16 Section "Electrical Identification."

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 16 Section "Overcurrent Protective Device Coordination."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 16443

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including JEA General Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes MCCs for use with ac circuits rated 600 V and less and having the following factory-installed components:
 - 1. Incoming main lugs and OCPDs.
 - 2. Full-voltage magnetic controllers.
 - 3. Reduced-voltage magnetic controllers.
 - 4. Reduced-voltage, solid-state controllers.
 - 5. Multispeed controllers.
 - 6. VFDs
 - 7. Feeder-tap units.
 - 8. Surge Protection Devices.
 - 9. Instrumentation.
 - 10. Auxiliary devices.

1.03 DEFINITIONS

- A. CE: Conformite Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. GFCI: Ground fault circuit interrupting.
- F. IGBT: Insulated-gate bipolar transistor.

- G. LAN: Local area network.
- H. LED: Light-emitting diode.
- I. MCC: Motor-control center.
- J. MCCB: Molded-case circuit breaker.
- K. MCP: Motor-circuit protector.
- L. NC: Normally closed.
- M. NO: Normally open.
- N. OCPD: Overcurrent protective device.
- O. PCC: Point of common coupling.
- P. PID: Control action, proportional plus integral plus derivative.
- Q. PT: Potential transformer.
- R. PWM: Pulse-width modulated.
- S. RFI: Radio-frequency interference.
- T. SCR: Silicon-controlled rectifier.
- U. TDD: Total demand (harmonic current) distortion.
- V. THD(V): Total harmonic v oltage demand.
- W. TVSS: Transient voltage surge suppressor.
- X. VFD: Variable-frequency drive.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of controller and each type of MCC. Include shipping and operating weights, features, performance, electrical ratings, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each MCC, manufacturer's approval, custom, and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry

locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

- 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Enclosure types and details.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
 - f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
 - g. Specified optional features and accessories.
- 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
- 3. Nameplate legends.
- 4. Vertical and horizontal bus capacities.
- 5. Features, characteristics, ratings, and factory settings of each installed unit.

1.05 INFORMATIONAL SUBMITTALS

- A. Standard Drawings: For each MCC, as defined in UL 845.
- B. Production Drawings: For each MCC, as defined in UL 845.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

- D. Product Certificates: For each MCC, from manufacturer.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
- I. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01730 Operation and Maintenance Data, include the following:
 - 1. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field- assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
 - 5. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 6. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
- 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
- 3. Indicating Lights: Two of each type and color installed.
- 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
- 5. Power Contacts: Furnish threespares for each size and type of magnetic contactor installed.
- 1.08 QUALITY ASSURANCE
 - A. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.
 - B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - C. Comply with NFPA 70.
- 1.09 DELIVERY, STORAGE, AND HANDLING
 - A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.
 - 1. The contractor shall coordinate the shipping splits with the MCC manufacturer for entry into the building.
 - 2. Shipping splits shall be noted on the MCC manufacturer drawings.
 - 3. MCCs are to be shipped with external lifting angles at the top and running continuously for each shipping split. Lifting eyelets are not acceptable
 - B. Handle MCCs according to the following:
 - 1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
 - 2. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. The MCC enclosure rating shall be appropriate for the environment where the MCC is to be located.
- 1.11 FIELD MEASUREMENTS
 - A. The Contractor shall verify all field measurements prior to the fabrication of the MCC.
- 1.12 PROJECT CONDITIONS
 - A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
 - 3. Humidity: Less than 95 percent (noncondensing).
 - 4. Altitude: Exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
 - B. Interruption of Existing Electrical Service or Distribution Systems: Do not interrupt electrical service to, or distribution systems within, a facility occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Engineer, and Owner no fewer than five business days in advance of proposed interruption of electrical service.
 - 2. Indicate method of providing temporary electrical service.
 - 3. Do not proceed with interruption of electrical service without Owner's written permission.
 - 4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for MCCs, including clearances between MCCs and adjacent surfaces and other items.

1.13 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate features of MCCs, installed units, and accessory devices with remote pilot devices and control circuits to which they connect.
- C. Coordinate features, accessories, and functions of each MCC, each controller, and each installed unit with ratings and characteristics of supply circuits, motors, required control sequences, and duty cycle of motors and loads.

1.14 REGULATORY REQUIREMENTS

A. Contractor shall ensure that the installation conforms to the requirements of the latest edition of the NFPA 70 'National Electrical Code' and/or other applicable installation standards.

1.15 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace all devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. Square D; a brand of Schneider Electric.
 - 3. Siemens Industry, Inc.
- B. General Requirements for MCCs: Comply with NEMA ICS 18 and UL 845

2.02 FUNCTIONAL FEATURES

A. Description: Modular arrangement of main units, controller units, control devices, feeder-tap units, instruments, metering, auxiliary devices, and other items mounted in vertical sections of MCC.

- B. Controller Units: Combination controller units.
 - 1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 - 2. Equip units in Type B and Type C MCCs with pull-apart terminal strips for external control connections.
- C. Feeder-Tap Units: Through 225-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
- D. Future Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
- E. Spare Units: Installed in compartments indicated "spare."

2.03 INCOMING MAINS

- A. Incoming Mains Location: as indicated on the contract drawings
- B. Main Lugs Only: Conductor connectors suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.

2.04 COMBINATION CONTROLLERS

- A. Full-Voltage Controllers:'
 - 1. General Requirements for Full-Voltage Enclosed Controllers: Comply with NEMA ICS 2, general purpose, Class A.
 - 2. Magnetic Controllers: Full voltage, across the line, electrically held.
 - a. Configuration: Nonreversing, or reversing, as indicated on the project drawings.
- B. Disconnecting Means and OCPDs:
 - 1. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-

only circuit breaker with front-mounted, field-adjustable, shortcircuit trip coordinated with motor locked-rotor amperes.

- b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
- d. NC alarm contact that operates only when MCP has tripped.
- e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
- C. Overload Relays:
 - 1. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
 - 2. NC/NO isolated overload alarm contact.
 - 3. External overload reset push button.
- D. Control Power:
 - 1. Control Circuits: 120V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 50VA.
- E. Digital Ammeters
 - 1. Where shown on the project drawings, include the manufacturer's standard digital ammeter and current transformers (CTs). The ammeter

display shall be digital, and mount to the face of the MCC cubicle for observation with the door closed.

2. Provide one CT per phase in a standard size for the device indicated. Connections between the CT and ammeter shall be fused.

2.05 VFDs

- A. VFDs shall be a standard product of the MCC manufacturer.
- B. All VFDs shall be provided with output DV/DT Filters
- C. All drives shall be provided with the following:
 - 1. H-O-A Selector Switch
 - 2. Red Run Indicator Light
 - 3. Green Off Indicator Light
 - 4. Amber Fault Indicator Light
 - 5. Human Machine Interface on the door of the MCC bucket enclosure
 - 6. Control Power Transformer
 - 7. Manual speed pot
 - 8. MCP overcurrent protection device with lockout capability
 - 9. Cooling fans with filters

2.06 FEEDER-TAP UNITS

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for lowlevel overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. (standard)
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting. (when shown on the one-line)

- 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings (when shown on the one-line as LSIG):
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2 t response.
- 4. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator. (when shown on the one-line)
 - d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. (when shown on the one-line diagram)
 - e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - f. Key Interlock Kit: Externally mounted to prohibit circuitbreaker operation; key shall be removable only when circuit breaker is in off position. (when shown on the one-line)

2.07 SURGE PROTECTION DEVICES

A. Surge Protection Devices shall be in accordance with Section 16289 Low-Voltage Surge Protection.

2.08 ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1 unless otherwise indicated to comply with environmental conditions at installed location.

- B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- C. Compartments: Modular; individual lift-off doors with concealed hinges and quick- captive screw fasteners. Interlocks on units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
- D. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- E. Each section shall be equipped with two full-metal side sheets to isolate each vertical section and to help reduce the likelihood of fault propagation between sections

2.09 STRUCTURE

- A. The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units.
- B. Vertical sections shall be rigid, free-standing structures.
 - 1. Vertical sections shall have internal mounting angles running continuously within the shipping block
 - 2. An external mounting channel that is required to maintain structure integrity is not acceptable
 - 3. Vertical sections shall be 90 in. high, 20 in. deep and 20 in. Wide, except where larger dimensions are required
 - 4. 71 in. high, reduced height sections shall be provided, if specified on the contract drawings
 - 5. Vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block
 - 6. Lifting eyes are not acceptable
 - 7. Each standard section shall be capable of being subdivided into 12 usable, unit spaces

- 8. Two unit spaces shall constitute one space factor and shall be 13 in. in height
- 9. One unit space shall constitute one-half space factor and shall be 6.5 in. in height
- C. Horizontal wireways.
 - 1. Horizontal wireways shall be located at the top and bottom of the MCC
 - 2. Horizontal wireways shall be 6 in. in height and extend the full depth of the vertical section to allow maximum flexibility in locating conduit for MCC feeds and loads
 - a. Pull-boxes to extend the height of the top horizontal wireway by 12 in. shall be provided, if specified on the contract drawings
 - 3. Horizontal wireways shall be continuous across the length of the MCC, except where access needs to be denied due to electrical isolation requirements
 - 4. The horizontal wireways shall be isolated from the power bus
 - 5. The horizontal wireways shall have removable covers held in place by captive screws
- D. Provide a full height vertical wireway, independent of the plug-in units, in each standard vertical section.
 - 1. The vertical wireway shall be isolated from the vertical and horizontal buses
 - 2. The vertical wireway shall be covered with a hinged and secured door
 - 3. Wireway tie bars shall be provided
 - 4. Isolation between the wireway and units shall be provided

2.10 AUXILIARY DEVICES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 - 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type, 30mm.
 - a. Push Buttons: Unguarded types; momentary contact unless otherwise indicated.

- b. Pilot Lights: LED types;; push to test.
- c. Selector Switches: Rotarytype.
- 2. Elapsed-Time Meters: Heavy duty with digital readout in hours nonresettable.
- 3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120degree scale and plus or minus 2 percent accuracy with selector switches having an off position.
- B. Reversible NC/NO contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solidstate sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Space heaters, with NC auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- G. Cover gaskets for Type 1 enclosures.
- H. Terminals for connecting power factor correction capacitors to the load side of overload relays.
- I. Spare control-wiring terminal blocks; wired.
- J. Spare-Fuse Cabinet: Identified cabinet with hinged lockable door.

2.11 CHARACTERISTICS AND RATINGS

- A. Wiring: NEMA ICS 18, Class II-S (see plans), Type B-T, for starter Size 3 and below.
- B. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller,

for conductors across hinges, and for conductors for interconnections between shipping units.

- C. Nominal System Voltage: as specified on the contract drawings.
- D. Short-Circuit Current Rating for Each Unit: as specified on the contract drawings.
- E. Short-Circuit Current Rating of MCC: as specified on the contract drawings.
- F. Environmental Ratings:
 - 1. Ambient Temperature Rating: Not less than 0 deg F (minus 18 deg C) and not exceeding 104 deg F (40 deg C), with an average value not exceeding 95 deg F (35 deg C) over a 24-hour period.
 - 2. Ambient Storage Temperature Rating: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C)
 - 3. Humidity Rating: Less than 95 percent (noncondensing).
 - 4. Altitude Rating: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if MCC includes solid-state devices.
- G. Main-Bus Continuous Rating: as specified on the contract drawings A.
- H. Vertical-Bus Minimum Continuous Rating: as required to supply the equipment in the vertical section, 300A minimum.
- I. Horizontal and Vertical Bus Bracing (Short-Circuit Current Rating): Match MCC short-circuit current rating.
- J. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends. Brace bus extensions for busway feeder bus.
- K. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
- L. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, tin plated.
- M. Phase and Neutral-Bus Material: Tin-plated, high-strength, electricalgrade aluminum alloy.
- N. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

- O. Ground Bus: Minimum size required by UL 845, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit equipment grounding conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
- P. Front-Connected, Front-Accessible MCCs:
 - 1. Main Devices: Drawout mounted.
 - 2. Controller Units: Drawout and fixed mounted.
 - 3. Feeder-Tap Units: Drawout and fixed mounted.
 - 4. Sections front and rear aligned.
- Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic MCC.
- R. Pull Box on Top of an MCC:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as MCC.
 - 2. Set back from front to clear circuit-breaker removal mechanism.
 - 3. Removable covers forming top, front, and sides. Top covers at rear easily removable for drilling and cutting.
 - 4. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
 - 5. Cable supports arranged to facilitate cabling and adequate to support cables, including those for future installation.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of unit.
- T. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
- U. Fungus Proofing: Permanent fungicidal treatment for OCPDs and other components including instruments and instrument transformers.

2.12 SOURCE QUALITY CONTROL

- A. MCC Testing: Inspect and test MCCs according to requirements in NEMA ICS 18
- B. VFD Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
 - 1. Test each VFD while connected to its specified motor.
 - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.
- C. MCCs will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Coordinate layout and installation of MCCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Floor-Mounting Controllers:
 - 1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3. Install anchor bolts to elevations required for proper attachment to supported equipment.

- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible switch.
- E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor- driven equipment.
- G. Comply with NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements in Section 16075 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label MCC and each cubicle with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.
 - 4. Mark up a set of manufacturer's connection wiring diagrams with field- assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.
- B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.04 CONTROL WIRING INSTALLATION

- A. Bundle, train, and support wiring in enclosures.
- B. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automaticcontrol devices that have no safety functions when switch is in manualcontrol position.
 - 2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as

low- and high- pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 CONNECTIONS

- A. Comply with requirements for installation of conduit in Section 16130 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Comply with requirements in Section 16060 "Grounding and Bonding for Electrical Systems."

3.06 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each enclosed controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer and Owner before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan

of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
- c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- 10. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.
- C. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.07 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient

motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.
- E. Program microprocessors in VFDs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- F. Set field-adjustable circuit-breaker trip ranges as specified in the "Overcurrent Protective Device Coordination Study."

3.08 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.09 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION

SECTION 16461

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.
 - 2. Buck-boost transformers.

1.03 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. If an independent testing agency is required, see Division 1 Section "Quality Requirements" for general testing and inspecting agency qualification requirements. If additional control is needed, retain one of first two paragraphs below to specify 29 CFR 1910.7 or other more specific criteria (e.g., NETA). 29 CFR 1910.7 defines a nationally recognized testing laboratory as it applies to testing and inspecting for safety, and lists, labels, or accepts equipment and materials that meet certain OSHA criteria.

- B. Retain first paragraph and subparagraph below if Contractor selects testing agency.
- C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.06 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Challenger Electrical Equipment Corp.; a division of Eaton Corp.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Products.
- 3. Square D; Schneider Electric.
- 4. Siemens
- 2.02 GENERAL TRANSFORMER REQUIREMENTS
 - A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
 - B. Cores: Grain-oriented, non-aging silicon steel.
 - C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Interior Noncorrosive Area Enclosures: Ventilated, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Exterior/Interior Corrosive Area Enclosures: Totally enclosed, nonventilated, NEMA 250, Type 4X, stainless steel.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: ANSI 49 gray.
- F. Taps for Transformers Smaller Than 3 kVA: None.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- J. Energy Efficiency for Transformers Rated 15 kVA and Larger:

- 1. Complying with NEMA TP 1, Class 1 efficiency levels.
- 2. Tested according to NEMA TP 2.
- K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - 2. Indicate value of K-factor on transformer nameplate.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Fungus Proofing: Permanent fungicidal treatment for coil and core.
- N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.04 BUCK-BOOST TRANSFORMERS

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.
- B. Enclosure: Ventilated, NEMA 250, Type 2.
 - 1. Finish Color: ANSI 49 gray.

2.05 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 16 Section "Electrical Identification."

2.06 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 16 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

3.03 CONNECTIONS

- A. Ground equipment according to Division 16 Section "Grounding and Bonding."
- B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

- 3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 16495

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SCOPE

- A. A. Variable frequency drives for the sewage pumps shall be constructed as detailed in the plans and specifications.
- 1.02 RELATED DOCUMENTS
 - A. Drawings and general provisions of the Contract, including JEA General Conditions and Division 01 Specification Sections, apply to this Section.
 - B. Detailed BOM and wiring drawings contained in the project drawing package.

1.03 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.04 DEFINITIONS

- A. CPT: Control power transformer.
- B. EMI: Electromagnetic interference.
- C. LED: Light-emitting diode.
- D. NC: Normally closed.
- E. NO: Normally open.
- F. OCPD: Overcurrent protective device.
- G. PID: Control action, proportional plus integral plus derivative.
- H. RFI: Radio-frequency interference.
- I. VFC/VFD/AFD: Variable-frequency motor controller.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated.
 - 1. Include dimensions and finishes for VFDs.

- 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- 3. Include data and calculations to support the minimum SCCR specified.
- B. Shop Drawings: For each VFD indicated.
 - 1. Include mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include marking data per NEC 70, Article 409.110

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Required working clearances and required area above and around VFDs.
 - 2. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements.
 - 3. Show support locations, type of support, and weight on each support.
 - 4. Indicate field measurements.
- B. Product Certificates: For each VFD from manufacturer.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 01730 "Operation and Maintenance Data," include the following:

- a. Manufacturer's written instructions for testing and adjusting thermal- magnetic circuit breaker and motor-circuit protector trip settings.
- b. Manufacturer's written instructions for setting field-adjustable overload relays.
- c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
- d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
- e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
- f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish Two spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

1.10 WARRANTY

- A. Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL

A. Construct VFDs per the contract drawings and Section 16910 Control Panel Construction.

2.02 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
 - 1. Test each VFD while connected to its specified motor
 - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.
- B. VFDs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Approved manufacturers per JEA's 2018 Standards shall be: Cutler Hammer and Siemens

PART 3 - EXECUTION

- 3.01 EXAMINATION
 - A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

- B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install fuses in each fusible-switch VFD.
- B. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- C. Install, connect, and fuse thermal-protector monitoring relays furnished with motor- driven equipment.
- D. Comply with NECA 1.

3.03 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's -control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic- control devices that have no safety functions when switches are in manual-control position
 - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.04 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 16120 "Low-Voltage Electrical Power Conductors and Cables."

- 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
- 2. Label each VFD with engraved nameplate.
- 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.05 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared

scan of each VFD. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFD 11 months after date of Substantial Completion.
- c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. VFDs will be considered defective if they do not pass tests and inspections.
- D. Perform Harmonic Distortion Testing at the point of common coupling defined in this specification and verify compliance with IEEE 519-2014 guidelines.
- E. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.06 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Set field-adjustable circuit-breaker trip ranges as specified in Section 16055 "Overcurrent Protective Device Coordination Study."

3.08 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

- B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.
- 3.09 DEMONSTRATION
 - A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION

SECTION 16515

INTERIOR AND EXTERIOR LIGHTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including GENERAL CONDITIONS.

1.02 SUMMARY

- A. This Section includes interior and exterior lighting fixtures, lamps, ballasts, emergency lighting units, and accessories.
- B. Related Sections: The following Division 16 Sections contain requirements that relate to this Section:
 - 1. "Exterior Lighting Fixtures" for exterior security lighting, roadway and parking lot lighting, poles, and standards.
 - 2. "Lighting Control Equipment" for modular dimmers, programmable lighting control systems, time switches, photoelectric relays, occupancy sensors, power relays, and contactors.
 - 3. Basic electrical requirements for submittal processing.

1.03 DEFINITIONS

- A. Luminaire: Fixture.
- B. Fixture: A complete lighting unit, exit sign, or emergency lighting unit. Fixtures include lamps and parts required to distribute the light, position and protect lamps, and connect lamps to the power supply.
- C. Emergency Lighting Unit: A fixture with integral emergency battery power supply and the means for controlling and charging the battery. They are also known as an emergency light set. Emergency units are available with integral lamps only.
- D. Exterior Lighting Unit: A fixture, or an assembly of fixtures with a common support, including a pole or bracket plus mounting and support accessories.
- E. Average Lamp Life: The time after which fifty (50%) percent will have failed and fifty (50%) percent will have survived under normal conditions.

1.04 SUBMITTALS

- A. General: Submit the following in accordance with CONDITIONS OF THE CONTRACT.
- B. Product data describing fixtures, lamps, ballasts, and emergency lighting units. Arrange product data for fixtures in order of fixture designation. Include data on features and accessories and the following information:
 - 1. Outline Drawings of fixtures indicating dimensions and principal features.
 - 2. Electrical ratings and photometric data with specified lamps and certified results of independent laboratory tests.
 - 3. Data on batteries and chargers of emergency lighting units.
- C. Maintenance data for products for inclusion in Operating and Maintenance Manual specified in Division 1.
- D. Product certifications signed by manufacturers of lighting fixtures certifying that their fixtures comply with specified requirements.
- E. Shop Drawings from manufactures detailing nonstandard fixtures and indicating dimensions, weights, methods of field assembly, components, features, and accessories.
- F. Coordination Drawings for fixtures mounted on, in, or above the ceiling indicating coordination with ceiling grids and other equipment installed in the same space.

1.05 WARRANTY

- A. Special Project Warranty: Submit a warranty, mutually executed by manufacturer and the Installer, agreeing to replace rechargeable system batteries that fail in materials or workmanship within the special Project warranty period specified below. This warranty is in addition to, and not a limitation of, other rights and remedies the Owner may have under the Contract Documents.
 - 1. Special Project Warranty Period: Ten (10) years, beginning on the date of Substantial Completion. A full warranty shall apply for the first year of the period, and a prorata warranty for the last nine (9) years.
 - 2. Protection of Metal from Corrosion: Warranty against perforation or erosion of the finish due to weathering.
 - 3. Color Retention: Warranty against fading, staining, and chalking due to the effects of weather and solar radiation.

PART 2 PRODUCTS

2.01 FIXTURES, GENERAL

- A. It shall specifically be the responsibility of the Contractor to verify the exact type ceiling and depth of all recessed fixtures and to furnish correct mounting trims and accessories for the specified and/or approved fixtures as required for the ceiling in which the fixtures are to be installed. <u>No consideration will be given to change requests/additional charges for failure to coordinate fixtures with final ceiling finishes.</u>
- B. Comply with the requirements specified in the Articles below and lighting fixture schedule.
- C. Recessed incandescent fixtures shall be rated for type ceiling installed. Units installed in insulated or lay-in ceiling shall be either insulated ceiling (IC) rated or shall be thermally protected (TP).
- D. Fluorescent fixtures shall be equipped with solid state octron ballasts.

2.02 SUSPENDED FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: ¹/₂-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two (2), ½-inch steel tubing with single canopy arranged to mount a single fixture. Finish same as fixture.
- C. Rod Hangers: 3/16-inch diameter cadmium plated, threaded steel rod.
- D. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, feed through box, cord, and locking- type plug.

2.03 FLUORESCENT FIXTURES

- A. Fixtures: Conform to UL 1570, "Fluorescent Lighting Fixtures."
- B. Ballasts: Conform to UL 935, "Fluorescent-Lamp Ballasts."
 - 1. Certification: By Electrical Testing Laboratory (ETL).
 - 2. Labeling: By Certified Ballast Manufacturers Association (CBM).
 - 3. Type: Class P, high-power-factory type except as indicated otherwise.
 - 4. Sound Rating: A rating.
 - 5. Voltage: Match connected circuits.

- C. Ballast manufacturer shall warrant ballasts to be free from defects in material or workmanship for at least five (5) years from date of manufacture under normal conditions of use.
- D. Low Temperature Ballast Minimum Starting Temperature: Minus twenty (20°) degress C.
- E. Electronic Ballasts: Solid-state, full-light-output, energy-saving type compatible with energy-saving lamps. Conform to FCC Regulations Part 15, Subpart J. for electromagnetic interference. Conform to IEEE C62.41, "Guide for Surge Voltages in Low-Voltage AC Power Circuits," Category A, for resistance to voltage surges for normal and common modes, by Motorola Lighting Inc. or approved equal.
 - 1. Minimum Power Factor: Ninety-nine (99%) percent.
 - 2. Minimum Operating Frequency: Twenty-five (25) Khz with less than two (2%) percent lamp flicker.
 - 3. Third Harmonic Content of Ballast Current: Less than ten (10%) percent.
 - 4. Ballasts shall not be potted.
 - 5. Lamp current crest factor (ratio of peak to R.M.S. lamp current) shall be 1.5 or less per lamp manufactures' recommendation.
 - 6. Average Input: The following is the average required wattage when tested according to ANSI C82.2, "Fluorescent Lamp Ballasts, Methods of Measurement."
 - a. Sixty (60) or less watts when operating two (2) thirty-two (32) watt T8 lamps.
 - b. Thirty (30) or less watts when operating one (1) thirty-two (32) watt T8 lamp.
- F. Manufacturer: Subject to compliance with the Drawings and Specifications Motorola, Advance, Magnetek.
- G. Electromagnetic Interference Filters: Integral to the fixture assembly. Provide one filter for each ballast. Suppress electromagnetic interference as required by MIL-STD-461, "Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference."

2.04 HIGH INTENSITY DISCHARGE (HID) FIXTURES

A. Fixtures: Conform to UL 1572, "High-Intensity Discharge Lighting Fixtures."

- B. Ballasts: Conform to UL 1029, "High-Intensity-Discharge Lamp Ballasts" and ANSI C82.4, "Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)." Provide ballasts with the following features, except as otherwise indicated.
 - 1. Constant wattage autotransformer (CWA) or regulator, high-power-factor type.
 - 2. Voltage rating matches system voltage.
 - 3. Single-Lamp Ballasts: Minimum starting temperature of minus thirty (30°) degrees C.
 - 4. Normal ambient operating temperature is forty (40°) degrees C.
 - 5. Open circuit operation will not reduce the average life.
 - 6. High pressure sodium (HPS) ballasts incorporate a solid-state ignitor/starter with an average life in the pulsing mode of ten-thousand (10,000) hours at an ignitor/starter case temperature of ninety (90°) degrees C.
 - 7. Noise Suppression: Manufacturer's standard epoxy encapsulated model designed to minimize audible fixture noise.
 - 8. Shall be equipped with HLR/GMF fuse properly sized.
- C. Instant Restrike Device: Solid-state, potted module, mounted inside fixture, and compatible with mogul-based HPS lamps, ballasts, and sockets up to one hundred-fifty (150) watts.
 - 1. Restrike Range: One hundred-five (105) to one hundred-thirty (130) VAC.
 - 2. Maximum Voltage: Two hundred-fifty (250) volts peak or one hundred-fifty (150) VAC RMS.
- D. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp when the fixture is initially energized and when momentary power outages occur. Turn quartz lamp off automatically when HID lamp reaches approximately sixty (60%) percent light output. Ballasts have internal components independent of the incoming line voltage.

2.05 INCANDESCENT FIXTURES

A. Conform to UL 1571, "Incandescent Lighting Fixtures."

2.06 FIXTURES FOR HAZARDOUS LOCATIONS

A. Conform to UL 844, "Electric Lighting Fixtures for Use in Hazardous (classified) Locations," or provide units that have Factory Mutual Engineering and Research Corporation (FM) certification for the indicated class and division of hazard.

2.07 EXIT SIGNS

- A. Conform to UL 924, "Emergency Lighting and Power Equipment," and the following:
 - 1. Sign Colors: Conform to local code.
 - 2. Minimum Height of Letters: Conform to local code.
 - 3. Arrows: Include as indicated.
 - 4. Lamps for AC Operation: As furnished with LED unit.
 - 5. Additional Lamps for DC Operation: Two (2) minimum, bayonet-base type, for connection to external dc source.
- B. Self-Powered Exit Signs (Battery Type): Integral automatic high/low trickle charger in a self-contained power pack.
 - 1. Battery: Sealed, maintenance-free, nickel cadmium type with special Project warranty.

2.08 EMERGENCY LIGHTING UNITS

- A. Conform to UL 924, "Emergency Lighting and Power Equipment" requirements for "Unit Equipment." Provide self-contained units with the following features and additional characteristics as indicated.
 - 1. Battery: Sealed, maintenance-free, lead-acid type with ten (10) year nominal life minimum, and special Project warranty.
 - 2. Charger: Minimum two (2) rate, fully-automatic, solid-state type, with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when supply circuit voltage drops to eighty (80%) percent of nominal or below. Lamp automatically disconnects from battery when voltage approaches deepdischarge level. Relay disconnects lamps and battery automatically recharges and floats on trickle charge when normal voltage is restored.
 - 4. Wire Guard: Where indicated, provide heavy chrome plated wire guard arranged to protect lamp heads or fixtures.

5. Time-Delay Relay: Provide time-delay relay in emergency lighting unit control circuit arranged to hold unit "on" for fixed interval after restoration of power from an outage. Provide adequate time delay to permit HID lamps to restrike and develop adequate output.

2.09 FINISH

- A. Steel Parts: Manufacturer's standard finish applied over corrosion-resistant primer, free of streaks, runs, holidays, stains, blisters, and defects. Remove fixtures showing evidence of corrosion during Project warranty period and replace with new fixtures.
- B. Other Parts: Manufacturer's standard finish.

PART 3 EXECUTION

3.01 INSTALLATION (INTERIOR FIXTURES)

- A. Support of luminaires responsibility of this Section.
- B. Submit hanging details to Engineer before luminaire installation.
- C. Wire grid luminaires (except those connected by flexible wiring systems) with flexible conduit individually to junction. Do not wire luminaire to luminaire.
- D. Setting and Securing: Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's printed instructions and approved shop Drawings.
- E. Support For Recessed and Semirecessed Fixtures: Install units may be supported from suspended ceiling support system. Install ceiling system support rods or wires at a minimum of four rods or wires per fixture located not more than six (6)-inches from fixture corners.
 - 1. Fixtures Smaller Than Ceiling Grid: Install a minimum of four rods or wires for each fixture and locate at corner of the ceiling grid where the fixture is located. Do not support fixtures by ceiling acoustical panels.
 - 2. Fixtures of Sizes Less Than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with at least two ³/₄-inch metal channels spanning and secured to the ceiling tees.
 - 3. Install support clips for recessed fixtures, securely fastened to ceiling grid members, at or near each fixture corners.
 - 4. Support luminaires from structural members of building, independent of ceiling. Support grid type luminaires from ceiling. Arrange with ceiling contractor for extra ceiling support. (One (1) at each corner of two (2)-ft. x four (4) ft. luminaire).

- 5. Anchor high intensity discharge luminaires mounted in ceiling or on wall to structure. Support recessed ceiling luminaires independent of ceiling construction. Supports to consist of ¼-inch diameter bolts or rods.
- 6. Support surface and pendant incandescent luminaires from 3/8-inch fixture stud in outlet box. Large surface or pendant incandescent luminaires (in excess of twenty (20) pounds) with 3/8-inch rod run through the outlet box to structure, anchored independent of ceiling and conduit systems.
- 7. Support surface and pendant fluorescent luminaires independent of furred ceiling with ¼-inch rods anchored to structure. Provide one (1) support for each four (4) feet of luminaire length, minimum of two (2) supports required. Support luminaires mounted on grid type ceiling, with Caddy type IDS clips with rods to structure.
- 8. Provide plaster frames for recessed fluorescent in plaster and concealed spline ceilings supported independent of ceiling construction with ¼-inch rod anchored to structure.
- 9. Individual flexible connections to luminaires with two (2) fourteen (#14) and one (1) fourteen (#14) (ground) THHN in 3/8 inch flexible conduit. Bond ground wire at each end.
- 10. Stems on fluorescent luminaires installed as follows (except luminaires with slide grip hangers): First and last stem in row in first knockout from end of luminaires; one stem installed between each two (2) luminaires; stem to center joint where luminaires join and attach by use of "joining plates".
- 11. Luminaires in continuous rows other than recessed grid type connected by nipples with locknuts and bushings.
- 12. Furnish complete manufacturers shop Drawings for continuous slot luminaires showing mounting, ceiling interface and complete luminaire layout.
- F. On fluorescent fixtures: Shall be ball aligner type, swivel below canopy, thirty (30°) degrees from vertical and shall be painted to match fixture trim.
- G. On individual mounted incandescent or HID fixtures: Shall be threaded into ball aligner sockets which are suspended from fixture studs, 3/7 inch minimum, in a ceiling outlet box secured to building structural members. In finished areas stems shall be painted to match fixtures.
- H. It shall specifically be the responsibility of the Contractor to verify the exact type ceiling and depth of all recessed fixtures and to furnish correct mounting trims and accessories fot the specified and/or approved fixtures as required for the ceiling in which the fixtures are to be installed.

I. Lamping: Lamp units according to manufacturer's instructions.

END OF SECTION

SECTION 16900 INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. In general, the work specified in this section of the specifications includes the furnishing of all labor, material, and services necessary to install the instrumentation, control and monitoring systems, including all fees, charges, and permits necessary.
- B. As specified in the section of these specifications entitled ELECTRICAL WORK -GENERAL, the Contractor shall furnish and install conduit, wiring, and connections for equipment and devices furnished under other sections of the specifications or under other contracts. The Contractor shall also install motor starters, switches, and other electrical equipment furnished under other sections or under other contracts.
- C. The Contractor shall refer to the mechanical specifications and drawings for locations of pressure-operated control switches, float switches, solenoid-operated valves, limit switches, alarm actuating contacts, and other devices requiring wiring.
- D. The Contractor shall make all interconnections required between transmitters, receivers, recorders, indicating instruments, control panels, and miscellaneous devices, and shall provide for electrical supply to metering and signal systems.
- E. All conduit and wiring between electrical and instrumentation panels, all fieldmounted devices, and power sources shall be furnished and installed as required for a complete operable system.
- F. Unless otherwise indicated, all electrical equipment and installation shall be in accordance with the section of these specifications entitled ELECTRICAL WORK GENERAL.

1.02 SYSTEM RESPONSIBILITY

- A. To insure coordinated control systems, to properly achieve the indicated functions, and to provide a maximum interchangeability of equipment items and parts, the complete instrument and control system shall be furnished by a single instrumentation system contractor/supplier who shall be responsible for the satisfactory operation of the system.
- B. The system contractor/supplier shall maintain permanent in-house system engineering and fabrication facilities including a quality assurance organization with the capability to perform complete system checkout and simulation in the shop prior to shipment.
- C. The system contractor/supplier shall maintain a permanent field service engineer for maintenance service.
- D. The system contractor/supplier shall perform all system engineering, prepare all

necessary internal and external wiring and piping drawings, and assume full responsibility with the performance requirements of these specifications, and as required for a complete and operable facility.

E. The instrumentation equipment locations and conduit drawings are diagrammatic to show the general scope and route of instrumentation system conduit. The instrumentation system contractor/supplier shall provide all conduit and wiring necessary for his specific requirements, in accordance with these specifications, and without additional cost to the Owner.

1.03 SUBMITTALS

- A. The Contractor's attention is directed to the requirements of the section of these specifications entitled ELECTRICAL WORK GENERAL, and the GENERAL CONTRACT CONDITIONS. In order to facilitate review and approval of the proposed system, shop drawing submittals shall be made in two steps. The first submittal shall include all in-line devices such as flow meters, control valves, etc., to be supplied or coordinated with the instrumentation system. The second submittal shall include complete details of the instrumentation system.
- B. Shop drawing submittals shall include the following:
 - 1. Complete Bill of Materials, front panel view with component locations, subpanel view with component locations, and electrical schematics.
 - 2. Functional description of the entire system including individual loop diagram descriptions.
 - 3. Detail loop diagrams showing both piping and wiring requirements for each analog instrument loop in the system.
 - 4. Component drawing for each component showing dimensions, mounting, and external connection details.
 - 5. Detail layout, dimensions, fabrication, piping, and wiring schematic, connection, and interconnection drawings for each instrumentation panel, graphic display, termination cabinet, etc.
 - 6. Component manufacturing data sheet for each component indicating pertinent data and identifying each component by item number and nomenclature as indicated on the drawings and in these specifications.
 - 7. Testing plan description, sample test reports, and proposed testing schedule.
 - 8. Training plan description, listing of training materials to be provided, and proposed training schedule.
- C. Shop drawings shall conform to JEA standard drawing/schematics. References to the Bill of Materials shall be located for each component.
- D. Operation and maintenance manuals, in accordance with the provisions of the GENERAL CONTRACT CONDITIONS, shall also be supplied. Operating instructions shall incorporate an updated functional description of the entire system including the system schematics which reflect as-built modifications. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
 - 1. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. In addition, an electronic copy of all drawings shall be submitted to JEA.

2. Electronic drawing files shall be in both PDF and AutoCAD 2010 format.

PART 2 - PRODUCTS

2.01 GENERAL CRITERIA

- A. All of the equipment shall be the manufacturer's latest and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the instrumentation system. The completed system shall be compatible with the functions required and the equipment furnished by the Contractor and shall include all necessary control relays, contacts, and additional devices required for a complete, coordinated, operable facility.
- B. Electrical control equipment, starters, contactors, etc., shall be full NEMA rated.
- C. All contacts for control of remote motor-operated or electrically-operated equipment shall be rated not less than 10 amperes on 120 volts.
- D. All electrical components of the instrumentation and control system shall operate on 120/1/60 power, except as noted otherwise in the specifications. Control circuits for components which are located in hazardous areas shall be 24 volt intrinsically safe.
- E. Where control equipment is not within sight of the motor, a safety lockout station with position indication, which shall prevent application of current to the motor, shall be located near the motor. Where the driven equipment is located on a different level than their driving motors, a safety lockout station shall be provided on each level.
- F. Programmable controllers shall be utilized for standard relay and control functions within motor control centers, control panels, etc., only where specifically approved. In general, conventional control equipment shall be provided.
- G. All controls for remote electrically-operated or motor-driven equipment shall be complete, including all necessary auxiliary relays so as to require only wiring and connections to the equipment control circuit.
- H. All remote motor-operated or electrically-operated equipment shall have a separate 120 volt control circuit, except as indicated otherwise.
- I. All necessary fuses or switches required by the instrumentation manufacturer for his equipment shall be provided with the equipment. All instruments requiring an internal power supply shall have an internal ON-OFF switch.
- J. The drawings and specifications indicate the energy sources that will be provided. Any other devices (isolation transformers, power supplies, lightning arresters, etc.) necessary to obtain proper operation and protection of the instrumentation system shall be furnished with the instrumentation system.
- K. Individually adjustable alarm modules shall be provided to generate all required alarm or interlocking contacts from analog signals.

- L. Signal isolators shall be provided for all analog signals to auxiliary equipment remote from instrumentation panels.
- M. All printed circuit boards throughout the instrumentation system shall have a protective coating to prevent corrosion.
- N. All components shall be tagged with the item number and nomenclature given in the specifications and component tabulation lists.
- O. Each field mounted transmitter shall be installed within a NEMA 12/3R aluminum or stainless steel enclosure for weather protection. Enclosures shall exceed the dimensions of the enclosed transmitter by a minimum of six inches on all sides and shall permit full unobstructed access to the enclosed transmitter. Enclosures shall be equipped with a continuous hinged access door with 3-point latching handle. Ventilation louvers shall be provided at top and bottom of both sides to promote convection cooling.
- P. Stainless steel spring-type terminals shall be used in all instrumentation and control panels; Wago TopJob S.rail mounted terminal blocks. All instrumentation and control panel control wiring shall terminate in ferrules.

2.02 CONTROL DEVICES

- A. Control Stations Control stations shall be heavy-duty, oil-tight, complete with NEMA 13 cast aluminum enclosures; Cutler-Hammer Type T, General Electric, or equal.
 - 1. Safety lockout stations (SAFE-OFF) shall be equipped with 316 stainless steel padlock devices for padlocking in the de-energized position.
 - 2. Unless specified otherwise, control stations installed outdoors, or in corrosive atmospheres, shall have watertight, NEMA 4X cast aluminum enclosures.
 - 3. Control stations within hazardous locations shall be explosion-proof and shall have galvanized cast iron enclosures; Crouse-Hinds Type EFS, Appleton, or equal.
- B. Float Switches Where required for control system operation, float switches consisting of a SPDT mechanical micro switch, rated 15 amps at 120 VAC, in a chemical-resistant casing, complete with chemical-resistant flexible cord, shall be provided; Shall meet latest JEA latest standardized equipment, or pre-approved equal.
- C. Limit Switches (Leverless) Where required for control system operation, magnetic target sensing, leverless limit switches shall be provided; GO Switch Model 81. Limit switches shall be NEMA 4X, hermetically sealed, 316 stainless steel construction. Limit switches shall be equipped with 72 inch potted leads. Unless otherwise required by the application and installation, limit switch outlet shall be located at the bottom of the enclosure. Limit switches shall be DPDT rated 10 amps at 120 VAC. Limit switches located in hazardous locations shall be explosion proof and intrinsically safe

2.03 CONTROL COMPONENTS

- A. General Where indicated on the drawings, or required by the functions specified, control components shall be furnished and installed with-in control panels, motor control center, or other approved locations. Suitable nameplates shall be provided for all panel door or surface-mounted control devices. All component terminals, including auxiliary contacts, shall be wired to master terminal boards.
- B. Instruments Instruments shall be of standard size not less than 5-1/2" in width and they shall present a uniform appearance when mounted upon the panels. Instruments shall have scales 5" in length and shall be accurate within 1% of full scale. Instrument scales shall be selected with full-load readings at 75% of the scale range, unless specified otherwise or approved.
- B. Pilot Devices Selector switches, pushbuttons, indicating pilot lights, and additional pilot devices as required, shall be 600 volt rated heavy-duty, oil-tight, 30mm pilot devices as manufactured by General Electric, Cutler-Hammer, or equal.
 - 1. Pushbuttons shall be standard type with anodized aluminum rings and colored buttons.
 - 2. Selector switches shall be standard handle type with anodized aluminum rings and handles.
 - 3. Pilot lights shall be full brightness LED type: Dialight Series 556.
 - 4. All pilot devices shall have appropriate nameplates and locking means for locking in the de-energized mode, and shall be color coded (red start, on, open, up; green stop, off, close, down; black test, silence, miscellaneous).
- D. Timers Where required for control system operation, multifunction programmable timing modules shall be provided. Timers shall have timing modes and cycle times as indicated, shall be provided for operation at voltage indicated, and shall have DPDT contacts; Potter & Brumfield CNS-35-96, or equal.
- E. Control Relays Where required for control system operation, control relays shall be 3P3T, 11 pin octal type, with 10 amp contacts, internal LED, test button, and large ice cube style case; Cutler-Hammer D3PF3AA, D3PF3AT1, or equal.
 - 1. Time delay relays shall be potentiometer adjustable time setting, 1.0% repeatability, 2PDT plug-in type time delay relays with, 10 amp contacts, 8-pin square sockets and hold-down springs. Delay on de-energize mode shall not require input power during the timing; Potter & Brumfield CK Series, or equal.

2.04 FIELD INSTRUMENTS

A. All field instruments shall be JEA latest standardized equipment as indicator on the drawings. Power and signal line surge protection shall be provided for each instrument signal. Each instrument shall include all mounting systems, fittings, etc. for a complete and proper installation in accordance with all manufacturer's requirements.

- B. Magnetic Flow Meters:
 - 1. Magnetic flow meters shall be of the pulsed DC short-form design utilizing electromagnetic induction to produce a Profibus DP and a scaled pulse output signal directly proportional to flow, in one direction only.
 - 2. Metering tubes shall be constructed of Type 304 stainless steel with a 200°F rated teflon liner and ANSI 150# carbon steel flange end connections. Electrodes shall be Type 316 stainless steel.
 - 3. Magnetic flow meters shall be NEMA 4 suitable for Class I, Group D, locations. Meter housings shall be provided with a corrosion-resistant epoxy coating. Meters shall be capable of accidental submergence up to 30'.
 - 4. Meters shall be equipped with type 316 stainless steel non-corrosive, metallic grounding rings and all necessary signal cable.
 - 5. Flow meters shall be hydraulically calibrated and computer printouts of the actual calibration data shall be furnished with each meter.
 - 6. Magnetic flow transmitters shall be of the feedback type utilizing solidstate printed circuit construction and shall be provided with low flow cutoff circuitry for positive return to zero during no flow conditions.
 - 7. Each transmitter shall be remote or integrally mounted to the flow tube as indicated. Flow transmitter housings shall be NEMA 4 cast aluminum or type 316 stainless steel. Flow transmitters shall be equipped with a full-scale indicating meter and observation window.
 - 8. Magnetic flow meter accuracy shall be ±0.5% full scale for the range indicated. Magnetic flow meters shall be latest JEA standard equipment, or pre-approved equal.
- C. Submersible Pressure Sensing Level Meters:
 - 1. The level transmitter system shall consist of a submersible pressure sensor/transmitter unit which is suitable for direct submersion into the liquid being measured.
 - 2. Sensor size shall not exceed 1.25" diameter by 9" length. The sensor shall be a solid state variable capacitance or diffused silicon semiconductor type which shall provide an output signal directly proportional to the sensed pressure over a factory-calibrated range. The sensor assembly shall have a stainless steel or titanium housing and shall be supported by a polyethylene or urethane jacketed cable with a minimum 200# test strength. The sensor assembly shall have a conduit adapter for connection to a PVC mounting support pipe. The sensor cable shall be of sufficient length so no splice or connector is required in the wet or inaccessible area, and the vent tube termination point is located in an area protected from dirt and moisture.
 - 3. The transmitter shall have a two-wire type 4-20 mA dc current output which is proportional to level. The transmitter shall have intrinsically safe barrier, regulated loop power supply and digital indicating meter located at the monitoring control panel, and signal isolator for PLC analog input signal. The output shall have surge protection, and shall not be damaged by reverse polarity. The transmitter shall be suitable for an operating temperature range of 0 to +50°C. Accuracy of the level transmitter shall be plus or minus 0.25 percent "best straight line", with an overall combined accuracy of plus or minus 1.0 percent over the entire operating temperature/pressure range.
 - 4. Submersible pressure sensing level transmitters shall latest JEA standard

equipment, or pre-approved equal.

2.05 SUPERVISORY CONTROL SYSTEM

- A. General: The supervisory control system (SCS) shall be a complete integrated system furnished and configured by the instrumentation system supplier who shall be responsible for the satisfactory operation of the entire system. The SCS shall consist of programmable logic controllers, operator interface panels, and communications network.
 - 1. The JEA shall provide the WinCC interface for the SCS.
 - 2. For all components furnished by the instrumentation system contractor/supplier, the instrumentation system contractor/supplier shall provide the JEA with all component data, calibration data, wiring diagrams, software copy of program with comments, etc. that may be required to facilitate the proper development of the SCS.
 - 3. System startup and testing shall be provided by the contractor and shall be witnessed and approved by JEA.
- B. Programmable Logic Controllers (PLC): Each PLC shall be fully equipped to monitor all equipment status, alarm, and instrumentation system analog signals, and control selected equipment operations; and seamlessly connect to the SCADA system network. To ensure coordination, compatibility, and maximum interchangeability with the JEA's existing systems, the basis of design for control system PLCs shall be Siemens Simatic S7-300 Series programmable logic controllers.
- C. PLC Configuration: Each PLC configuration shall be based upon the following JEA standardized components:

1.	6ES7 315-2EH14-0AB0	CPU
2.	6ES7 953-8LL31-0AA0	Micro Memory Card
3.	6ES7 321-1FH00-0AA0	Digital Input Modules
4.	6ES7 322-1HH01-0AA0	Digital Output Modules
5.	6ES7 331-7NF10-0AB0	Analog Input Modules
6.	6ES7 332-7ND02-0AB0	Analog Output Modules
7.	6ES7 392-1AJ00-0AA020	Terminal Front Connectors
8.	6ES7 392-1AM00-0AA0	40 Terminal Front Connectors
9.	6ES7 307-1EA01-0AA0	Power Supply
10.	6GK5 204-2BB10-2AA3	Scalance Éthernet Switch
11.	6AV2 124-0MC01-0AX0	TP1200 Operator Interface Panel

- D. All PLC equipment shall be suitable for installation and operation within harsh industrial environments, including 5%-95% non-condensating humidity, 0-50°C temperature, vibration, shock, surges, etc., with-out fans, air conditioning, or electrical filtering.
- E. Simatic Step 7 engineering software shall be used for all PLC programming. The Step 7 version to be used shall be the latest version presently utilized by JEA. Upon final acceptance, electronic copies of the final programming shall be included within the O&M manuals.
- F. Unless indicated otherwise, each PLC shall be factory-loaded and tested at the instrumentation system contractor/supplier manufacturing facility, and shall be

witnessed and approved by JEA.

2.06 COMMUNICATION NETWORKS

- A. All Profibus installation must comply with the Profibus User Organization. More information can be found at "WWW.Profibus.com".
 - 1. Reference "Profibus Installation Guideline for Planning", order number 8.0012.
 - 2. Reference "Profibus Assembly Guideline", order number 8.0022.
 - 3. All recommendations from the Profibus User Organization must be followed, such as using fiber optic cable instead of copper when leaving a building.
 - 4. Profibus connectors shall be made of metal housing and have Power, Transmit, Termination and Error indicating LED's. Connectors shall be Brad Harrison MA9D00-42 and MA9D01-42 type or equal.
 - 5. Only Diagnostic Repeaters shall be used where repeaters are required. Standard repeaters shall not be accepted. Repeaters shall be Siemens Diagnostic repeater 6ES7 972-0AB01-0XA0.
 - 6. Provide an active termination resistor on the last device in the segment. Termination resistor shall be Procentec 101-00211A.
 - 7. For fiber optic communications use the Siemens OLM G12 Part # 6GK1503-3CB00.
 - 8. Profibus cable shall be type FC (Fast Connect) 2 wire shielded cable specifically designed for rapid installation; Siemens 6XV1830.
- B. All Ethernet installation must comply with the Profinet User Organization. More information can be found at "WWW.Profinet.com".
 - 1. Reference "Profinet Installation Guideline for Cabling and Assembly" order number 8.072.
 - 2. All recommendations from the Profinet User Organization must be followed such as using fiber optic cable when leaving a building.
 - 3. Ethernet Connector connectors shall be made of metal housing. Connectors shall be Siemens 6GK1901-1BB10-2AA0 type or equal.
 - 4. All switches shall have the capability to be managed. Switches shall be of type Siemens Scalance X212-2 at minimum.

PART 3 - EXECUTION

3.01 SYSTEM DESCRIPTIONS

- A. General The general arrangement of the analog instrument and control system is shown on the drawings.
 - 1. No attempt has been made to detail on the drawings all accessories and devices required for the complete system. The system contractor/supplier shall be responsible for the preparation of all detail installation drawings showing wiring, piping, mounting, etc.
 - 2. The system contractor/supplier shall be responsible for furnishing all devices required for a complete functioning system.

- 3. All PLC operator "adjustable" or "selectable" settings shall be accessible from the PLC operator interface panel.
- B. Control Panels
 - 1. Main Control Panel
 - i. The main control panel shall monitor and control all of the equipment associated with the pump station including: the service pumps, wetwell and dry well sump pumps, wetwell mixer, seal water pumps and tank, screens, and ventilation equipment. It shall interface with the client's central SCADA system and personnel currently responsible for monitoring/control of the site via fiber optic (primary), radio (secondary), and phone line (if necessary).
 - ii. The following signals shall be monitored and/or controlled by the main control panel:
 - 1. Level Instruments
 - a. Wetwell Floats Low Level, Off, Lead On, 1st Lag On, 2nd Lag On & High Level
 - b. Wetwell Level Transducer Primary and Backup
 - 2. Mechanical Screens, Screening Conveyor, Wetwell Mixer, Wetwell Sump pump & Drywell Sump Pumps
 - a. Running status (7)
 - b. Fault status (7)
 - c. Hand-Off-Auto status (7)
 - d. Motor thermal fault (7)
 - e. Seal failure fault (4)
 - f. Hand-Off-Remote (5)
 - 3. Service Pumps
 - a. Running status (3)
 - b. Fault status (3)
 - c. Hand-Off-Auto status (3)
 - d. Motor thermal fault (3)
 - e. Start/stop command (3)
 - f. Check valve position (3)
 - g. Discharge pressure (3)
 - h. Desired speed (3)
 - i. E-Stop (3)
 - 4. Backup Pump
 - a. Running
 - b. Common Fault
 - c. Low Fuel
 - d. Low/off level float
 - e. On level float
 - f. High level float
 - 5. Wash water pumps
 - a. Running (3)
 - b. Fault (3)
 - 6. Instruments
 - a. Level
 - i. Wetwell Floats Low Level, Off, Lead On, 1st Lag On, 2nd Lag On & High Level
 - ii. Wetwell Level Transducer Primary and Backup

- iii. Drywell Floats Low/Off, Lead On, Lag On/High Level
- b. Flow Meters
 - i. Station Effluent Flow
 - Pressure Transducers
 - i. Effluent discharge pressure
- iii. Control sequence

c.

- 1. Service Pumps
 - a. The main control panel shall start and stop the service pumps based on the level in the wetwell. The operational levels shall be based on the wetwell level transmitter(s) and operators shall be able to adjust them as necessary.
 - b. The service pumps shall alternate assignments (lead, 1st lag, 2nd lag) on an operator adjustable interval (typically every 24 hours) and after each operational cycle, whichever comes first.
 - c. The control panel shall contain relay-based float backup logic to start/stop the pumps in the event of a PLC failure. The backup logic shall be designed to prevent simultaneous starting of the pumps and shall alternate operation of the pumps after each cycle. The pumps shall be staged on in accordance with the floats. The circuitry and devices selected shall allow operators to take a specific pump sequence for maintenance and the circuitry/devices shall omit that pump in its operation. In the event that the low-level float is tripped all three pumps shall be locked out of operation in both the primary and backup mode of operation.
 - d. Alarms shall be generated at operator adjustable levels in association with the wetwell's level transmitter(s) as well as for the high and low float switches.

3.02 CONTROL PANELS

- A. Where indicated on the drawings, specified, or required by the functions specified, control panels, including all necessary accessories, shall be provided for control of the associated equipment.
- B. Control panels shall be constructed in accordance with the requirements of Section 433 of the *JEA Water & Sewer Standards*, and shall be manufactured by a JEA approved manufacturer.
- C. Control panels shall be constructed in accordance with UL 508A & UL 698A requirements for enclosed industrial control panels and shall bear the UL508A and UL698A (where applicable) serialized label.
- D. All components shall be mounted using stainless steel machine screws. All holes shall be drilled and tapped. The uses of self-tapping screws are unacceptable.

3.03 WIRING

- Identification All wiring shall be color-coded as follows: А.
 - 1. 120 VAC (Unswitched Hot) #12 AWG Black
 - 2. 120 Volt Dry Contacts #16 AWG Red
 - 3. 120 VAC (Neutral)
 - 120 VAC (Switched Hot) 4.
- #14 AWG Red #18 AWG Blue

5. 24 VDC+ 6. 24 VDC-

#12 AWG White

- #18 AWG Blue with White Tracer
- 7. Ground

- #12 AWG Green
- B. Conductors #12 AWG and smaller shall be tinned copper hook-up/lead wire: Belden 35612 UL AWM Style 3173-XL-DUR, or equal.
- C. All control cabinet wiring to the PLC and control devices shall be 18 AWG.
- D. Control wiring shall be numbered/lettered at each end. Wire numbers/letters shall be flattened polyolefin heat shrink markers for permanent wire and cable identification or JEA pre-approved equal.
- E. Wire Duct - All wiring shall be routed through a wiring duct system to provide wire protection and an organized appearance. Wire duct shall be permanently attached using screws into the back panel.
- F. Terminals - Terminals shall be provided for interface with field installed equipment. The terminal blocks shall be mounted on a 30 degree angle for ease of field connection. Terminals shall be Siemens Model #8WA1011-1DF11 or current Siemens equivalent.

3.04 NAMEPLATES

- А. Nameplates shall be a laminated two-part system using black letters on a yellow background providing protection against fading, pealing or warping. The labeling system shall be computer controlled to provide logos, post-script type or custom designs. The uses of embossed plastic type tags are not acceptable.
- B. As a minimum the following components shall be labeled using a laser-screened Mylar nameplate:
 - 1. Relays
 - 2. Fuses
 - 3. Circuit breakers

3.05 MOUNTING HARDWARE

All components shall be mounted using stainless steel machine screws. All holes Α. shall be drilled and tapped. The uses of self-tapping screws are unacceptable.

UL LABELS 3.06

А. Each control panel shall bear a UL 508 serialized label "Enclosed Industrial Control Panel^{*}. The use of the UL label "Industrial Control Panel Enclosure" without the UL 508 serialized label is not acceptable. The entire control system shall bear a UL 913 serialized label "Industrial Panels Relating to Hazardous Locations".

3.07 ELECTRICAL TRANSIENT AND SURGE PROTECTION

- A. All components of the instrumentation system shall be equipped with suitable surge arresting devices to protect the equipment from damage due to electrical transients, including lightning induced electrical power surges.
- B. All power and signal circuits of each field instrument shall be protected with surge and transient protectors installed at both the source and destination ends of each circuit.
 - 1. Protectors for 120 volt power circuits shall be DS41S-120.
 - 2. Protectors for analog signal circuits shall be Citel DLAW-24D3.
- C. Surge and transient protectors shall be connected to the electrical system ground. Supplemental grounding shall be provided in accordance with the protection equipment manufacturer's recommendations.

3.08 FIELD CALIBRATION AND TRAINING

- A. Prior to initiation of preliminary instrumentation system startup, the Contractor must submit a certified statement from his installation subcontractor confirming that all field wiring is complete, has been terminated and marked in accordance with the latest set of approved shop drawings, and has been tested for improper grounds, short circuits, and continuity.
- B. The complete instrumentation system shall be systematically calibrated and proper performance demonstrated in the presence of the JEA Representative and Engineer.
 - 1. Process calibration, such as volumetric drawdown tests on flow and level measurements, shall be conducted on all measuring systems as required by the JEA Representative.
 - 2. Performance demonstrations shall be provided individually for each complete instrumentation loop. Successful performance shall depend on proper performance of each and every component associated with the loop.
 - 3. The Contractor shall submit certified calibration and performance reports from his system contractor/supplier confirming that the entire instrumentation system is complete and operating properly.
- C. All calibration, testing, demonstrations, training, etc., shall be at no additional cost to the JEA.

End of Section

SECTION 16910

CONTROL PANEL CONSTRUCTION

PART 1 - GENERAL

- 1.01 SCOPE
 - A. Requirements for the CONTRACTOR to construct, furnish, and install control panels referenced on the Contract Drawings and specified herein.
- 1.02 REFERENCE SECTIONS
 - A. Division 16 Electrical
- 1.03 REFERENCE STANDARDS
 - A. National Fire Protection Association (NFPA)
 - B. Occupational Safety & Health Administration (OSHA)
 - C. The Institute of Electrical and Electronics Engineers (IEEE)
 - D. International Society of Automation (ISA)
 - E. Building Industry Consulting Service International
 - F. Telecommunications Industry Association (TIA)
 - G. Underwriters' Laboratories, Inc. (UL)
 - H. National Electric MANUFACTURERs Association (NEMA)
 - I. American National Standards Institute (ANSI)

1.04 QUALITY CONTROL

- A. The control panel components shall be of the most current and proven design. Specifications and Drawings call attention to certain features but do not purport to cover all details entering into the design of the control panels. The components provided by the Control Panel Builder shall be compatible with the functions required and shall form a complete working system.
- B. The control panel shall be UL listed as a complete assembly in accordance with UL-508 and shall be affixed with a sticker indicating same.

1.05 SUBMITTALS

A. Shop drawings shall be submitted in accordance with Section 01300 and shall include at a minimum the following:

- 1. Catalog information and descriptive literature of all components, wiring diagrams, and panel layout drawings showing dimensions to all devices.
- 2. Loop diagram and field wiring diagrams for each control panel.
- 3. Network installation drawings/schematics related to the panel.
- 4. Material test certifications and MANUFACTURER's material certifications.
- 5. Heat load calculations for equipment containing active electronic components.
- 6. CONTRACTOR's installation methods, equipment, materials, and product data.
- 7. Material test certifications and MANUFACTURER's material certifications.
- 8. Material Safety Data Sheets (MSDSs) for all materials to be used to meet the requirements of this section.
- 9. Electronic copies of all PLC Program and HMI Project files shall be delivered to JEA upon completion of the Project. Delivery media shall be Compact Disc or Digital Video Disc as size requires.

1.06 WARRANTY

A. CONTRACTOR shall provide a MANUFACTURER'S warranty covering the full replacement of all equipment specified within this section. All equipment supplied under this section shall be warranted for a period of one (1) year by MANUFACTURER. Warranty period shall commence as outlined in Section 01740 and JEA General Conditions.

PART 2 - PRODUCTS

2.01 CONTROL PANEL

- A. All completed control panel assemblies shall be manufactured by one of the following JEA-approved control panel shops:
 - 1. ECS
 - 2. EG Controls, Inc.
 - 3. Suncoast
 - 4. Sun State System, Inc.
- 5. Information Technologies Group
- B. The control panel enclosure shall be designed and sized in accordance with the requirements of the Drawings and as specified herein. The control panel enclosure shall be manufactured by Hoffman or Engineer approved equal.
- C. Control panel enclosures located in conditioned spaces shall be NEMA 1, minimum 14 USS gauge.
 - 1. Panels with any dimension greater than 36" shall be 12 USS gauge minimum.
 - 2. Piano type hinged, overlapping doors with neoprene gasket. Doors shall be equipped with a heavy-duty 3-point latching mechanism operated by a padlocking handle.
 - 3. Following fabrication, the control panel shall be degreased and cleaned.
 - 4. All panels shall have continuously welded seams.
- D. Control panel enclosures located in unconditioned spaces or outside shall be NEMA, 4X, 0.125 inch marine grade aluminum or 316L SS.
 - 1. Panels shall be equipped with the following:
 - a. Piano type hinged, overlapping doors with neoprene gasket. Doors shall be equipped with a heavy-duty 3-point latching mechanism operated by a padlocking handle.
 - b. Following fabrication, the control panel shall be degreased and cleaned. Stainless steel panels shall also be treated with a phosphatizing process.
 - c. All panels shall have continuously welded seams.
 - d. Panel enclosures shall be equipped with aluminum sun shields of the same grade and thickness material as the panel. Sun-shields shall be mounted with 1.5 inch of separation from the panel, in a manner that maintains the NEMA rating of the panel.
 - 2. The maximum size of an aluminum enclosure shall be no taller than 60" wide or 60" high with 12" floor stands for a total height of 60". Any enclosure that requires a larger size must be 316 SS.
 - 3. Aluminum enclosures with free standing bases shall have the bases manufactured out of 316 SS, to give extra strength.

- E. Panel Finishes
 - 1. Marine Grade Aluminum: Factory finished immediately after cleaning and pretreating with MANUFACTURER's standard two-coat, baked-on finish consisting of prime coat and thermosetting polyester powder topcoat. The panel shall be white and the exterior shall be gray.
 - 2. Carbon Steel: Factory finished immediately after cleaning and pretreating with MANUFACTURER's standard two-coat, baked-on finish consisting of prime coat and thermosetting powder topcoat. The inside of the panel shall be white and the exterior shall be gray.
 - 3. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- F. Hardware / Fasteners:
 - 1. All hardware and fasteners shall be 316 stainless steel.
 - 2. All mounting screws shall be drilled and tapped, no self-tapping screws are allowed.
- G. Provide a plastic data pocket in the control panel. Data pocket shall be attached to the lower portion of the enclosure door or the lower right door of two (2) door models.
- H. Instrumentation Wire
 - 1. Cable for 4-20mA instrumentation, potentiometer or similar analog circuits shall be multi-conductor twisted, tinned, 20 AWG, with a FOIL and BRAIDED shield.
 - 2. Insulation is to be stripped back 6" from the terminal connection to allow clamp on measurement of 20ma loop.

2.02 PANEL MOUNTED DEVICES

- A. Enclosure Door Switches
 - 1. Provide door switches on the enclosure doors for remote indication that the door is open
 - 2. The door switch shall be comprised of a microswitch with a swing-arm activation mechanism.
 - 3. Enclosure door switches shall be manufactured per the drawings or Engineer approved equal.

- B. Enclosure Lighting:
 - 1. Panel shall have adequate lighting.
 - 2. Lighting shall be LED
 - 3. Light switch inside the panel shall be provided to activate the light.
- C. Control Circuit Breakers
 - 1. Control circuit breakers shall be of energy-limiting design and fieldmountable for selective applications.
 - 2. Circuit breakers shall mount on a DIN rail.
 - 3. Control Circuit breakers, fed by an integral Control Power Transformer shall have a UL/CSA Rated Interrupt Capacity of 10,000 A.
- D. Surge Protection Devices
 - 1. The Control Panel will have a minimum Type 2 SPD with a surge capacity of 40kA at 8x20us.or above.
 - 2. The surge suppression listed in TABLE 1-1 are all approved for the application listed. No other device will be accepted.

Part Number	Application
DLAW-24D3	Analog
DLA-12DBC	Profibus
DS220S-24DC	24VDC
DS41S-120	120VAC Surge
DS42S-230	240VAC

Table 1-1: CITEL Surge Arrestors

E. 24 Volt DC Power Supplies (Where specifically shown on the drawings)

1. All control devices such as PLC, HMI and other such devices shall be on its own clean 24VDC power supply and is to be separate from the field power

- 2. UPS All control devices such as PLC, HMI and other such devices shall be on its own UPS.
- 3. 24 volt DC power supplies shall be mounted in control panels to supply 24 volt DC power for the programmable controller inputs and for the 2wire instrumentation. The power supplies shall be sized as required plus 25% spare capacity. Load calculations shall be provided with the control panel shop drawing submittal.
- 4. The 24 volt DC power supplies shall be manufactured by:
 - a. Siemens
 - b. Puls
- 5. Grounds commons and power for each electrical device shall have its own wire connected to one central distribution. Daisy chained shall not be accepted.
- F. Selector Switches (Where specified)
 - 1. Selector switches shall be 30.5 mm, heavy-duty, and non-illuminated.
 - 2. Switches shall have double-break silver contacts and shall be maintained contact type unless otherwise indicated on the Drawings. Auxiliary contact blocks shall be provided on switches where indicated on the Drawings or in the Description of Operation.
 - 3. Selector switches shall carry the same NEMA rating as the panel on which installed.
 - 4. Provide a white legend plate for each switch with black engraving as indicated on the Drawings.
 - 5. Selector switches shall be manufactured by:
 - a. Siemens
 - b. Rockwell (Allen-Bradley)
 - c. Square D
 - d. General Electric
 - e. or Engineer approved equal
- G. Push Buttons (Where specified)
 - 1. Push buttons shall be 30.5 mm, heavy-duty, non-illuminated.

- 2. Push buttons shall have double-break silver contacts, momentary contact type and shall be color-coded as indicated on the Drawings. Push Buttons without a color indication shall be black.
- 3. Push buttons shall carry the same NEMA rating as the panel on which installed.
- 4. All push buttons shall have flush heads unless otherwise indicated on the Drawings.
- 5. Provide a white legend plate for each push button with black engraving as indicated on the Drawings.
- 6. Selector switches shall be manufactured by:
 - a. Siemens
 - b. Rockwell (Allen-Bradley)
 - c. Square D
 - d. General Electric
 - e. or Engineer approved equal
- H. Pilot Lights (Where specified)
 - 1. Pilot lights shall be 30.5 mm, heavy-duty, push to test, with universal LED lamps. Lens color shall be as indicated on the drawings.
 - 2. Pilot lights shall carry the same NEMA rating as the panel on which installed.
 - 3. Provide a white legend plate for each pilot light with black engraving as indicated on the Drawings.
 - 4. Selector switches shall be manufactured by:
 - a. Siemens
 - b. Rockwell (Allen-Bradley)
 - c. Square D
 - d. General Electric
 - e. or Engineer approved equal

- I. Relays, General Purpose:
 - 1. General purpose relays as shown on the drawings shall be UL labeled, industrial grade as manufactured by:
 - a. Finder
 - 2. Relays shall have LED indication of energized/de-energized state.
- J. Interposing Relays Used with PLC I/O
 - 1. Interposing relays shall be miniature industrial type with 120 VAC coils or pluggable miniature type for 24 VDC coils.
 - 2. Relays shall have LED indication of energized/de-energized state.
 - 3. Relays shall be SPDT or DPDT type with AgNi contacts rated for 6A resistive minimum.
 - 4. Interposing relays shall be manufactured by:
 - a. Finder
- K. Fuses (only to be used when specified in the drawings)
 - 1. All fuses shall be sized as required for the circuit they are protecting.
 - 2. Fuses shall be rated at 600 VAC/170 VDC (1/2-20 A) and 480 VAC/300 VDC (25 60 A).
 - 3. Fuses shall be listed UL Std. 248.
 - 4. Fuses shall comply with section 16491 Fuses.
 - 5. Fuses shall be supplied with MANUFACTURER recommended fuse blocks.
 - 6. Fuses shall be manufactured by:
 - a. Cooper Bussman, Inc.
 - b. Ferraz Shawmut, Inc.
 - c. Littlefuse, Inc.
 - d. Edison Fuse, Inc.
 - e. or Engineer approved equal

- L. Terminal Blocks
 - 1. Terminal Blocks shall be by:
 - a. WAGO, Top Job S,
 - b. Or Approved Equivalent
 - 2. The minimum size shall be 4mm.
 - 3. Terminals colors are to match UL508A voltage color code
 - 4. Terminal blocks shall be provided in each control panel for terminating field wiring. Terminal blocks shall be din-rail mounted.
 - 5. All terminal blocks shall be rated for 600 volts AC, and shall be identified with a permanent machine printed marking.
 - 6. A maximum of two (2) wires shall be provided per terminal block.
 - 7. Wire all spare I/O to corresponding terminal blocks. Minimum 25% spare.
 - 8. The spring portion of the clamp shall be fabricated of a chrome nickel spring steel of high tensile strength and shall be solid, without perforation. The chrome nickel spring steel spring tension mechanism shall provide the installer the opportunity to directly insert solid or ferruled conductors without having to utilize tooling to open the clamping mechanism. The terminal block shall be designed to accept solid and/or stranded copper conductors without requiring special preparation, such as crimps, ferrules or tinning. Proportional clamping shall ensure mechanical and electrical connection integrity without damage to the conductors of various sizes throughout the rated range. The design of the terminal block shall not prevent or interfere with the use of wire preparation methods, such as crimps, ferrules or tinning. Due consideration shall be given to the possible increase in conductor diameter when using any wire preparation method. Each CCS mechanism shall be limited to the connection of one wire or conductor. Multiple CCS mechanisms on the same current bar for multiple wire applications shall be acceptable
 - 9. The current bar of the device shall be fabricated from an electrolytic copper alloy and shall be formed so that there is a defined contact area where the CCS mechanism crosses the contact surface. The current bar shall be formed in such a manner as to completely surround the conductor and not allow the migration of individual strands. The current carrying parts shall be coated or plated to prevent corrosion. The manufacturing process for constructing the conductor opening in the

current bar shall not incorporate a procedure that reduces the conductive mass as a result of punching, forming and/or bending, therefore potentially degrading the current-carrying capacity of the product.

- M. GFCI Convenience Outlet
 - 1. GFCI convenience outlets shall be UL labeled, industrial grade, and DIN rail mounted. GFCI outlets shall be rated for 120 VAC, 15 A.
 - 2. GFCI convenience outlets shall be labeled with the tag number indicated in the Contract Drawings and shall clearly indicate the maximum current available.
- N. Wiring
 - 1. Type and Identification
 - a. All wire colors in the panel are to follow the UL508A standards.
 - Wire type #12 AWG and smaller shall be Hook-Up/Lead tinned copper, # 18 AWG stranded is minimum, unless otherwise noted: BELDEN – 35612 Hook-Up Lead-UL AWM Style 3173-XL-DUR or equal.
 - c. Control Wiring shall be numbered / lettered at each end. Wire numbers / letters shall be Flattened Polyolefin Heat Shrink Markers for Permanent Wire and Cable Identification (Panduit) or JEA approved equal.
 - 2. All wiring shall be stranded copper. Control wiring within the panel shall be #18 AWG, 600V, Type RHW2 or as indicated in the Drawings. All wiring outside of the control panel shall be as indicated on the drawings, minimum #12 AWG.
 - 3. Control Wiring shall be numbered / lettered at each end. Wire numbers / letters shall be Flattened Polyolefin Heat Shrink Markers for Permanent Wire and Cable Identification (Panduit) or JEA approved equal.
 - 4. Cable for 4-20mA instrumentation, potentiometer or similar analog circuits shall be multi-conductor twisted, tinned, 20 AWG, with a FOIL and BRAIDED shield.
 - 5. All wiring and terminal strips shall be isolated by voltage levels to the greatest possible extent.
 - 6. Wiring shall be continuous with no splices.

- 7. All control wiring shall be tagged at each end with a legible, permanent coded wire-marking sleeve. Sleeves shall be white with black marking. Markings shall be identical on each end and match the terminal numbers.
- 8. All control wires, including those from field devices, are to be terminated with insulated ferrules.
- O. Wiring Duct
 - 1. Wiring duct shall be as follows
 - a. Panduit Wide Slot with a Hinged Cover. Non hinged covers will not be accepted. An example part number is H1.5X2LG6 / HC1.5LG6 but not limited to this size.
 - 2. Wiring duct is to have a maximum fill limit of 40%.
 - 3. The outside edge of the Panduit can be placed no closer than 1.5 inches to the nearest terminal edge or component. This is to allow adequate space to wire the terminals.
 - 4. Wire duct installed on the outside edges of the back panel must be a minimum of 1.5 inches from the edge of the back panel.
- P. Grounding Bus (Where specifically shown on the drawings)
 - 1. Provide a copper isolated grounding bus inside the control panel for terminating all ground wires.
 - 2. Grounding busses shall be 2" x ¼" x 12" long and manufactured of copper. Grounding busses used for isolated grounds shall be provided with a standard hardware kit that includes fixtures for isolation from the panel. The installation kit shall include at least one (1) #2 compression lug.
 - 3. Grounding busses shall be manufactured by:
 - a. Cooper Industries (SBTGBK)
 - b. Panduit
 - c. Eritech
 - d. or Engineer approved equal
- Q. Nameplates
 - 1. Nameplates are to be provided for all individual panels, instruments and panel mounted devices.

- 2. Use plastic laminate nameplates having engraved white letters on a black background.
- 3. Letters must be a minimum of 24 Font.
- 4. Nameplate must be visible when devices are wired
- R. Programmable Logic Controllers
 - 1. Master Control Panel PLCs shall be as follows:
 - a. Siemens: Model SIMATIC S7-300, 315-2 PN/DP.
 - b. JEA software version shall be Step 7 Version 5.5
 - 2. Independent Control Panels Requiring a PLC shall be as follows:
 - a. Siemens: Model SIMATIC S7-300 with CPU 313C-2 DP.
 - b. This units applies to: VCP-200 and the Ventilation Control Panel.
 - c. Electronic copies of all PLC Program and HMI Project files shall be delivered to JEA upon completion of the Project. Delivery media shall be Compact Disc or Digital Video Disc as size requires.
 - 3. Provide a complete PLC system with processors, communication modules, local and remote I/O modules and other system components as shown on the Drawings. All PLC hardware components shall be configured to perform the functions shown on the Drawings.
 - 4. The PLC shall be suitable for use under the following environmental conditions:
 - a. Operating temperature: 0°C to 60°C for horizontal configuration: 0°C to 40°C for vertical configuration.
 - b. Relative humidity: 95% at 25°C, non-condensing
 - c. Discrete and Analog remote mounted I/O modules of the types and quantities as shown on the drawings.
 - 5. The PLC shall be provided with a minimum of 20% I/O points.
 - 6. The CONTRACTOR shall provide all Ethernet switches, adapters, connectors, and interconnection cables necessary to connect the PLCs to the network

- 7. Analog Input modules shall be isolated from the backplane and each channel shall be individually isolated from each other.
- 8. Each Input module shall have two fuses to divide the inputs
- 9. Maximum I/O per card shall be as follows:
 - a. Discrete Input 16
 - b. Discrete Output 16
 - c. Analog Input 8
 - d. Analog Output -8
- S. Communication Networks
 - 1. All Profibus installation must comply with the PROFIBUS User Organization. More information can be found at "WWW.Profibus.com".
 - a. Reference "PROFIBUS Installation Guideline for Planning" order number 8.0012.
 - b. Reference "PROFIBUS Assembly Guideline" order number 8.0022.
 - c. ALL recommendations from the Profibus User Organization must be followed, such as using Fiber Optic instead of copper when leaving a building.
 - d. Profibus connectors shall be made of metal housing and have Power, Transmit, Termination and Error indicating LED's. Connectors shall be Brad Harrison MA9D00-42 and MA9D01-42 type or equal.
 - e. Only Diagnostic Repeaters shall be used where repeaters are required. Standard repeaters shall not be accepted. Repeaters shall be Siemens Diagnostic Repeater 6ES7 972-0AB01-0XA0 or equal.
 - f. For fiber optic communications use the Siemens OLM G12 Part # 6GK1503-3CB00.
 - 2. All Ethernet installation must comply with the PROFINET User Organization. More information can be found at "WWW.Profinet.com".
 - a. Reference "PROFINET Installation Guideline for Cabling and Assembly" order number 8.072.

- b. ALL recommendations from the Profinet User Organization must be followed such as using Fiber Optic when leaving a building.
- c. Ethernet Connector connectors shall be made of metal housing. Connectors shall be Siemens 6GK1901-1BB10-2AA0 type or equal.
- d. All switches shall have the capability to be managed. Switches shall be of type Siemens SCALANCE X212-2 at minimum.
- T. Full Voltage Non-Reversing Starters
 - 1. Contactors
 - a. Contactors shall be manufactured, tested, and rated as NEMA devices. IEC equivalents are not acceptable.
 - b. The minimum size shall be NEMA Size 1.
 - c. Fractional size contactors shall not be accepted.
 - d. Provide contactors by one of the following:
 - 1) Siemens
 - 2) Eaton
 - 3) Square D
 - 2. Overloads
 - a. Provide Bimetallic Overloads
 - b. Overloads shall be from the same MANUFACTURER as the CONTACTORS.
 - 3. Thermal Magnetic Circuit Breakers:
 - a. As a minimum the breakers must comply with the standards as follows:
 - 1) Circuit breakers shall be minimum "E" frame.
 - a) "E" frame circuit breakers shall contain a self-test "Trip Selector" permitting a mechanical simulation of the over current tripping device.
 - 2) Protector operators shall be quick make, quick break, and trip free.

- 3) Shall be rated at a minimum of 460 Volt @ 14 KAIC for 240 Volt systems and 600 Volt @ 18 KAIC for 460/480 Volt systems, unless otherwise noted on the drawings.
- 4) The thermal and magnetic elements shall operate independently and multiple pole breakers shall be designed with common trip bar breaking all poles when a fault is received on any pole.
- U. Variable Frequency Drives
 - 1. Variable frequency drives shall be in accordance with Section 16495.
 - 2. VFD interface terminals shall be accessible on the face of the control panel enclosure.
- V. Spare Parts
 - 1. Provide the following spare parts for all of the control panels within the project:
 - a. 10% of all the parts used but no less than one of each item.
 - 2. Spare parts shall be packaged individually in boxes that are clearly labeled with part name and MANUFACTURER's part/stock number.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Start-up and Testing
 - 1. Check the panel for conformity with the approved shop drawings for the panel being supplied.
 - 2. Test the operation of the control panel and all controls.
 - a. Prior to shipment, arrange for the Engineer and JEA to attend a Factory Acceptance Test for each panel. For the Factory Acceptance test, all panel I/O shall be demonstrated to be functional as described in the Project Documents.
 - 3. Test the operation of all communication equipment.
 - 4. All start-up and testing shall be performed in the presence of JEA and the

- B. Training
 - 1. Provide up to sixteen (16) hours of training for the OWNER's personnel on the operation of the control panel.
 - 2. Training shall be provided on at least two separate days and two separate shifts, as necessary, to accommodate personnel on all work schedules and shifts.
 - 3. Training shall include operation of the controls and troubleshooting procedures.

END OF SECTION

SECTION 16930 PROCESS LOOP DESCRIPTIONS

PART 1- GENERAL

1.01 SCOPE

- A This section describes the general function each primary process loop to be modified or included. The Control System Integrator shall provide additional functions as needed to adhere to good control and engineering practices. These additional functions shall be outlined and explained as part of the submittal process.
- B JEA will serve as the Control System Integrator.
- C The CONTRACTOR shall provide the Main Control Panel (MCP) which shall be located in the proposed Electrical Room.

PART 2- GENERAL

- 2.01 SYSTEM DESCRIPTION
 - A This project includes work for the rehabilitation of the Buffalo Ave. Pump Station.
 - B Overall requirements of the pump station operating and control system are as described in the loop descriptions in these specifications as well as the instrumentation and control schematics included in the project drawings.
 - C General functionality of the motor driven equipment includes Hand-Off-Remote, Hand-Off-Auto, or Local-Off-Remote selector switches at the local central panel. In the "Remote" or "Auto" position, the motors shall be controlled by external inputs to the control panel. In the "Hand" or "Local" position, the motors shall be called to run from the panel.
 - D Access to HMI modifiable fields shall be via password controlled one-level access rights.

2.02 ALARM CONDITIONS

- A All alarm conditions for the proposed equipment shall:
 - 1. Be displayed on the HMI (Human Machine Interface) located on the main control panel in the treatment plant pump building.
 - 2. Be recorded in the HMI alarm database
 - 3. Trigger the alarm contacts associated with the SCADA system

2.03 DATA ARCHIVAL AND TRENDING

A The HMI shall be configured to trend all points connected to the station control system within the HMIs available memory.

2.04 PRIMARY PROCESS CONTROL LOOP DESCRIPTIONS

- A Influent Channel Sluice Gates
 - 1. The influent channel sluice gates are not connected to the control system and therefore do not have a control loop. All operation of these devices is manual.
- B Wet Well Level Transmitters (LE-100-1, LE-100-2)
 - 1. The MCP shall monitor the level of the water in the wet well using submersible pressure transmitters.
 - 2. The level shall be displayed on the face of the HMI with a dedicated display.
 - 3. The level shall be used to control the sewage pumps as indicated in the sewage pump control loops.
- C Wet Well Back Up Floats (LSH-100-3,LS-100-4, LS-100-5, LS-100-6, LSL-100-7)
 - 1. The back up floats shall be wired into the MCP wiring logic as indicated on the plans for back up level monitoring and pump control.
- D Wet Well Mixer (M-100-8)
 - 1. The wet well mixer shall operate continually and shall be started and stopped manually using a selector switch on the associated starter panel.
- E Dry Well Sump Pumps
 - 1. The dry well sump pump control panel shall power and control the two dry well sump pumps.
 - 2. The MCP shall monitor the status of the dry well pumps and level in the drywell sump.
- F Service Pumps (M-200-8, M-200-9, M -200-10)
 - 1. There are three wastewater service pumps, all VFD driven.
 - 2. The VFDs shall be configured to limit current to the motors at the limit listed on the motor nameplate, in a manner which cannot be overridden by any command. Therefore the pumps may not develop

full speed based on the system head even though full speed is automatically called for by the MCP OR if speed is manually selected at the MCP or VFD.

- 3. Pumps shall always be operated at the same speed if called to run.
- 4. The MCP shall primarily control each VFD using Profibus communication, with additional hard wired monitoring and back up control.
 - a. The primary Profibus control points include:
 - 1) Run Command,
 - 2) Reset Command
 - 3) Run Status,
 - 4) Auto Status,
 - 5) Fault Status,
 - 6) Speed Reference, and
 - 7) Speed Feedback,
 - b. The hard-wired monitoring and back up control include:
 - 1) Motor Over-temperature
 - 2) Back-Up High Level Float Control
 - 3) Pump Seal Water Flow
 - 4) Open Seal Water Valve
- 5. The Main Control Panel shall control each pump, which shall be selected to operate in Hand, Off or Auto via selector switch. Automatic operation is described below.
- 6. The Main Control Panel, shall select the lead, lag, and 2nd lag pump every 24 hours based on pump runtimes. The pump with the lowest runtime shall then be designated as the lead pump. The lag pump shall

be the next higher consecutively numbered pump. If Pump 3 is the lead pump, then Pump 1 shall become the lag pump and so on.

- 7. HMI shall display which pump is lead.
- 8. Pump speed shall vary, linearly-proportional to the water level in the wet well. PLC shall calculate pump speed based upon Pump Span Settings (%/ft) and water level in the wet well (ft). All fields identified below in the Pump Span Settings Summary shall be variable set points displayed on the HMI and shall be modifiable by password protected access rights.

Pump	Span	Settings	Summary	7 (O	perator	variable	fields	on	HMI)
Level	-12.75	Ū	Min Spe	ed	75%				
Level	-17.75		Max Spe	eed	100%				

- 9. The pump PID loops shall be per JEA's current control scheme.
 - a. Pump PID Loop 1:
 - The lead pump shall be started at the "Lead Pump On Level" at a speed proportional to the level of the wet well. The lead pump shall operate as the only pump running until the water level in the wet well reaches the "Start Lag Pump Level." The PID loop shall vary the speed of the pump based on the water level in the wet well.
 - 2) At the "All Pumps Off Level" the lead pump shall shut down.
 - b. Pump PID Loop 2:
 - 1) The lag pump shall be started when the level of the wet well reaches the "Start Lag Pump Level". The lead and lag pumps shall operate at the same speed. The PID loop shall vary the speed of the pumps based on the water level in the wet well.
 - 2) At the "Stop Lag Pump Level" the control system shall shut down the lag pump and go back to PID Loop 1 with only one pump running.
 - c. Pump PID Loop 3:
 - The second lag pump shall be started when the level of the wet well reaches the "Start 2nd Lag Pump Level." The lead, lag, and second lag pumps shall operate at the same speed.

The PID loop shall vary the speed of the pumps based on the water level in the wet well

- 2) AT the "Stop 2nd Lag Pump Level" the control system shall shut down the second lag pump and go back to PID Loop 2 with only two pumps running.
- 10. For the level control the operator shall be able to input and modify the wet well level setpoints, which shall all be displayed on the HMI.

	Wet Well Water	Wet Well Level	Pump Speed
	Surface	Depth (ft)	(%)
	Elevation (ft)		
Low Level Alarm	-18.25	3.35	
All Pumps Off	-17.75	3.85	75
Start Lead Pump	-12.75	8.85	100
Stop Lag Pump	-17.25	4.35	75
Start Lag Pump	-12.25	9.35	100
Stop 2 nd Lag Pump	-16.75	4.85	75
Start 2 nd Lag Pump	-11.75	9.85	100
High Level Alarm	-11.25	10.35	
High High Level Alarm	-10.75	10.85	

- 11. Pump Back Up Level Control
 - a. The back up level control for the pumps shall be based on the float controls and wired as shown in the project drawings.
 - b. The back up control shall begin if the High Level Alarm is achieved.
 - c. The back up control shall stop all pumps if the Low Level Alarm is Achieved.
- 12. The Main Control Panel shall monitor the closed status of each pump check valve using limit switches provided with each valve (LS-200-11-13).
- G Wash Water Pump (P-300-1)
 - 1. The control system shall monitor and control the wash water pump.
 - 2. A pressure switch on the wash water bladder tank shall start and stop the pump based on preset low and high pressure conditions, respectively.
- H Seal Water Pumps (P-300-2, P-300-3)
 - 1. The control system shall monitor and control the seal water pumps.
 - 2. When any service pump is running, the Main Control Panel shall call a seal water pump to run.
 - 3. The Main Control Panel shall monitor a pump room temperature sensor. In the event the temperature is below freezing, the seal water pumps shall run to prevent the water lines from freezing.
 - 4. The Main Control Panel shall select the lead and lag, pump every 24 hours based on pump runtimes. The pump with the lowest runtime shall be the lead pump.
- I SCADA
 - 1. The Main Control Panel shall output digital and analog information to the SCADA system as required by JEA. The signals will be same information displayed on the HMI in a digital or analog format.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 16950

FIELD INSTRUMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including JEA General Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Submersible Pressure Transmitters
 - 2. Ultra Sonic Level
 - 3. Liquid Level Floats
 - 4. LEL Detection
 - 5. Air Flow Switch
 - 6. Duct Smoke Detectors
 - 7. Pressure Transmitters
 - 8. Pressure Guages
 - 9. Rotary Flow Switches
 - 10. Ultrasonic Flowmeter
- B. Related Sections: Division 16.

1.03 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base air ratings on sea-level conditions.
- B. Operating Temperature: 0 degrees F to 100 degrees F.
- C. Environment: Water.
- 1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01300.
- B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:
 - 1. Sensor housing, NEMA rating.
 - 2. Power requirements.
 - 3. Sensitivity ranges.
 - 4. Mounting requirements.
- C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connections.
- D. Coordination Drawings, including plumbing/connection plans and sections drawn accurately to scale. Submit with Shop Drawings. Show layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- E. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- F. O&M manuals shall be submitted in accordance with Section 01730.

1.05 QUALITY ASSURANCE

- A. Electrical Component Standard: provide components that comply with NFPA 70 and that are listed and labeled by UL where available.
- B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver units as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Lift and support units with the manufacturer's designated lifting and covering.

1.07 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements. Verify clearances for installation.

1.08 COORDINATION AND SCHEDULING

A. Coordinate with the Engineer for the mounting locations of each instrument prior to installation.

1.09 EXTRA MATERIALS

A. Furnish any spare parts that are expected to be replaced within a 1-year period in sufficient quantity to keep monitoring equipment operating for a minimum period of one year.

1.10 WARRANTY

- A. All equipment supplied under this section shall be warranted for a period of one (1) year by the MANUFACTURER. Warranty period shall commence as outlined in Section 01740 and JEA General Conditions.
- 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 ex- pense to the OWNER.
- C. The MANUFACTURER'S warranty period shall run concurrently with the CONTRACTOR'S warranty period. No exception to this provision shall be allowed.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE PRESSURE TRANSMITTERS

А.	Sensor Manufacturer:	GP:50
B.	Sensor Model:	311-SZ-CZ-Y367
C.	Cable Manufacturer:	Spectrum Cable Corp
D.	Cable gauge:	18 AWG, 19 AWG Drain
E.	Wire insulation:	16/30 TC polyethylene, mylar wrap.
F.	Cable Jacket:	Polyurethane.

2.02 ULTRASONIC LEVEL TRANSMITTERS

FIELD INSTRUMENTS

	А.	Manufacturer:	Siemens
	B.	Sensor Model:	XRS-5
	C.	Range:	0 – 10 feet
	D.	Blocking Distance:	0 –3 feet
	E.	Temperature Range:	-40 to 80 degrees Celsius
	F.	Material:	PVDF
	G.	Transmitter Model:	SITRANS LUT400
	H.	Transmitter Supply Voltag	ge: 10-32VDC
	I.	Signal Output:	4 to 20 mA with HART
	J.	Relay Outputs:	6 SPDT (can be inverted)
	K.	Applications:	Level
	L.	Housing:	NEMA 4X
	M.	Operating Temperature:	-40 to 60 degrees Celsius
2.03	LIQU	ID LEVEL FLOATS	
	А.	Manufacturer:	B/W Controls
	В.	Catalog Section:	7010
	C.	Description:	Weighted Float Switch
2.04	LEL I	DETECTION	
	А.	Manufacturer:	MSA
	В.	Model:	A-ULTIMAX-XP-E-03-U-2-S-2-0-2-0-0-1-1-0
	C.	Parameters:	LEL Detection
	D.	Sensor:	Remote
	E.	Options:	120VAC Input, Relay Output

FIELD INSTRUMENTS

	F.	Sample:	IR
	G.	Signal Output:	4 to 20 mA, 2 – Relay Output
	H.	Housing:	Class I, Div I
2.05	AIR F	LOW SWITCH	
	А.	Manufacturer:	W.E. Anderson Div., Dwyer Instruments, INC.
	B.	Model:	Bulletin E-71, Series V4
	C.	Construction:	Stainless Steel
2.06	DUCI	SMOKE DETECTORS	
	А.	Manufacturer:	Det-Tronics
	B.	Model:	U5015
	C.	Sensor:	Duct mount.
	D.	Source Voltage:	12-30VDC (24Vdc Nominal)
	E.	Signal Output:	Smoke Relay Output, Form C, 5A at 30VDC
	F.	Housing:	Class I, Div 1
	G.	Operating Temperature:	-20 to 65 degrees Celsius
2.07	PRESS	SURE TRANSMITTERS	
	A.	Manufacturer:	UNITED ELECTRIC CONTROLS

C. Pressure Range: Equal to 1.5 times shutoff head of pumps supplying

TX200B

- system, but not greater than 3.0 times shutoff head.
- D. Each pressure transmitter shall be supplied with a pulsation dampener.

2.08 PRESSURE GUAGES

B.

A. General

Model:

1. Each pressure gauge shall be direct mounted, 304 SS, and furnished with a clear glass crystal window and 1/4 inch shut off valve. Provide diaphragm seals between shut off valve and pressure gauge.

FIELD INSTRUMENTS

- B. Manufacturer: Emerson/Bristol Babcock
- C. Model No: Helicoid 900 Series
- D. Type: Liquid Filled
- E. Display: $4\frac{1}{2}$ -inch
- F. Housing: Stainless Steel
- G. Pressure Range: Equal to 1.5 times shutoff head of pumps supplying system, but not greater than 3.0 times shutoff head. Dual Scale in PSI and Feet of Water
- H. Each pressure gauge shall be supplied with a pulsation dampener.

2.09 ROTARY FLOW SWITCHES

А.	Manufacturer:	GEMS Sensors and Controls
B.	Туре:	RFS
C.	Part Number:	165077 with Low Flow Adapter

2.10 ULTRASONIC FLOWMETER

A.	Manufacturer:	Flexim
B.	Model:	Fluxus ADM 7407
C.	Velocity range:	0.03 - 82 ft/s
D.	Housing:	Stainless Steel

PART 3 - EXECUTION

3.01 TRAINING

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventative maintenance.
- B. Demonstrate operation of products specified in this Section. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each product.

3.02 INSTALLATION

- A. Install according to manufacturer's written instructions.
- B. Install units with clearances for service and maintenance.
- C. All pressure gauges, switches, and transmitters shall be installed as per the details on the drawings.
- D. All transmitters shall be provided with sun/rain hoods.

3.03 CONNECTIONS

- A. Electrical: Conform to applicable requirements in Division 16 Sections.
- B. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque- tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation and electrical connections, and to report results in writing.
- B. Contractor shall install all equipment and related accessories before having the manufacturer's field service. If additional trips are required due to incorrect installation, Contractor shall pay for the costs for the field services.

END OF SECTION