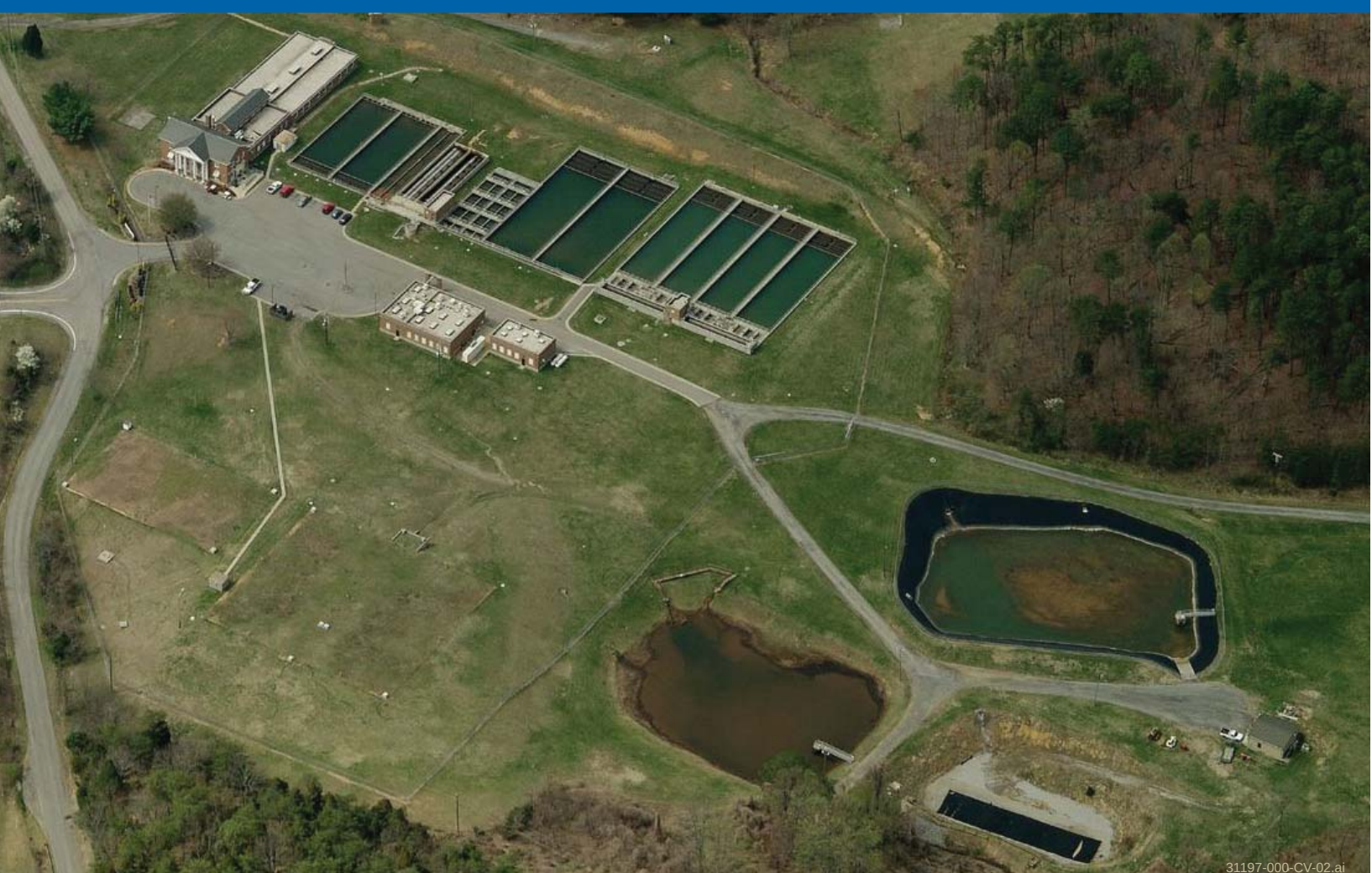
WESTERN VIRGINIA WATER AUTHORITY

As-Built Design Specifications

Carvins Cove Water Treatment Facility Disinfection Improvements

Western Virginia Water Authority
Roanoke, Virginia



April 2015

CROWDER CONSTRUCTION COMPANY SINCE 1947 / HAZEN AND SAWYER Environmental Engineers & Scientists

WESTERN VIRGINIA
WATER AUTHORITY

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WESTERN VIRGINIA WATER AUTHORITY
ROANOKE, VIRGINIA

CARVINS COVE WATER TREATMENT FACILITY
DISINFECTION IMPROVEMENTS

SECTION 00003

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SECTION 01300

SUBMITTALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Working Drawings

1. Working Drawings include, but are not limited to, Shop Drawings, layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc. Design/Builder shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Working Drawings required and necessary under this Contract and to fulfill all other requirements of his Contract. Design/Builder shall secure such information, details, Drawings, etc., from all possible sources including the Drawings, Working Drawings prepared by subcontractors, Engineers, suppliers, etc.

2. Working Drawings shall accurately and clearly present the following:

a. All working and installation dimensions.

b. Arrangement and sectional views.

c. Units of equipment in the proposed positions for installation, details of required attachments and connections, and dimensioned locations between units and in relation to the structures.

d. Necessary details and information for making connections between the various trades including, but not limited to, power supplies and interconnecting wiring between units, accessories, appurtenances, etc.

4. The Drawings are used for engineering and general arrangement purposes only and are not to be used for Working Drawings.

5. Shop Drawings

a. Design/Builder shall submit for review by the Engineer Shop Drawings for all fabricated work and for all manufactured items required to be furnished by the Contract Documents.

b. Structural and all other layout Drawings prepared specifically for the Project shall have a plan scale of not less than 1/4-inch = 1 foot.

c. Where manufacturer's publications in the form of catalogs, brochures, illustrations or other data sheets are submitted in lieu of prepared Shop Drawings, such submittals shall specifically indicate the item for which

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approval is requested. Identification of items shall be made in ink, and submittals showing only general information are not acceptable.

6. Layout and Installation Drawings

   a. Design/Builder shall prepare and submit for review by the Engineer layout and installation drawings for all pipes, valves, fittings, sewers, drains, heating and ventilation ducts, all electrical, heating, ventilating and other conduits, plumbing lines, electrical cable trays, lighting fixture layouts, and circuiting, instrumentation, interconnection wiring diagrams, communications, power supply, alarm circuits, etc., under this Contract. The final dimensions, elevation, location, etc., of pipe, valves, fittings, sewers, ducts, conduits, electrical cable trays, equipment, etc., may depend upon the dimensions of equipment and valves to be furnished by the Design/Builder.

   b. Layout and installation drawings are required for both interior and exterior piping, valves, fittings, sewers, drains, heating and ventilation ducts, conduits, plumbing lines, electrical cable trays, etc.

   c. Layout and installation Drawings shall show connections to structures, equipment, sleeves, valves, fittings, etc.

   d. Drawings shall show the location and type of all supports, hangers, foundations, etc., and the required clearances to operate valves, equipment, etc.

   e. The Drawings for pipes, ducts, conduits, etc., shall show all 3-inch and larger electrical conduits and pressure piping, electrical cable trays, heating and ventilation ducts or pipes, structure, manholes or any other feature within four (4) feet (measured as the clear dimension) from the pipe duct, conduit, etc., for which the profile is drawn.

7. Design/Builder Responsibilities

   a. All submittals from subcontractors, manufacturers or suppliers shall be sent directly to the Design/Builder for checking. Design/Builder shall thoroughly check all Drawings for accuracy and conformance to the intent of the Contract Documents. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors, manufacturers, or suppliers by the Design/Builder for correction before submitting them to the Engineer.

   b. All submittals shall be bound, dated, properly labeled and consecutively numbered. Information on the label shall indicate Specification Section, Drawing number, subcontractors, manufacturer's or supplier's name and the name or type of item the submittal covers. Each part of a submittal shall be marked and tabulated.

   c. Working Drawings shall be submitted as a single complete package including all associated drawings relating to a complete assembly of the various parts necessary for a complete unit or system.

d. Shop Drawings shall be submitted as a single complete package for any operating system and shall include all items of equipment and any mechanical units involved or necessary for the functioning of such system. Where applicable, the submittal shall include elementary wiring diagrams showing circuit functioning and necessary interconnection wiring diagrams for construction.

e. ALL SUBMITTALS SHALL BE THOROUGHLY CHECKED BY THE DESIGN/BUILDER FOR ACCURACY AND CONFORMANCE TO THE INTENT OF THE CONTRACT DOCUMENTS BEFORE BEING SUBMITTED TO THE ENGINEER AND SHALL BEAR THE DESIGN/BUILDER'S STAMP OF APPROVAL CERTIFYING THAT THEY HAVE BEEN SO CHECKED. SUBMITTALS WITHOUT THE DESIGN/BUILDER'S STAMP OF APPROVAL WILL NOT BE REVIEWED BY THE ENGINEER AND WILL BE RETURNED TO THE DESIGN/BUILDER.

f. If the submittals contain any departures from the Contract Documents, specific mention thereof shall be made in the Design/Builder's letter of transmittal. Otherwise, the review of such submittals shall not constitute approval of the departure.

g. No materials or equipment shall be ordered, fabricated, shipped or any work performed until the Engineer returns to the Design/Builder the submittals, herein required, annotated "Furnish as Submitted", "Furnish as Corrected", or “Furnish as Corrected – Confirm.” If a submittal is returned “Furnish as Corrected – Confirm” the portions of work covered by the submittal that require confirmation by the Engineer shall not be ordered, fabricated, shipped, or any work performed until those portions are approved in a subsequent submittal either "Furnish as Submitted" or "Furnish as Corrected".

h. Where errors, deviations, and/or omissions are discovered at a later date in any of the submittals, the Engineer's prior review of the submittals does not relieve the Design/Builder of the responsibility for correcting all errors, deviations, and/or omissions.

8. Procedure for Review

a. Submittals shall be transmitted in sufficient time to allow the Engineer at least ten (10) working days for review and processing.

b. Design/Builder shall transmit four (4) copies of all technical data or drawing to be reviewed.

c. Submittal shall be accompanied by a letter of transmittal containing date, project title, Design/Builder's name, number and titles of submittals, a list of relevant specification sections, notification of departures from any Contract requirement, and any other pertinent data to facilitate review.

d. Submittals will be annotated by the Engineer in one of the following ways:

"Furnish as Submitted" (FAS) - no exceptions are taken

"Furnish as Corrected" (FAC) - minor corrections are noted and shall be made.

“Furnish as Corrected – Confirm” (FACC) - some corrections are noted and a partial resubmittal or additional information are required as specifically requested.

"Revise and Resubmit" (R&R) - major corrections are noted and a full resubmittal is required.

"For Information Only – Not Reviewed” (FIO) – submittal was received and was distributed for record purposes without review.

e. If a submittal is satisfactory to the Engineer in full or in part, the Engineer will annotate the submittal "Furnish as Submitted", "Furnish as Corrected", or “Furnish as Corrected – Confirm”, retain four (4) copies and return remaining copies to the Design/Builder. If reproducible transparencies are submitted, the Engineer will retain the copies and return the reproducible transparencies to the Design/Builder. In the case of “Furnish as Corrected – Confirm” a partial resubmittal or additional information are required as specifically requested.

f. If a full resubmittal is required, the Engineer will annotate the submittal "Revise and Resubmit" and transmit three (3) copies to the Design/Builder for appropriate action. If reproducible transparencies are submitted, the Engineer will retain the copies and return the reproducible transparencies to the Design/Builder.

g. Design/Builder shall continue to resubmit submittals in part if they are returned “Furnish as Corrected – Confirm” or in full if they are returned “Revise and Resubmit” as required by the Engineer until submittals are acceptable to the Engineer. It is understood by the Design/Builder that Owner may charge the Design/Builder the Engineer's charges for review in the event a submittal is not approved (either "Furnish as Submitted" or "Furnish as Corrected") by the third submittal for a system or piece of equipment. These charges shall be for all costs associated with engineering review, meetings with the Design/Builder or manufacturer, etc., commencing with the fourth submittal of a system or type of equipment submitted for a particular Specification Section.

h. Acceptance of a Working Drawing by the Engineer will constitute acceptance of the subject matter for which the Drawing was submitted and not for any other structure, material, equipment or appurtenances indicated or shown.

9. Engineer's Review

a. Engineer's review of the Design/Builder's submittals shall in no way relieve the Design/Builder of any of his responsibilities under the Contract. An acceptance of a submittal shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications.

b. Engineer's review will be confined to general arrangement and compliance with the Contract Drawings and Specifications only, and will not be for the purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of trades, etc.

10. Record Working Drawings

a. Design/Builder shall maintain current record drawings onsite for the Engineer's review. Record drawings shall be updated monthly at a minimum.

b. Prior to final payment, the Design/Builder shall furnish the Engineer one complete set of all accepted Working Drawings, including Shop Drawings, for equipment, piping, electrical work, heating system, ventilating system, air conditioning system, instrumentation system, plumbing system, structural, interconnection wiring diagrams, etc.

c. Working Drawings furnished shall be corrected to include any departures from previously accepted Drawings.

D. Operation and Maintenance Manuals

1. Two (2) preliminary copies of Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals shall be provided to the Engineer not less than 14 days prior to the start-up of the respective equipment.

2. The preliminary manuals shall be reviewed by the Engineer prior to the Design/Builder submitting final copies for distribution to the Owner. Following review of the preliminary copies of the Operation and Maintenance Manuals, one (1) copy will be returned to the Design/Builder with required revisions noted, or the acceptance of the Engineer noted.

3. Manuals shall contain complete information in connection with assembly, operation, lubrication, adjustment, wiring diagrams and schematics, maintenance, and repair, including detailed parts lists with drawings or photographs identifying the parts.

4. Manuals furnished shall be assembled and bound in separate volumes, by major equipment items or trades, and properly indexed to facilitate locating any required information. In addition, manuals should be labeled in the front cover with the project, name, equipment description, and manufacturer contract information.

5. Engineer and the Owner shall be the sole judge of the acceptability and completeness of the manuals and may reject any submittal for insufficient information included, incorrect references and/or the manner in which the material is assembled.

6. Following the Engineer's review of the preliminary manuals, the Design/Builder shall submit four (4) paper copies and an electronic copy of the final Operation and Maintenance Manuals to the Engineer. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents. Failure of the final manuals to reflect the required revisions noted by the Engineer during a review of the Preliminary documents will result in the manuals being returned to the

Design/Builder. Acceptable final Operation and Maintenance Manuals shall be provided not less than two week prior to equipment start-up.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01520

MAINTENANCE OF UTILITY OPERATIONS DURING CONSTRUCTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The intent of this section is to outline the minimum requirements necessary to provide continuous treatment and disinfection of the finished water flow throughout the construction period.

1.02 GENERAL CONSTRAINTS

A. Existing plant operation will be continuously maintained by the Owner during the entire construction period. Construction work will be scheduled and conducted by the Design/Builder so as not to impede any treatment process, reduce the quality of the finished water, or other nuisances. In performing the work, the Design/Builder will plan and schedule his work to meet plant and distribution system operating requirements and the constraints and construction requirements as outlined below.

B. The Design/Builder will coordinate the construction schedules. Permanent or temporary power will be available for all existing, proposed, and temporary facilities that are required to be on line at any given time. The Design/Builder will also provide additional temporary facilities, if needed, to eliminate a constraint and maintain continuous and dependable plant operation.

C. All treatment processes will be maintained in continuous operation during the construction period except during approved process interruptions. All system or partial system shutdowns and diversions will be approved, coordinated, and scheduled at times suitable to the Owner. Shutdowns will be fully coordinated with the Owner at least 7 days before the scheduled shutdown. Shutdowns will typically be scheduled for weekend or midnight low flow periods and will be limited depending on distribution system flow rate demand and storage volume in the distribution and treatment systems. The duration of shutdowns will be at the discretion of the Owner. Further, the Owner will have the authority to order work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the plant operations.

D. Shutdowns will not begin until all required materials are on hand and ready for installation. The Design/Builder shall proceed with the work continuously, start to finish, until the work is completed and normal plant operation is restored. Appropriate diversion facilities will be furnished when the plant cannot be shutdown for a sufficient period of time to accomplish the work. If the Design/Builder completes all required work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service. In the event that plant operation is impaired, the Design/Builder will immediately make all repairs or replacements and do all work necessary to restore the plant to operation to the satisfaction of the Owner. Such work shall progress continuously to completion on a 24 hour-per-day, seven work days-per-week basis.

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1.03 SPECIFIC OPERATIONAL CONSTRAINTS

A. Listed in this section are specific construction restraints and shutdowns required for the different project components. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements.

B. The construction of the disinfection improvements for the Carvins Cove WTF will be started after the design documents are reviewed by Virginia Department of Health and approvals are obtained. Improvements will consist of new sodium hypochlorite storage and feed facilities. The construction of disinfection improvements to the Carvins Cove WTF site shall not impact existing plant operation unless otherwise approved by the Owner.

C. Sodium Hypochlorite Bulk Storage Facilities (Chemical Building No. 2)

1. Prior to Design/Builder starting its work in the proposed bulk storage area, the Owner shall convert the existing Filter Aid Polymer Bulk Storage Tank to an Orthophosphate Bulk Storage Tank by rerouting the tank existing transfer pump suction lines to connect to the Filter Aid Polymer Bulk Storage Tank. The Owner shall transfer or have removed all remaining Orthophosphate chemical from the two (2) existing tanks.

2. The sodium hypochlorite bulk storage tanks, recirculation/transfer pumps, and associated controls shall be installed, tested, and fully operational before work begins in Chemical Building No. 1.

D. Sodium Hypochlorite Feed Facilities (Chemical Building No. 1)

1. Removal of chlorine gas cylinders not currently in use shall be coordinated with the Owner prior to starting work in this area.

2. Existing gas chlorine ‘on-line’ cylinders and feed equipment shall remain in service until new sodium hypochlorite feed pumps have either been temporarily or permanently installed and connected to the required feed points. Provision to supply chemical to the suction of the feed pumps directly from the bulk storage tanks in Chemical Building No. 2 shall be provided.

3. Installation of Sodium Hypochlorite Day Tanks (including pads, containment curbs, etc.) shall not occur until the successful start-up and switchover to Sodium Hypochlorite has been accomplished via the direct feed from Chemical Building No. 2 as described above.

4. Demolition of the existing ‘on-line’ chlorine cylinders and all remaining chlorine gas feed systems shall not occur until after the successful start-up and switchover to Sodium Hypochlorite has been accomplished.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION –

SECTION 06610

GLASS FIBER AND RESIN FABRICATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install all fiberglass items as specified herein and as shown on the Drawings. Coordinate with related work specified elsewhere and to provide all hardware, accessories and appurtenances required for a complete installation, including all fabrication and mounting hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 09900, Painting

B. Structural note sheet located on the Contract Drawings

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM D2996 – Specification for Filament Sound Reinforced Thermosetting Resin Pipe

2. ASTM D3647 - Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition

3. ASTM D3917 - Standard Specification for Dimensional Tolerances of Thermosetting Glass - Reinforced Plastic Pultruded Shapes

4. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products

1.04 SUBMITTALS

A. Submit shop drawings showing fabrication details for all items specified herein in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions.

B. Certification of compliance with ASTM Standards.

C. Where specifically requested, design calculations sealed by a currently Registered Professional Engineer in the Commonwealth of Virginia.

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1.05 QUALITY ASSURANCE

A. All fiberglass items of the same type provided shall be the products of a single manufacturer for compatibility.

B. Ensure that the fiberglass items and appurtenances furnished shall be compatible and have the necessary operating clearances with the structural elements and equipment shown on the Drawings.

C. Manufacturer shall provide a 1 year warranty on all FRP products against defect in material and workmanship.

PART 2 -- MATERIALS

2.01 GENERAL

A. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Design/Builder with certified test reports consisting of physical tests of samples.

B. Ultraviolet light resistive resins shall be used for all exterior locations and where specified.

C. All FRP resins shall be flame resistant and shall meet the requirements of ASTM D 635 and ASTM E 84, Class 1 with a maximum flame spread rating of 25.

D. All edges shall be sealed in the mold where possible. Machined or cut edges shall be sealed with a compatible resin system.

2.02 GRATING

A. Fiberglass grating shall be furnished and installed in areas shown on the Drawings including all FRP angle supports, fasteners and accessories. Gratings shall be either molded grating or pultruded grating meeting the requirements below.

B. Molded grating shall be a one piece, molded construction square mesh pattern grating providing bidirectional strength and fabricated with bearing bars and cross bars in the same plane. Grating shall be a minimum of 1-1/2” deep with a minimum 1- 1/2” square mesh pattern. Grating shall be capable of supporting a 100 psf uniform load or a 300 pound concentrated load with a deflection limit of 0.375” or grating span/ 240, whichever is less. Grating shall be manufactured with a concave, meniscus profile on the top of each bar for slip resistance. Bar intersections shall be filleted (1/16” minimum) to eliminate local stress concentrations.

C. Pultruded grating shall consist of bearing bars positioned and locked by crossbars, with the crossbars located beneath the walking surface of the tread. Grating shall be capable of supporting a 100 psf uniform load or a 300 pound concentrated load with a deflection limit of 0.375” or grating span/ 240, whichever is less.

D. Grating shall be fabricated into easily removable sections as large as possible up to 150 lbs. per section.

E. Fasteners shall not project above the grating surface.

F. Fiberglass grating shall be manufactured of polyester resin except for sodium hypochlorite applications where vinyl ester resin shall be used. Grating shall be produced by IKG Industries, Fibergrate, Inc., IMCO Reinforced Plastics, Inc., or equal.

G. The grating and tread supplier shall supply all shelf support angles, embedded angles with anchors, concrete anchors and necessary 316 stainless steel grating clips coated with epoxy paint per Section 09900, Painting, for a complete system.

2.03 FIXED LADDERS

A. Provide fixed ladder systems as shown on the Contract Drawings with all safety cages, landings, mounting clips, fasteners, and necessary appurtenances for a complete and rigid installation.

B. The ladder systems shall be designed to meet or exceed all OSHA requirements.

C. Ladders and cages shall be fabricated from pultruded shapes conforming to Extren Series 525 except for sodium hypochlorite applications where Extren Series 625 shall be used. Shapes shall be manufactured by Strongwell, Inc., or equal.

D. Ladder side rails shall be fabricated from channel members or 2 inch minimum square tube.

E. Side rails shall be anchored with FRP standoff clips manufactured of polyester resin except for sodium hypochlorite applications where vinyl ester resin shall be used. Clips shall be placed at the top and bottom of the ladder and at 6 foot maximum vertical centers.

F. Rungs

1. Rungs shall be 18 inches long, serrated and covered with a silica grit to produce and ant-skid surface.

2. Rungs shall be uniformly spaced at 12 inches on center.

3. Rungs shall be designed to support a 1,200 pound vertical load applied at midspan.

4. Rungs shall be both mechanically attached and epoxy bonded to the side rails.

2.04 CONNECTIONS

A. All connections shall be non-corrosive, non-staining, and concealed where practicable, as detailed on the Drawings or specified herein.

B. Fiberglass fasteners shall be "Fibrebolt", as manufactured by Strongwell, Inc., or equal.

C. All metal fasteners shall be Type 316 stainless steel, except for sodium hypochlorite applications, Hastelloy C-276 shall be used unless noted otherwise.

D. Holes for bolts and screws shall be drilled.

E. Joints exposed to weather shall be formed to exclude water.

F. Design and installation of fiberglass items shall provide for expansion and contraction, prevent shearing of bolts, screws and other fastenings, and provide close fitting of sections.

2.05 STRUCTURAL SHAPES AND FLAT SHEETS

A. Shapes shall conform to sizes indicated on Drawings and shall be Extren 525 except for sodium hypochlorite applications where Extren 625 shall be used. Shapes shall be manufactured by Strongwell, Inc., or equal.

B. Metal bolted connections shall be made with stainless steel bolts except for sodium hypochlorite applications where Hastelloy C bolts shall be used.

C. Adhesive bonded connections shall be made with a compatible epoxy adhesive following manufacturer's instructions.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All cut edges and holes shall be sealed with a compatible resin.

B. All FRP items shall conform to the dimensions indicated on the Drawings.

C. All fiberglass items described in this Section shall be supplied by a manufacturer that normally fabricates such items so that appearance and quality control are first class.

3.02 HANDLING, TRANSPORTING, AND STORING

A. All FRP items shall be properly packed, labeled and stored in accordance with Divisions 1 and 11, and where directed by the Design/Builder.

3.03 INSTALLATION

A. Installation of all items shall be according to manufacturer's instructions, unless otherwise noted.

B. Exposed threads of FRP bolts shall be sealed with a compatible resin after installation of the bolts. Where bolts are attaching removable items, the exposed threads shall be sealed with a light coat of polyurethane sprayed onto the threads.

- END OF SECTION -

SECTION 09900

PAINTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein.

B. Section Includes:

1. Paint Materials

2. Shop Painting

3. Field Painting

a. Surface Preparation

b. Piping and Equipment Identification

c. Schedule of Colors

d. Work in Confined Spaces

e. OSHA Safety Colors

1.02 RELATED SECTIONS

A. Section 15030 - Piping and Equipment Identification Systems

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications the Work shall conform to the applicable requirements of the following documents:

1. SSPC – The Society for Protective Coatings Standards

a.	SSPC-Vis 1	Pictorial Surface Preparation Standards for Painting Steel Structures
b.	SSPC-SP2	Hand Tool Cleaning
c.	SSPC-SP3	Power Tool Cleaning
d.	SSPC-SP5	White Metal Blast Cleaning
e.	SSPC-SP6	Commercial Blast Cleaning

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f. SSPC-SP10 Near-White Metal Blast

g. SSPC-SP13/NACE6 Surface Preparation of Concrete

2. NACE - National Association of Corrosion Engineers

3. ASTM D1737 - Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus

4. ASTM B117 - Method of Salt Spray (Fog) Testing

5. ASTM D4060 - Test Method for Abrasion Resistance of Organic Coating by the Taber Abraser

6. ASTM D3359 - Method for Measuring Adhesion by Tape Test

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature and Material Safety Data Sheets for each product.

2. Painting schedule identifying surface preparation and paint systems proposed. Cross-reference with Tables 9-1 and 9-2. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items.

1.05 SYSTEM DESCRIPTION

A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenance.

B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.

C. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

1.06 QUALITY ASSURANCE

A. Painting operations shall be accomplished by skilled craftsman and licensed by the state to perform painting work.

B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.

1.07 STORAGE AND DELIVERY

A. Bring materials to the job site in the original sealed and labeled containers.

B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

PART 2 -- MATERIALS

2.01 GENERAL INFORMATION

A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.

B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared, products were properly applied, and the paint systems were proper for the exposure and service.

C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.

D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.

E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.

F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Tnemec Company Inc.

2. Ameron

3. CARBOLINE

4. Sherwin-Williams

PART 3 -- EXECUTION

3.01 SHOP PAINTING

A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.

B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints.

3.02 SURFACE PREPARATION

A. General

1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.

2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted prior to cleaning and painting. Reposition items removed upon completion of painting operations.

3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.

4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.

5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch-up coats are in addition to the specified applied systems, and not considered a field coat.

6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.

7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

B. Metal Surface Preparation

1. Conform to current The Society for Protective Coatings Standards (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.

2. Perform blast cleaning operations for metal when following conditions exist:

   a. Moisture is not present on the surface.

   b. Relative humidity is below 80%.

   c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.

   d. Painting or drying of paint is not being performed in the area.

   e. Equipment is in good operating condition.

   f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.

3. Sandblast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.

4. Sandblast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service.

5. Sandblast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment.

6. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system.

7. Prime cleaned metals immediately after cleaning to prevent rusting.

8. Clean rusted metals down to bright metal by sandblasting and immediately field primed.

C. Concrete Surface Preparation

1. Cure concrete a minimum of 30 days before surface preparation, and painting begins.

2. Test concrete for moisture content using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.

3. Prepare concrete surfaces to receive coatings in accordance with SSPC-13 – Concrete Surface Preparation. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall be similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.

4. Acid etch (Reference ASTM D 260) concrete floors to receive paint. Following method is a minimum requirement. Remove residual dust and dirt. Wet surface of concrete until surface is damp. Etch surface with 15% to 20% muriatic acid solution to produce a "medium sandpaper" texture. Do not allow acid solution to dry on concrete. Rinse concrete when bubbling action of the acid begins to subside. Continue rinsing process until pH is 7 or higher. Remove excess water and allow concrete to thoroughly dry before coating. Other methods may be used, if approved by Engineer.

5. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric filler compatible with painting system. Complete fill coats may be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.

6. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.

7. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.

D. Wood

1. Clean wood surfaces free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Remove sap and resin by scraping and wipe clean with rags dampened with mineral spirits.

2. Saturate end grain, cut wood, knots, and pitch pockets with an appropriate sealer before priming.

3. Prime and backprime wood trim before setting in place.

4. After prime coat has dried, fill nailholes, cracks, open joints, and other small holes with approved spackling putty. Lightly sand wood trim prior to applying second coat of paint.

E. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.

2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

F. Masonry

1. Cure for a minimum of 30 days prior to paint application.

2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.

3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

G. Gypsum Drywall

1. Sand joint compound with sandpaper to provide a smooth flat surface. Avoid sanding of adjacent drywall paper.

2. Remove dust, dirt, and other contaminants.

H. Previously-Painted Surfaces

1. Totally remove existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.

2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.

3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.

4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer's recommendations.

5. Check existing paints for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

3.03 APPLICATION OF PAINT

A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.

B. Apply paint without runs, sags, thin spots, or unacceptable marks.

C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.

D. Special attention shall be given to nuts, bolts, edges, angles, flanges, etc., where insufficient film thicknesses are likely. Stripe paint prior to applying prime coat. Stripe painting shall be in addition to coats specified.

E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.

F. Allow paint to dry a minimum of twenty-four hours between application of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.

G. Suspend painting when any of the following conditions exist:

1. Rainy or excessively damp weather.

2. Relative humidity exceeds 85%.

3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.

4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.

5. Surface temperature of item is within 5 degrees of dewpoint.

6. Dew or moisture condensation are anticipated.

7. Surface temperature exceeds the manufacturer's recommendations.

3.04 INSPECTION

A. Each field coat of paint will be inspected and approved by the Engineer or his authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.

B. Use magnetic dry film thickness gauges and wet fiber thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.

C. Coatings shall pass a holiday detector test.

D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.

E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.

1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.

2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.

F. Paint manufacturer or his representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES

A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.

B. Take all necessary precautions to contain dispersion of sandblasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the sandblasting debris and paint. Suspend painting operations when sanding debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

3.06 PIPING AND EQUIPMENT IDENTIFICATION

A. Piping and equipment identification shall be in accordance with Section 15030, Piping and Equipment Identification Systems.

3.07 SCHEDULE OF COLORS

A. Match colors indicated. Piping and equipment colors are indicated in Section 15030. Colors which are not indicated shall be selected from the manufacturer's full range of colors by the Engineer. No variation shall be made in colors without the Engineer's approval. Color names and numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

3.08 WORK IN CONFINED SPACES

A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or direct air supply to individual workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosion-proof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state and local regulations at all times.

3.09 OSHA SAFETY COLORS

A. Paint wall around wall-mounted breathing or fire apparatus with the appropriate safety red color; area not exceed 2-feet wide by 3-feet high, unless apparatus covers the area. Fire apparatus include fire hoses, extinguisher, and hydrants.

B. Paint hazardous areas and objects in accordance with OSHA regulations.

TABLE 9-1
PAINTING SCHEDULE

SURFACE	APPLICATION	PAINTING SYSTEM & NO. OF COATS	PRODUCT REFERENCE (TABLE 9.2)	TOTAL MIN. DRY FILM THICKNESS (MILS)
Concrete and Masonry				
Containment Liner	Secondary containment floors and walls	2 coats high solids epoxy coating	119	6-10/coat
Metals				
Interior and exterior nonsubmerged (gloss)	All new blowers, pumps, motors and mechanical equipment, piping, etc.	1 coat epoxy polyamide primer	104	4-6
		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	4-6 3-5
Steel doors, windows and door frames, steel stairs, monorails, structural steel, misc. metals (steel)	All new metal (steel) components	1 coat epoxy polyamide	102	5-8
		1 coat aliphatic polyurethane	115	3-4

TABLE 9-2

PRODUCT LISTING

REF.	SYSTEM	PURPOSE	PRODUCT			
			Tnemec Series	AMERON	CARBOLINE	Sherwin-Williams
101	Acrylic filler	Primer-sealer	130-6601	AMERCOAT 147	Sanitile 100	Cement-Plex 875
102	Epoxy polyamide	Finish coat semi-gloss or gloss	66	AMERCOAT 385	Carboguard 890	Macropoxy 646
103	Acrylic latex	Sealer	6	AMERGUARD 220	Carbocrylic 3359DTM	DTM Acrylic Primer/Finish
104	Epoxy Polyamide – metal	Primer	66	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
105	Epoxy	Primer/Finish	20	--	Carboguard 561/56LT	Macropoxy 646 PW
106	Coal tar epoxy	Finish high-coat build	46H-413	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
107	Coal tar	Sealer	46-465	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
108	Alkyd-medium oil	Finish coat	2H	AMERCOAT 5401 HS	Carbocoat 139	Industrial Enamel
109	Alkyd-long oil	Finish coat	23	AMERCOAT 5401 HS	Carbocoat 139	Industrial Enamel
110	Epoxy polyamide	Primer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
112	Epoxy polyamide	Sealer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 920 Pre-Prime
113	Urethane	Barrier coat	530	--	Rustbond	--
114	Polyamine Epoxy	Intermediate coat	27	--	Carboguard 893SG	--
115	Aliphatic Polyurethane	Finish coat	1074 or 1075	AMERCOAT 450 HS	Carbothane 134HB	Acrolon 218HS
116	Acrylic epoxy	Finish coat	113 or 114	AMERCOAT 335	Sanitile 255	Water-Based Catalyzed Epoxy
117	Epoxy block filler	Sealer	54-562	AMERLOCK 400 BF	Sanitile 600	Cement Plex 875
118	Catalyzed epoxy	Finish coat	84	AMERCOAT 320	Carboguard 890	Macropoxy 646
119	High solids epoxy	Finish coat	104	AMERLOCK 400	Carboguard 890	Dura-Plate 235
120	Epoxy	Top coat	N69	--	Carboguard 890	--

- END OF SECTION -

SECTION 10524

EMERGENCY SHOWER/EYEWASH STATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install emergency shower/eyewash stations as shown on the Drawings and as specified herein. Coordinate work in this Section with painting and marking as specified in Section 09900, Painting. Certain equipment items will be field located by Owner, if not otherwise shown on the Drawings.

1.02 SUBMITTALS

A. Submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified for all items of equipment in this Section in accordance with Section 11000, Equipment General Provisions and Section 01300, Submittals. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.03 MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers' recommendations.

PART 2 -- PRODUCTS

2.01 EMERGENCY SHOWER/EYEWASH STATIONS

A. Combination shower and eyewash stations shall be installed where shown on the Contract Drawings.

B. For interior combination shower/eyewash units, the drench shower shall be operated by pull rod with triangular handle that remains open until manually closed, and the eyewash shall be operated by hand actuated flag type handle or foot treadle that remains open until manually closed. All interior combination shower/eyewash stations shall be Model S19-310UU as manufactured by Bradley, Model 8300 as manufactured by Haws, or equal. Dual automatic pressure compensation devices shall provide steady water flow under pressures varying from 30 to 75 psi.

C. Emergency shower/eyewash station shall be provided with a flow switch assembly. The flow switch contacts shall be rated for 120 VAC power and shall be U.L. listed. Flow switch assembly shall be installed as shown on the Drawings.

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2.02 TEMPERED WATER HEATER SYSTEM

A. Water heater shall be a 119-gallon capacity glass-lined Statesman premium heavy duty commercial electric as manufactured by State or equal. Heater shall be rated at 12 kW, 480 volts, 3 phase, 60 hertz, shall be constructed in accordance with ASME code, and shall be listed with underwriters' laboratories and approved by National Sanitation Foundation. Minimum recovery rate shall be 49 gallons per hour at 100 degrees F water temperature rise. All internal surfaces of the tank shall be glass-lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature of 1600 degrees. Tank shall be cathodically protected with adequate extruded magnesium rod. The entire vessel shall be enclosed in a round steel enclosure with baked enamel finish. Control components shall be hinged and shall house 120 volts control circuit transformer, transformer fusing, magnetic contactors, immersion style operating thermostats, high limit thermostats, element fusing per N.E.C., and commercial grade incoloy sheathed flange mounted elements with prewired terminal leads. Temperature controls shall include limiting switch, which will require resetting manually in the event the temperature reaches 190 degrees. Foam insulation shall exceed latest requirements of ASHRAE 90.1b-1999 for heat loss efficiency. Heaters shall include ASME T&P relief valve and drain valve.

B. Diaphragm-type pre-pressurized expansion tank shall be provided. Expansion tank shall be Amtrol Therm-X-Trol Model ST-42V, or equal. Watts Model 36A or equal vacuum relief valve shall also be provided.

C. The emergency shower mixing valve shall employ two fully independent control mechanisms which split the flow in half, blend each half to the design temperature and then integrate each stream at the outlet. The valve shall control outlet temperature over a wide range of flow and shall be suitable for deluge shower or eyewash applications. The valve shall include one thermometer to measure the merged flow. Each independent control mechanism shall employ a liquid-filled thermostatic motor to drive the valve without additional power requirements. Each control mechanism shall employ a stainless steel sliding piston control device with reverse seat closure and both fixed and variable cold water bypass. In the event of interruption of the cold water supply, each control mechanism shall close off the hot water port, stopping all flow. In the event of interruption of the hot water supply, each control mechanism shall allow cold flow through both the fixed and variable bypass. In the event that one liquid motor fails, the control mechanism shall close off the hot water port with the reverse seat and fully open the internal variable bypass to allow cold water flow. The other control mechanism shall be unaffected by the failure and shall maintain design temperature. Valves shall be Lawler Model 911E or equal.

D. The Contractor shall provide a drain line from the temperature and pressure relief valve and from the drain valve to the nearest drain. Contractor shall also provide dielectric unions and shut-off isolation valves at each water connection.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Emergency shower/eyewash stations shall be installed where shown on the Drawings or as directed by the Design/Builder. Where required by OSHA regulations, the background of the mounting location shall be painted the appropriate color.

- END OF SECTION –

SECTION 11000

EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish, install, test, and place in acceptable operation all mechanical equipment and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system.

B. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, and other appurtenances as specified, and as may be required for a complete and operating installation.

C. The requirements of this section shall apply to equipment furnished under Divisions 11, 13, and 15.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in the Specifications.

1.03 SHOP DRAWINGS

A. Shop Drawings shall be submitted to the Design/Builder for all equipment in accordance with Section 01300, Submittals and shall include the following information in addition to the requirements of Section 01300, Submittals:

1. Performance characteristics and descriptive data.

2. Detailed equipment dimensional drawings and setting plans.

3. General lifting, erection, installation, and adjustment instructions, and recommendations.

4. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.

5. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.

6. Details on materials of construction of all components including applicable ASTM designations.

7. Information on bearing types and bearing life.

8. Gear box design and performance criteria and AGMA service factor.

9. Piping schematics.

10. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at ½, ¾, and full load; slip at full load; running, full load, and locked rotor current values; and safe running time-current curves.

11. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

12. Equipment shop coating systems, interior and exterior.

13. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.

14. A list of spare parts and special tools to be provided.

15. Any additional information required to show conformance with the equipment specifications.

16. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.

1.04 OPERATION AND MAINTENANCE INSTRUCTION/MANUALS

A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01300, Submittals.

B. O&M manuals shall include instructions, equipment ratings, technical bulletins, and any other printed matter such as wiring diagrams and schematics, prints or drawings, containing full information required for the proper operation, maintenance, and repair of the equipment. Included in this submission shall be a spare parts diagram, complete spare parts list, bill of materials, OEM part numbers and manufacturer's catalog information of all equipment components.

C. Each set of instructions shall be bound together in appropriate three-ring binders with a detailed Table of Contents.

D. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item.

E. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission.

F. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.

G. Extensive pictorial cuts of equipment are required for operator reference in servicing.

H. When written instructions include Shop Drawings and other information previously reviewed by the Engineer, only those editions thereof which were approved by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the instructions.

1.05 GENERAL INFORMATION AND DESCRIPTION

A. All parts of the equipment furnished shall, be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all conditions of operation. All materials shall be new, and both workmanship and materials shall be entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.

B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.

C. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards.

D. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provision shall be made for accessible lubrication by extending lubrication lines and fittings to approximately 30 inches above finished floor elevation.

E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.

G. All machinery and equipment shall be safeguarded in accordance with the safety codes of the USA and the State in which the project is located.

H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with suitable protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.

I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.

J. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products. .

1.06 EQUIPMENT WARRANTIES

A. Warranty requirements may be added to or modified in the individual equipment specifications.

B. The equipment furnished under this Contract shall be guaranteed to be free from defects in workmanship, design and/or materials for a period of one (1) year unless otherwise specified in the individual equipment specifications. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

C. The Equipment Supplier shall guarantee to the Owner that all equipment offered under these specifications, or that any process resulting from the use of such equipment in the manner stated is not the subject of patent litigation, and that he has not knowingly offered equipment, the installation or use of which is likely to result in a patent controversy, in which the Owner as user is likely to be made the defendant.

Where patent infringements are likely to occur, each Equipment Supplier shall submit, as a part of his bid, license arrangements between himself, or the manufacturer of the equipment offered, and the patent owner or the controller of the patent, which will permit the use in the specified manner of such mechanical equipment as he may be bidding.

Each Equipment Supplier, by submitting his bid, agrees to hold and save the Owner and Design/Builder or its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the work under this contract, including the use of the same by the Owner.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The materials covered by these Specifications are intended to be equipment of proven reliability, and as manufactured by reputable manufacturers having experience in the production of such equipment. The Equipment Supplier shall, upon request of the Design/Builder, furnish the names of not less than 5 successful installations of the manufacturer's equipment of the same size and model of that offered under this contract. The equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

2.02 ANCHORS AND SUPPORTS

A. The Equipment Supplier shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and suitable templates shall be used when required in the detailed equipment Specifications.

B. Anchor bolts and fasteners shall be furnished in accordance with Drawing S1 – General Structural Notes, and with the individual equipment Specifications. All anchor bolts shall be a minimum of 1/2-inch diameter. All anchor bolts, handrail bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.

2.03 DISSIMILAR METALS

A. All dissimilar metals shall be properly isolated to the satisfaction of the Design/Builder.

2.04 STANDARDIZATION OF GREASE FITTINGS

A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be “Zerk” type.

2.05 ELECTRICAL REQUIREMENTS

A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 16 specifications and the latest National Electric Code.

B. In the individual equipment specifications, specified motor horsepower is intended to be the minimum size motor to be provided. If a larger motor is required to meet the specified operating conditions and performance requirements, the Equipment Supplier shall furnish the larger sized motor at no additional cost to the Owner.

C. Where variable frequency drives (VFDs) are specified, the Equipment Supplier shall be responsible for coordinating with the VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16.

D. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.06 ACCESSORIES, SPARE PARTS, AND SPECIAL TOOLS

A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications or where recommended by the equipment manufacturer.

B. Spare parts shall be identical and interchangeable with original parts.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Painting requirements for spare parts shall be identical to those for original, installed parts. Where no painting or protective coating is specified, suitable provisions shall be made to protect against corrosion.

E. Spare parts shall be delivered at the same time as the equipment to which they pertain. Spare parts shall be stored separately in a locked area, maintained by the Design/Builder, and shall be turned over to the Owner in a group prior to substantial completion. All of these materials shall be properly packed, labeled, and stored where directed by the Owner and Design/Builder.

F. The Equipment Suppliers shall furnish all special tools necessary to operate, disassemble, service, repair, and adjust the equipment in accordance with the manufacturers operation and maintenance manual.

G. The Equipment Suppliers shall furnish a one year supply of all recommended lubricating oils and greases. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required. All of these materials shall be properly packed, labeled and stored where directed by the Design/Builder.

2.07 EQUIPMENT IDENTIFICATION

A. All mechanical equipment shall be provided with a substantial stainless steel nameplate, mechanically fastened with stainless steel hardware in a conspicuous place, and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

B. Each pump and other piece of mechanical equipment shall also be identified as to name and number by a suitable laminated plastic or stainless steel nameplate mechanically fastened with stainless steel hardware; for example, "Raw Water Pump #1". Coordinate name and number with same on remotely located controls, control panel, and other related equipment.

C. Nameplates shall not be painted over.

PART 3 -- EXECUTION

3.01 SHOP TESTING

A. All equipment shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.

B. No equipment shall be shipped to the project until the Design/Builder has been furnished a certified copy of test results and has notified the Equipment Supplier, in writing, that the results of such tests are acceptable.

C. Five (5) certified copies of the manufacturer's actual test data and interpreted results thereof shall be forwarded to the Design/Builder for review.

D. If required by the individual equipment Specifications, arrangements shall be made for the Owner/Design/Builder to witness performance tests in the manufacturer's shop. The Design/Builder shall be notified ten working days before shop testing commences. Expenses are to be paid by Owner.

E. Shop testing of electric motors shall be in accordance with applicable requirements of the equipment specifications and Section 16000, Basic Electrical Requirements.

3.02 MANUFACTURER'S FIELD SERVICES

A. The Design/Builder shall arrange for a qualified Technical Representative from each manufacturer or supplier of equipment who is regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of the specified equipment. Qualification of the Technical Representative shall be appropriate to the type of equipment furnished and subject to the approval of the Design/Builder and the Owner. Where equipment furnished has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment. When necessary, the Design/Builder shall schedule multiple Technical Representatives to be present at the same time for the purpose of coordinating the operation of multiple pieces of related equipment.

B. For each site visit, the Technical Representative shall submit jointly to the Owner and Design/Builder a complete signed report of the results of his inspection, operation, adjustments, and testing. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified.

C. The manufacturer's Technical Representative shall provide the following services.

1. Installation: The Technical Representative shall inspect the installed equipment to verify that installation is in accordance with the manufacturer's requirements. Where required by individual equipment specifications, the Technical Representative shall also supervise the installation of the equipment.

2. Testing: After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Technical Representative shall inspect, operate, test, and adjust the equipment as required to prove that the equipment is in proper condition for satisfactory operation under the conditions specified. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for startup and that nothing in the installation will render the manufacturer's warranty null and void. The report shall include date of final acceptance field test, as well as a listing of all persons present during tests.

3. Startup: The Technical Representative shall start up the equipment for actual service with the help of the Design/Builder. In the event that equipment or installation problems are experienced, the Design/Builder and the representative shall provide the necessary services until the equipment is operating satisfactorily and performing according to the specifications at no additional cost to the Owner. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and

is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

4. Training: The Technical Representative shall instruct the Owner's operating personnel in correct operation and maintenance procedures. The instruction shall demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment. Such instruction shall be scheduled at a time arranged with the Owner at least 2 weeks in advance of the training and shall be provided while the respective Technical Representative's equipment is fully operational. The Equipment Supplier shall have submitted, and had accepted, the O&M Manuals prior to commencement of training. Training shall be provided to separate shifts of the Owner's personnel as necessary. The Equipment Supplier shall provide professional video taping of all training sessions. Completed, labeled tapes shall be provided to the Owner for each type of training session.

5. Services after Startup: Where required by the individual equipment specifications, the Technical Representative shall return to the project site thirty (30) days after the start up date to review the equipment performance, correct any equipment problems, and conduct operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of Technical Representative prior to and during equipment startup. At this time, if there are no equipment problems, each manufacturer shall certify to the Owner in writing that his equipment is fully operational and capable of meeting operating requirements. If the equipment is operating incorrectly, the Technical Representative will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful thirty (30) days operating period.

D. Services of the Technical Representative will require a minimum of two (2) site visits, one for installation and testing and one for startup and training, and will be for the minimum number of days recommended by the manufacturer and approved by the Design/Builder but will not be less than the number of days specified in individual equipment sections.

E. The Contract amount shall include the cost of furnishing the Technical Representative for the minimum number of days specified, and any additional time required to achieve successful installation and operation. The times specified for services by the Technical Representative in the equipment Specifications are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

F. The Equipment Supplier shall notify the Design/Builder at least 14 days in advance of each equipment test or Owner training session.

G. The Technical Representative shall sign in and out at the office of the Design/Builder’s Resident Project Representative on each day he is at the project.

3.03 PAINTING

A. All surface preparation, shop painting, field repairs, finish painting, and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900, Painting.

B. All shop coatings shall be compatible with proposed field coatings.

C. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.

D. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

- END OF SECTION –

SECTION 11100

PUMPS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish, install, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.

B. All pumping equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.

D. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.

1.02 SHOP DRAWINGS

A. Shop Drawings shall include the following information in addition to the requirements of Section 01300, Submittals and Section 11000, Equipment General Provisions.

1. Details of shaft sealing system

2. Pump performance curves at rated speed and reduced speed (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, NPSH required, and minimum submergence. Curves shall include limits (minimum and maximum flows) for stable operation without cavitation, overheating, recirculation, or excessive vibration.

3. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, and anchor bolt locations and forces.

4. Foundry certificates and results of Brinnell hardness testing showing compliance to ASTM A 532 (where required in the individual pump specifications).

5. Submersible pump submittals shall also include:

   a. Product data sheets for power and control cables and length of cables.
   b. Details on pump guide rail system and mounting requirements.

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PART 2 -- PRODUCTS

2.01 MATERIALS

A. All materials employed in the pumping equipment shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.

2. Bronze pump impellers shall conform to ASTM B 584, “G” bronze.

3. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.

B. Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.

C. Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.02 APPURTENANCES

A. Pressure Gauges

1. Furnish and install pressure gauges on the suction and discharge of each pump, except wet-pit submersible pumps and vertical turbine pumps.

2. Furnish and install pressure gauges on the discharge piping of each wet-pit submersible pump and vertical turbine pump in the locations shown on the Drawings or as directed by the Design/Builder.

3. Suction gauges shall be of the single scale compound type to indicate both pressure and vacuum. Each suction gauge shall be graduated in feet of water over the span of 34 feet below and above zero.

4. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head or to a minimum of 30% above the maximum operation pressure, whichever is greater. Graduation shall be in feet of water.

5. All gauges shall be supplied by one manufacturer and shall be as specified in Section 17650, Pressure Gauges.

6. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 17698, Instrumentation and Control Accessories.

B. Flexible couplings for direct driven pumps shall be as manufactured by Falk, Dodge, Woods Corp., or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.

2.02 ELECTRICAL REQUIREMENTS

A. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Design/Builder.

B. Where variable frequency drives (VFDs) are specified, the Equipment Supplier shall be responsible for coordinating with the VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16 and shall be as specified in Section 16495, Variable Frequency Drive Systems.

C. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.03 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of Section 11000, Equipment General Provisions, nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency at the primary design point.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Drains: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with galvanized steel pipe or copper tube, properly supported with brackets.

B. Solenoid Valves: Where required, the pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

3.02 SHOP TESTING

A. Shop tests shall be performed in accordance with Section 11000, Equipment General Provisions, and except where stated otherwise herein, shall be conducted in accordance with applicable methods and standards of the American National Standard for Centrifugal Pump Tests by the Hydraulic Institute, or American National Standard for Vertical Pump Tests by the Hydraulic Institute for Vertical Pumps.

B. Pump testing shall be witnessed by the Owner/Design/Builder where specified in the individual pump specifications. The testing procedure shall be submitted to the Design/Builder for review before scheduling the testing. The Design/Builder shall be given at least 2 weeks advanced notice of the scheduled testing date.

C. Certified test curves for shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications. Certified tests will not be required for submersible sump pumps (as specified in Sections 11133 and 11136) with motors less than 5 hp.

D. Pumps shall be within the tolerances specified by the Hydraulic Institute Standards with the following exceptions:

1. At design heads, +10% of design capacities or at design capacities, +5% of design heads.

2. No minus tolerances shall be allowed with respect to capacity, head, or efficiency at the design points.

E. For wet pit submersible pumps and vertical turbine pumps, all tests shall be run at minimum pump submergence specified in the individual pump specifications.

F. Where required in the individual pump specifications, each individual casting shall be Brinnell tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E-10. Results shall be certified by a registered professional ENGINEER. Test results shall verify the satisfaction of the required Brinnell hardness of the finished product as specified in respective subsections.

3.03 FIELD TESTING

A. Field tests shall be performed in accordance with in Section 11000, Equipment General Provisions and additionally as specified below and in the individual pump specifications.

B. Final acceptance tests shall demonstrate the following:

1. The pumps have been properly installed and are in proper alignment.

2. The pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.

3. The pumps can meet the specified operating conditions. All pumps shall be checked at maximum speed for a minimum of four points on the pump curve for capacity, head, and amperage. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing.

- END OF SECTION -

SECTION 11300

CHEMICAL METERING PUMPS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish, deliver, install, test and place in satisfactory operation peristaltic chemical metering pumps complete with all mechanical equipment, controls, and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system. All pumps shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions and Section 11100, Pumps - General.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Chemical Properties

	Sodium Hypochlorite
Concentration	5-12% (trade)
Specific Gravity	1.2
Freezing Point	-11ºF
pH	11-13
Viscosity	3

B. Pump Performance Requirements

Chemical Service	**Sodium Hypochlorite**	
No. of Units	4	3
Pump ID	SHMP-3, 5, 6, and 7	SHMP-1, 2, and 4
Minimum Capacity	0.3 gph	1 gph
Maximum Capacity	10 gph	50 gph
Minimum Discharge Pressure	65 psig	65 psig
Suction Connection	½"	½"
Discharge Connection	½"	½"
Maximum Drive Speed	130 rpm	130 rpm
Drive Type	DC, Variable Speed	DC, Variable Speed
Application Point	1 – 44/54 Flash Mix 1 – 94 Top of Filter 1 – 54 Top of Filter 1 – 44 Top of Filter	1 – 36" Post Filter 1 – 42" Post Filter 1 – 94 Flash Mix and Spare

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1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals and Section 11000, Equipment General Provisions:

1. Submit pump manufacturer's hydraulic calculations based on the pump schedule attached in this section, including a pump characteristic performance curve showing flow rate as a function or rpm and pressure.

2. Tubing design information (chemical resistance, life cycle, wall thickness, pressure rating, etc.)

B. Shop drawings shall include all pumps and accessories and shall be submitted as a complete system. Partial submittals will be unacceptable.

1.04 RESPONSIBILITIES AND GUARANTEE

A. The metering pump manufacturer shall warrant the system for materials and workmanship for a period of two (2) years after the Substantial Completion of the project. Warranty shall be submitted with the Shop Drawings. The manufacturer shall replace or repair defective or unsatisfactory equipment during the warranty period at no cost to the Owner.

B. Warranty shall include chemical damage to the pump head and roller assembly caused by a ruptured pump tube assembly when proper TFD system instructions and maintenance are followed.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The Manufacturer shall be a company specializing in manufacture, assembly, and field performance of peristaltic chemical metering pumps with a minimum of five years experience.

B. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

C. The metering pumps shall be ProSeries M pumps as manufactured by Blue-White Industries, or equivalent by Verderflex or PeriFlo.

2.03 PERISTALTIC METERING PUMPS

A. Metering Pump

1. Pump shall be a positive displacement, peristaltic type tubing pump with a brushless variable speed motor, non-spring loaded roller assembly located in the pump head,

integral tube failure detection system, and flexible tubing with attached connection fittings.

2. There shall be no valves, diaphragms, springs, or dynamic seals in the fluid path. Process fluid shall contact the pump tubing assembly and connection fittings only.

3. Pump shall be capable of self-priming at the rated maximum pressure of up to 125 PSI.

4. Pump shall be capable of running dry without damage.

5. Pump rollers shall be capable of operating in either direction at the maximum rated pump pressure and without output variation.

6. Suction lift shall be 30 feet of water.

7. Repeatability shall be +/- 0.5 percent. Accuracy shall be +/- 0.5 percent of full scale.

B. Pump Head

1. Pump head shall be a single, unbroken track with a clear removable cover.

2. Tube failure detection sensors shall be wholly located in the pump head. Tube failure detection system shall not trigger with water contact. Float switch type switches alone shall not be used. Process fluid waste ports or leak drains shall not be provided as the sole means of protection.

3. Squeeze rollers with encapsulated ball bearings shall be directly coupled to a one-piece thermoplastic rotor. Four polymeric rollers shall be provided; two squeeze rollers for tubing compression shall be located 180 degrees apart and two guide rollers that do not compress the tubing shall be located 180 degrees apart. The roller diameters and occlusion gap shall be factory set to provide the optimum tubing compression; field adjustment shall not be required. Spring loaded or hinged rollers shall not be used.

4. Rotor assembly shall be installed on a D-shaped, chrome plated motor shaft and removable without tools.

5. For tubing installation and removal, rotor assembly shall be rotated by the motor drive at 6 RPM maximum when the pump head cover is removed. Hand cranking of the rotor assembly shall not be required.

6. Pump head and tubing compression surface shall be corrosion-resistant Valox thermoplastic. Manufacturer shall confirm suitability with the specified chemical.

7. The pump head cover shall be clear, annealed acrylic thermoplastic with an integral ball bearing fitted to support the overhung load on the motor shaft. Manufacturer shall confirm suitability with the specified chemical. Cover shall include an imbedded magnetic safety interlock which will limit the motor rotation speed to 6 RPM when removed.

8. Cover shall be positively secured to the pump head using a minimum of four thumb screws. Tools shall not be required to remove the pump head cover.

C. Pump Tube Assembly

1. To ensure pump performance and accuracy, only tubing provided by the manufacturer is acceptable.

2. Pump tube shall be assembled to connection fittings of PVDF material.

3. Connection fittings shall be permanently attached to the tubing at the factory. To prevent tubing misalignment and ensure accuracy, fittings shall insert into keyed slots located in the pump head and secured in place by the pump head cover.

4. Connection fittings shall be 1/2" M/NPT. Alternate fittings shall accept 1/4" ID x 3/8" OD flexible tubing.

5. Tube size shall be selected by the manufacturer to achieve the specified feed rates.

6. Tubing shall be Norprene. Manufacturer shall confirm suitability with specified chemicals.

2.03 DRIVES AND CONTROLS

A. Drive system shall be factory installed and totally enclosed in a NEMA 4X, (IP66) wash-down enclosure. Pump shall be capable of operating on any input power from 110VAC to 240VAC, 50/60 Hz single phase supply without user configuration or selection switches.

1. Motor shall be reversible, brushless DC gear motor rated for continuous duty. Motor shall include overload protection. The maximum gear motor RPM shall be 130 RPM.

2. Enclosure

a. Enclosure shall be pressure cast aluminum with acidic liquid iron phosphate three-stage clean and coat pretreatment and exterior grade corrosion resistant polyester polyurethane powder coat. Enclosure shall be rated NEMA 4X.

b. Enclosure shall be provided with 316SS floor/shelf level mounting brackets and hardware.

c. A wiring compartment shall be provided for connection of input/output signal wires and alarm output loads to un-pluggable type terminal block connectors. Terminal board shall be positively secured to the rear of the pump housing by two polymeric screws and fully enclosed by the wiring compartment cover. The terminal board shall not be disturbed by the removal of the wiring compartment cover. Ribbon cables shall not be used in the wiring compartment. Conduit hubs, liquid-tight connectors, connector through holes and tapped holes shall be sized in U.S. inches.

3. Control Circuitry

a. Control Circuitry shall be integral to the pump and capable of adjusting the pump motor speed from 1% to 100 % in 0.1% increments.

b. The pump output shall be capable of being manually controlled via front panel user touchpad controls. The pump motor speed shall be adjustable from 1% to 100% in 0.1% increments.

c. The pump output shall have the hardware necessary for being remotely controlled via 4-20mA analog input. The input resolution shall be 0.1% of input value and capable of adjusting the pump motor speed from 0% to 100% motor speed in 0.1% increments. Four values shall be user configurable to define the low and high points on the output slope; a low input value, the required pump percentage of motor speed at the low input value, a high input value, the required pump percentage of motor speed at the high input value.

c. The pump shall be provided with a 8-button front panel user touchpad control for stop/start, configuration menu access and navigation, operating mode selection, auto priming, and reverse direction.

d. The pump shall be provided with a back-lit LCD display for menu configuration settings, current pump operating mode, pump output value, tube timer hour counter, tube failure detection (TFD) system and flow verification system (FVS) alarms status, motor direction, remote input signal values, and tubing life timer value.

e. Remote stop/start of pump shall be provided via a non-powered contact closure loop.

f. Pump shall be provided with a user-selectable 4-20mA output signal which is scalable and proportional to pump output volume.

g. Pump shall be provided with a Form C contact closure alarm output rated at 3A-250VAC (3A-30VDC) that will change state when the TFD system or FVS system is triggered.

h. Pump shall be provided with an open collector output, suitable for 5 to 24 VDC, for pump run indication.

i. Pump shall be provided with an auto-prime function that will run the pump at 100% motor speed for 60 seconds maximum when the Prime button is pressed.

j. Pump shall be provided with a flow verification system with programmable alarm delay time from 1-255 seconds. FVS system shall monitor the FVS flow sensor while pump is running only. System shall not monitor pump while not running.

2.04 FLOW VERIFICATION SENSOR

A. Flow verification sensor shall output high speed digital pulse signal, while pump is running only, to verify chemical injection. Flow verification sensor shall be a paddlewheel type sensor. Sensor body, paddle, lens cap, and axle material shall be PVDF. Inlet and outlet fitting connections shall be PVC or PVDF.

2.05 SAFETY

A. The pump shall be listed to UL standard 778 as a motor operated pump and CSA standard C22.2 as process control equipment.

B. Tube Failure Detection (TFD) system sensors shall be wholly located in the pump head. TFD system will stop the pump within three seconds of leak detection. To prevent false alarms due to rain, wash-down, condensation, etc., tube failure detection system shall not trigger with water contact. Process fluid waste ports or leak drains shall not be provided as sole means of protection.

C. Pump head cover shall include an imbedded magnetic safety interlock which will stop the pump when removed. Pump rotor speed shall be limited to 6 RPM when cover is removed.

2.06 PUMP ACCESSORIES

A. The metering pump supplier shall furnish accessory equipment as specified herein and as shown on the Drawings including but not limited to the following:

1. Pressure gauges - Gauges shall be provided on the discharge of metering pumps as shown on the Schematic. Gauges shall be as specified in Section 17650. Each gauge shall have a range of zero to 100 psi. Each gauge shall be provided with a diaphragm seal as specified in Section 17650 constructed of materials which are completely resistant to corrosion by the chemicals referred to in this section. Each pressure gauge shall also be provided with an isolation valve. Isolation valves shall be PVC with seals that are resistant to the chemical applications.

2. Pressure relief valves – Pressure relief valves shall be provided on the discharge of metering pumps as shown on the Schematic. Valves shall be manufactured by the pump manufacturer and shall be completely resistant to the chemicals for which they are provided. Sizing of the valves shall be the responsibility of the manufacturer and calculations shall be submitted with Shop Drawings.

3. Calibration Column – Calibration columns shall be provided as shown on the Schematic. Calibration columns shall be constructed of transparent PVC and shall be provided with threaded ends. Graduations shall be in mL and gallons. Each calibration column shall be sized such that at 50% pump capacity, the calibration column will be emptied in 60 to 90 seconds.

B. Piping on the suction and discharge of each metering pump shall be as specified in the Piping System Schedule at the end of Section 15390. Materials of construction shall be completely compatible with the specified chemical.

2.07 TOOLS, SUPPLIES AND SPARE PARTS

A. The equipment manufacturer shall furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

B. The manufacturer shall furnish the following for each pump model:

1. One (1) spare tube
2. One (1) year supply of hose lubricant per pump, if required
3. One (1) spare pump head

2.08 EQUIPMENT IDENTIFICATION

A. The equipment shall be provided with a substantial stainless steel nameplate, securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Testing	1	1
Startup and Training	1	1

3.02 TESTING

A. Testing of the chemical metering pumps shall be as specified herein, and in accordance with Section 11000 - Equipment-General.

B. All pumps shall be shop tested for capacity at rated pressure prior to shipment, with documented results provided.

C. The system supplier shall demonstrate to the Owner and Design/Builder that the chemical metering pumps meet the functional requirements intended and that all components of the system are properly adjusted and calibrated and operate reliably.

D. Field Pump Tests

1. After all pumping equipment is installed, it is required that a witness testing of the pump by the Design/Builder be conducted to insure that the pumping equipment conforms to the specifications. Testing of the pumps will be at 5%, 25%, 50%, 75% and 100% of rated speeds.

2. Should the performance not meet the Design/Builder's standard as set in the specifications, corrective measures to meet these standards will be made by the Manufacturer which may include replacement of the units.

3. A 24 hour operating period of the pump will be required before acceptance by the Design/Builder. During this operating period, the pump will perform according to specifications without any excessive vibrations, noise or overheating.

E. Check the functioning of all system components including pump accessories and shall repair or replace all malfunctioning or unsatisfactory components identified during testing, start-up, and through the warranty period.

3.03 PAINTING

A. All surface preparation, shop painting, field repairs, field painting and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900 -Painting.

- END OF SECTION -

SECTION 11330

MAGNETIC DRIVE CENTRIFUGAL PUMPS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish, deliver, install, test and place in satisfactory operation magnetic drive centrifugal pumps for chemical recirculation and transfer service at the locations shown on the Drawings and as specified herein. All pumps shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions and Section 11100, Pumps - General.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Pumps and pump components shall be suitable for use in the chemical service specified herein. The equipment supplier is responsible for the coordination and selection of corrosion resistant materials for the chemical solutions specified herein and shall guarantee the suitability of the materials used in manufacturing the equipment.

B. Chemical Properties

	Sodium Hypochlorite
Concentration	5% - 12% (trade)
Specific Gravity	1.1 - 1.2
pH	>12
Viscosity	2.5 cps

C. Pump Performance Requirements

Service	Two (2) for Sodium Hypochlorite Service		
Design Capacity (gpm)	60	70	82
Total Dynamic Head (feet)	61	57	15
Brake Horsepower	1.72	1.83	1.96
Pump Speed (rpm)	3,450		
Temperature of Liquid Pumped	Ambient		
Suction Condition	Flooded Suction		
Minimum Suction Diameter (in.)	2		
Minimum Discharge Diameter (in.)	1-1/2		
Minimum Impeller Diameter (in.)	4.4		

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D. Total dynamic head and horsepower calculations for the chemical pumps are based on clean water. The pump supplier shall adjust for the specific gravity and viscosity anticipated and shall submit calculations verifying pump head and horsepower.

1.03 SUBMITTALS

A. Submittals shall be provided in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The pumps shall be Model TE-7.5K-MD magnetically driven sealless centrifugal pumps as manufactured by March Manufacturing, Inc., or equal by IWAKI America or approved equal.

2.02 MATERIALS OF CONSTRUCTION OF MAGNETIC DRIVE CENTRIFUGAL PUMPS

A. The pumps shall have Kynar casing with all wetted parts suitable for the specified chemical service. All wetted parts shall also be NSF 61 approved. These Specifications shall be considered as minimum requirements. The Contractor shall inform himself of the practices and experiences of similar pumping units handling the specified chemical solution. The manufacturer shall add features as necessary for satisfactory operation and shall guarantee the suitability of the materials used in the manufacture of the recirculation pumps. Motors shall be non-overloading over the range of pump performance.

B. The pumps shall be seal-less magnetic drive type applying all the laws of centrifugal pump design. The pumps shall be capable of operating without damage to the pumps at low or no process liquid flow. The pump housing shall be constructed of Kynar. The impellers shall be balanced to minimize vibration and shall be constructed of Kynar. The bearings shall support driven magnetic assembly and shall be lubricated by pumped liquid. The pump manufacturer shall be responsible for selecting bearing material to withstand periods of dry-running. The magnet shall be encapsulated by materials that are completely resistant to corrosion by the chemical solution. The materials in contact with the hypochlorite solution shall be Viton, Teflon, Kynar and ceramic.

C. Pumps shall be provided with a substantial stainless steel nameplate, securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

A. All conduit and associated appurtenances shall be furnished and installed under Division 16.

B. Electrical Requirements

Motors	
Rating	460V, 3 ph, 60 Hz
Horsepower	2

Speed, rpm	3,450
Enclosure	TEFC
Insulation	Class F
Inverter Duty	No
Service Factor	1.15
Space Heater	No
Motor Winding Temperature Switches	No

C. Motors shall be as specified in Section 15170.

2.04 SPARE PARTS

A. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following for each series of pumps:

1. One (1) complete assembly of pump bearings

2. Two (2) sets of gaskets for all gasketed covers

3. One (1) set of wearing rings

4. One (1) impeller with nut and washers

5. Two (2) sets of all seals

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions. For each series of pumps, field services shall include the following site visits:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Testing	1	1
Startup and Training	1	1

3.02 SHOP TESTING

A. Shop testing shall be in accordance with Section 11000, Equipment General Provisions.

- END OF SECTION –

SECTION 11340

WATER SOFTENING SYSTEM

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish, install, test, and place in acceptable operation a complete water softening system complete with all mechanical equipment, controller, and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system.

B. The system shall include, but not be limited to, two media tanks complete with conditioning media, one salt storage and brine production tank, a regeneration control valve, a controller, and all required piping and valves. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, and other appurtenances as specified, and as may be required for a complete and operating installation.

C. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Water Softening System

Continuous Supply Water Flow Rate	47 gpm
Supply Water Pressure Range	55 – 65 psi
Supply Water Temperature Range	35 – 80°F
Maximum Supply Water Hardness	50 mg/L as $CaCO_3$
Maximum Supply Water Chlorine Residual	2 mg/L
Maximum Pressure Drop Through System	5 psi
Number of Media Tanks	2
Empty Bed Volume, per tank	6.55 ft^3
Media Type	Cation Resin
Media Volume, per tank	4.0 ft^3
Number of Brine Tanks	1
Brine Tank Dimensions	24” diameter x 40”
Salt Capacity, per tank	500 pounds
Number of Regeneration Control Valves	1
Number of Controllers	1

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1.03 SUBMITTALS

A. Submit complete Shop Drawings, Operation and Maintenance Instructions and other information as specified in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions.

1.04 RESPONSIBILITIES AND GUARANTEE

A. The water softening system manufacturer shall warrant the system for materials and workmanship for a period of two (2) years after the Substantial Completion of the project. Warranty shall be submitted with the Shop Drawings. The manufacturer shall replace or repair defective or unsatisfactory equipment during the warranty period at no cost to the Owner.

PART 2 -- EQUIPMENT

2.01 MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

B. The water softening system shall be Model CP 216s OD softener with Smart Start Controller as manufactured by Kinetico Water Systems, or equal.

2.02 GENERAL

A. A duplex water softener system composed of two resin tanks with one brine tank shall be provided and installed as shown on the Drawings. The duplex water softener shall include controls, piping, and valves to provide continuous softened water flow with a manual auxiliary hard water bypass. The system shall not be designed to operate in overdrive. Regeneration of one resin tank shall be accomplished while the other tank is in service.

C. The regeneration cycle shall be automatic and based on water flow. The regeneration cycle shall be last a maximum of 90 minutes and consume a maximum of 160 gallons.

2.03 MEDIA TANKS

A. Media tanks shall be constructed of polypropylene and shall be reinforced with a fiberglass wrapping. Each tank shall have a 4” threaded top opening and shall be NSF/ANSI Standard 44 approved.

B. Media tanks shall be designed for a maximum working pressure of 125 psi and shall be hydrostatically tested at 300 psi.

C. The upper distribution system shall be a slot design, and the lower distribution system shall be a hub and lateral design. The distribution system shall provide even distribution for both regeneration and water collection.

2.04 CONDITIONING MEDIA

A. Each softener shall use strong acid, no-solvent, high capacity, cation resin with a minimum exchange capacity of 30,000 grains removed per cubic foot of media when regenerated with a dose of 15 pounds of salt per cubic foot of media. The media shall be solid, of a proper article size, and shall contain no plates, shells, agglomerates or other shapes that might interfere with the normal function of the water softener.

2.05 BRINE SYSTEM

A. Combination salt storage and brine production tanks shall be manufactured of corrosion-resistant, rigid polyethylene. The brine tank shall have an internal brine well chamber to house the brine valve assembly. The brine float assembly with adjustable salt settings shall provide for a shut-off to the brine refill. The brine tank shall include a safety overflow connection plumbed to a suitable drain.

2.06 REGENERATION CONTROLS

A. The regeneration control valve, manufactured from non-corrosive materials, shall be mounted on top of the media tank. The control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-ring sealed adapter. Interconnection between tanks shall be made through the regeneration valves with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 15 psi. Pressure shall be used to drive all valve functions. No electric power supply shall be required. Control valve shall incorporate four operational cycles including service, brine draw, slow rinse, and a combined fast rinse and brine refill. Service cycle shall operate in a downflow direction. The brine cycle shall operate in an upflow direction, opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The control valves will prevent the by-pass of hard water to service during the regeneration cycle. Control valve shall be certified to NSF/ANSI 61.

2.07 PIPE AND FITTINGS

A. Pipe shall be Schedule 80 PVC, Type I, Grade 1 (Class 12454-B), conforming to ASTM D 1784 and D 1785. Hard water piping shall be located at a minimum of 24 inches above the softener unit for filling.

B. Short nipples shall be the same as the PVC pipe.

C. Fittings shall be made of the same material as the pipe. Flanges shall match the dimensions of ANSI B16.5, Class 150, steel flanges.

D. Unions shall have socket-type ends, Viton O-rings, and shall be Schedule 80. Material shall be Type I, Grade 1 PVC, per ASTM D2564. Unions shall be located on inlet and outlet connections of control valve to facilitate servicing.

E. Pipe and fitting joints shall be socket welded except where threaded and flanged joints are required to connect to unions, valves, and equipment.

F. Minimum drain tube size shall be ½ inch. No direct connection shall be made to the drain. An air gap at least four times the diameter of the drain pipe shall be provided between the drain piping and drain to conform to sanitation codes and permit the observation of the drain flow.

G. Solvent cement for socket joints shall comply with ASTM D 2564.

H. Gaskets for flanges shall conform to Section 15008.

I. Bolts and nuts shall be stainless steel conforming to ASTM A 914, Grade 8M.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Testing	1	1
Startup and Training	1	1

3.02 TESTING AND START-UP

A. Testing of the water softener system shall be as specified herein, and in accordance with Section 11000 - Equipment-General.

B. The system supplier shall demonstrate to the Owner and Design/Builder that the water softening system meets the functional requirements intended and that all components of the system are properly adjusted and calibrated and operate reliably.

C. Check the functioning of all system components and repair or replace all malfunctioning or unsatisfactory components identified during testing, start-up, and through the warranty period.

3.04 PAINTING

A. All surface preparation, shop painting, field repairs, field painting and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900 - Painting.

3.05 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

B. Furnish spare parts as recommended by the equipment manufacturer. All of these materials shall be properly packed, labeled and stored where directed by the Design/Builder.

3.06 EQUIPMENT IDENTIFICATION

A. The equipment shall be provided with a substantial stainless steel nameplate, securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

- END OF SECTION –

SECTION 13207

POLYETHYLENE STORAGE TANKS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish, deliver, install, test and place in satisfactory operation polyethylene storage tanks, complete with all necessary accessories, at the locations shown on the Drawings and as specified herein.

B. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

1.02 CONDITIONS OF SERVICE/STORAGE TANK SCHEDULE

	Sodium Hypochlorite Bulk Tanks	**Sodium Hypochlorite Day Tank**
Max Solution Concentration	15% Trade	
Specific Gravity	1.2	
Viscosity	3 cPs	
pH	>12	
Quantity	Two (2)	Two (2)
Type	Vertical, Cylindrical	Vertical, Cylindrical
Bottom Configuration	Flat Bottom	Flat Bottom
Top Configuration	Dome Top	Dome Top
Minimum Useable Capacity (to invert of overflow)	6,000 gallons	3,000 gallons
Maximum Diameter	9'-2"	7'-6"
Maximum Overall Height	16’-4”	12’-0”
Connection Openings:		
1) Fill	N/A	3”
2) Fill/Dilution Water Fill	2"	N/A
3) Pump Suction	3"	2"
4) Recirculation Discharge	3”	N/A
5) Overflow	4"	3"
6) Vent	6"	4"
7) Manway Diameter (Top)	2'-0"	2'-0"
8) Ultrasonic Level Instrument	4”	N/A
9) High Level Probe	N/A	2”
10) Pressure (Level) Transmitter	N/A	2”
Heating Panels and Insulation	No	No
Materials of Construction for Metal Parts	Titanium	Titanium
Materials of Construction for Elastomers	Viton	Viton
Containment Wall Height**	52”	24”

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. American National Standards Institute (ANSI)

1. ANSI B16.5 – Pipe Flanges and Flanged Fittings.

B. American Society of Testing Materials (ASTM)

1. ASTM D638 – Standard Test Methods for Tensile Properties of Plastics.

2. ASTM D746 – Brittleness Temperature of Plastics and Elastomers by Impact.

3. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

4. ASTM D883 – Standard Definitions of Terms Relating to Plastics.

5. ASTM D1505 – Density of Plastics by the Density-Gradient Technique.

6. ASTM D1525 – Vicat Softening Temperature of Plastics.

7. ASTM D1693 – ESCR Spec. Thickness .125" F50-10% Igepal.

8. ASTM D1998 – Standard Specification for Polyethylene Upright Storage Tanks.

1.04 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals and Section 11000, Equipment General Provisions:

1. Installation list of the type and size being proposed, date installed, contact name, address and phone number

2. Warranty

3. Dimensions of tank, fittings and attachments

4. Wall thickness calculations per ASTM D 1998-06 using 600 psi design hoop stress @ 100°F

5. Location of fittings and attachments

6. A complete manufacturer's specification of the resin used

7. Weight of tanks

8. Statement that fabrication is in accordance with these Specifications

9. Instructions for handling, storage and installation of tanks.

10. Statement that materials and resin used are suitable for intended service.

11. Supporting information of UL tank manufacturing capabilities.

12. Supporting information of quality assurance program.

13. Supporting information of NSF 61 certification.

1.05 QUALITY ASSURANCE

A. Tanks shall be constructed by a firm that has at least ten years prior experience in construction of similar polyethylene tanks in similar applications.

B. Tanks shall be manufactured by a firm with a nationally accepted quality standard (i.e., ISO 9001 or equal).

1.06 WARRANTY AND GUARANTEE

A. Warranty and Guarantee shall be as specified in Section 11000 with the exception that the warranty period shall be for three (3) years.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The polyethylene storage tank(s) shall be as manufactured by Poly Processing Company, Snyder Industries, or equal.

2.02 MATERIALS AND CONSTRUCTION

A. The tanks shall be one-piece construction, rotationally molded, high density cross linked polyethylene or rotationally molded high density linear polyethylene. Tank shall have a specific gravity rating of 1.9 and shall be completely resistant to corrosion by the specified chemicals. The tank manufacturer shall be fully responsible for the structural design and integrity and watertightness of the tank, including all anchorages and connections. The tanks shall be capable of storing the specified chemical at temperatures up to 140°F.

B. Tank materials shall be NSF 61 certified for use in the treatment of drinking water. Tank manufacturer shall provide a low-density polyethylene liner if required for oxidation resistance for the specified chemicals.

C. The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent UV stabilizer and maximum of 0.60 percent. Pigments may be added as designated by the manufacturer, not to exceed 0.5 percent of dry blended or 2 percent if melt compound of the total weight of the tank.

D. The nominal properties of the material are as follows based on molded parts:

Property	ASTM Specification	Value for Crosslinked Polyethylene	Value for Linear Polyethylene
Density	D1505	.940 to .945 g/cc	.940 to .948 g/cc
ESCR Specification Thickness .125" F50 10% Igepal	D1693A	>1,000 hours	48 hours
Tensile Strength Ultimate 2 in/min	D638 Type IV Specification	2,830 psi	2950 psi
Elongation at Break 2 in/min.	D638	700 percent	>16.2 percent
Vicat Softening Temperature	D1525	240 degrees F	235 degrees F
Flextural Modulus	D790B	86,700 psi	129,000 psi

E. Design Requirements

1. The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187 inches thick.

   T = P x O.D./2 SD = 0.433 x S.G. x H x O.D./2 SD
   T = wall thickness
   SD = Hydrostatic design stress, PSI
   P = pressure (.433 x S.G. x H), PSI
   H = fluid head, ft.
   S.G. = specific gravity, g/cm^3
   O.D. = outside diameter, in.

2. The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application. The hydrostatic design stress is 600 PSI at 73 degrees Fahrenheit.

3. The hydrostatic design stress shall be derated for service above 100 degrees Fahrenheit and for mechanical loading of the tank.

4. The standard design specific gravity shall be 1.9.

5. The minimum required wall thickness for the cylinder shell must be sufficient to support its own weight in an upright position without any external support.

6. For dome top tanks, the top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The cover shall be provided with a manway and connections as described herein and as shown on the Drawings.

F. All tank capacities (volumes) specified shall include only that volume in the straight shell below the overflow pipe invert elevation.

G. Tanks shall be anchored to the concrete base in accordance with the manufacturer's recommendation.

H. The tanks shall be cylindrical and vertical in orientation with tank penetrations as indicated on the Contract Drawings.

2.03 CONNECTIONS AND ACCESSORIES

A. All connections/openings shall be flanged in accordance with ANSI B 16.5 150 pounds. Flanged connections, nozzles and openings shall be reinforced and shall be perpendicular to the straight shell of the tank. All piping connected to the tanks shall be perpendicular or parallel to the straight shell of the tanks. All piping into the tanks shall be supported such that no weight is placed on the tank and its connections.

B. Each tank outlet connection shall be provided with a flexible connector resistant to the specified chemical to allow for lateral and vertical expansion and contraction of the tank and to isolate the tank from pump and piping vibration. Flexible connectors shall be provided by the tank manufacturer.

C. Sidewall fittings above the chemical fill level shall be Schedule 80 PVC or CPVC bulkhead fittings. Sidewall fittings below chemical fill level shall be bolted one-piece polyethylene with backing ring designed to reduce stress on the fitting. Opening for pump suction line shall be Integrally Molded Flanged Outlet or other approved integrally molded full drain outlet. Bolts and gaskets shall be constructed of materials as shown in the Storage Tank Schedule.

D. Vent lines shall be top-mounted. Each vent shall be extended to the atmosphere and shall have a PVC vent insect screen. Vent lines shall be furnished as required.

E. Each storage tank fill line shall be provided with a cam lock type quick connect coupling with either a ball check valve located downstream or an integral check valve. The dry quick connections shall be provided between the delivery vehicle and the chemical storage tanks as shown on the Drawings. The dry quick connections shall be resistant to corrosion by the specified chemicals and shall be provided with fittings, quick lock coupling and dust cap and chain. Furnish and install a sign at each chemical fill station to identify the chemical filled.

F. Each tank shall be provided with an overflow pipe as specified and indicated on the Drawings. The tank manufacturer shall provide a Flange Insert Check Valve (FIV) for the overflow pipe of interior storage tanks as shown on the Drawings. The FIVs shall be complete with unions, liquid traps, and flanges as indicated in the Drawings. The valves shall be flanged check valve type inserted between two mating flanges. The valves shall be the same size as the tank overflow line. Each valve shall have a cracking pressure of 1/8 psig. The valve bodies shall be constructed of PVC, and valve seats and metal springs shall be as specified in the Tank Schedule. The flange insert valves shall be as manufactured by Check-All Valves Manufacturing Company, or equal.

G. Each tank shall be provided with level instruments in accordance with Division 17, Control and Information Systems. The mounting and connecting requirements shall be coordinated with the Instrument Supplier.

H. Each tank shall be provided with a top-mounted chemically-resistant manway with cover. Bolts shall be resistant to specified chemicals.

I. The tank shall be provided with a minimum of three lifting lugs integrally molded into the top head. Lifting lugs shall be capable of withstanding weight of an empty tank with a safety factor of 3 to 1.

J. Each tank shall be provided with a restraint system with necessary cable assemblies, anchor clips and anchor bolts. Restraint system shall be capable of withstanding seismic activity. Seismic restraint systems shall be designed to meet the 2012 Virginia Uniform Statewide Building Code and Chapter 13 of ASCE 7 - 10. For design purposes the manufacturer shall consider this facility to be a Site Class D, Risk Category III structure with a component importance factor (Ip) equal to 1.5. The tank manufacturer shall submit calculations to the Engineer indicating worst case vertical and lateral reactions to the anchors for verification that supporting structure can withstand reaction forces.

K. The tank shall be provided with a permanently attached label providing the following information:

- Type of material stored
- Concentration of material stored
- Specific gravity
- Maximum temperature
- Tank capacity
- Manufacturer
- Date of manufacture

2.04 PIPING SUPPORT

A. All horizontal sections of piping inside the containment area and trench shall be supported by thermoplastic pads at maximum 5 foot intervals as shown in the Drawings to prevent the piping from resting directly on concrete.

B. For vertical piping exterior to the tank, all pipe supports, hardware, accessories, etc., shall be provided for connections as shown in the Tank Schedule. Vertical piping into the tanks shall be supported every five feet and shall be parallel to the tank wall

C. All piping into the tanks shall be supported such that no weight is placed on the tank or its connections.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All piping, valves, fittings, conduit, wiring, etc., required to interconnect system components shall be as specified in Divisions 15 and 16.

B. Install 2 layers of roofing paper between each concrete pad and storage tank. The tanks shall be installed on level pads.

3.03 FIELD TESTING

A. Upon completion of installation of tank and prior to connecting piping, blind flanges or other suitable plugs shall be provided for all openings in the tanks, tanks shall be filled with clean water provided by the Owner from a source approved by the Design/Builder, and a leakage test shall be conducted as specified herein. Tanks shall be filled up to the top of the straight shell of the tank and left to sit over a 5-day test period. There shall be no leakage over the test period. Leakage around openings in the tanks shall be stopped by tightening nuts and bolts or replacing gaskets as required. Upon satisfactory completion of leakage test, tanks shall be drained, and water shall be disposed of in a suitable manner.

- END OF SECTION -

SECTION 15008

PVC/CPVC PIPE

PART 1 -- GENERAL

NOT USED

PART 2 -- PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC pipe and fittings shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein, in Section 15390 - Schedules, or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. PVC pipe shall be Type 1 Grade 1 conforming to ASTM D 1784 and D 1785. Fittings shall conform to the following standard specifications:

Socket Type (Schedule 40); ASTM D 2466
Socket Type (Schedule 80); ASTM D 2467

D. Provide flanged fittings of the same material as the specified pipe and material conforming to ANSI B16.5 at all valves and equipment with Teflon filled or natural rubber gaskets. Bolts shall be type 316 stainless steel for flanged joints. Flanges are not required at true (double) union valves.

E. Solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings. SOLVENT CEMENT FOR SODIUM HYPOCHLORITE SERVICE SHALL BE WELD-ON 724 AS MANUFACTURED BY IPS CORPORATION, OR EQUAL.

F. C900-Class 200 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chloride (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 14 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

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2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 914 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 985 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 200, DR 14 shall be ductile iron, bolted mechanical joint.

G. C900-Class 150 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chlorine (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 18 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2677. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 435 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 755 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 150, DR 18 shall be ductile iron, bolted mechanical joint.

H. PVC pressure rated pipe (PR 160) shall be in sizes between 1 1/2 inches and 12 inches and shall conform to all the requirements of ASTM D1784 and ASTM D2241 and shall be a minimum of SDR 26 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (1± inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed materials shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 135 psi for all sizes when tested in accordance with ASTM D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 500 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. The pipe shall be designed to pass for 1000 hours a sustained test pressure of 340 psi when tested in accordance with ASTM D1598, as referenced in ASTM D2241.

I. Fittings for PR 160, SDR 26 shall be PVC and designed for the pipe being supplied.

J. Acrylonitrile-butadiene-styrene (ABS) shall conform to the requirements of ASTM D 2661. Pipe and fittings shall have socket type couplings with solvent cement joints. Solvent cement shall conform to ASTM D 2235.

K. Type PSM polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of ASTM D 3034 with a maximum SDR of 35. Pipe and fittings shall have bell and spigot ends with O-ring rubber gasketed, compression type joints. Joints shall conform to the requirements of ASTM Specification D 3212. Reruns of reclaimed materials shall not be accepted. Unless indicated otherwise, PVC wall pipes shall be provided for all piping passing through exterior walls. Wall pipes shall have a water stop solvent-welded to the pipe. Each wall pipe shall be of the same class and type as the piping to which it is joined.

L. Perforated and closed drainage pipe and fittings shall be rigid PVC pipe, Schedule 40 unless otherwise shown or specified with solvent welded type joints, or approved equal. Pipe shall be slotted or have two rows of 1/4-inch diameter holes spaced 4-inches apart along the circumference of the pipe. Longitudinal spacing of holes shall be 5-inches maximum.

2.02 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

A. CPVC shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. CPVC pipe shall be Type 4, Grade 1, Schedule 80, conforming to ASTM D 1784 and ASTM F 441. CPVC fittings shall be socket type conforming to ASTM F 439.

D. Solvent cement for socket type joints shall conform to ASTM F 493 for CPVC pipe and fittings. SOLVENT CEMENT FOR SODIUM HYPOCHLORITE SERVICE SHALL BE WELD-ON 724 AS MANUFACTURED BY IPS CORPORATION, OR EQUAL.

- END OF SECTION –

SECTION 15030

PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install all components of the system for identification of piping and equipment as specified hereinafter.

B. Submit a schedule of the colors and designations proposed in accordance with Section 01300, Submittals, and this Section. A minimum of four (4) color charts with cross-references to the colors listed herein shall be included with the Submittal.

PART 2 -- PRODUCTS

2.01 PIPING IDENTIFICATION LEGEND

A. Apply identification legends to all types and sections of piping as shown on the Drawings or as designated by the Design/Builder. Such legends shall be in the form of plain block lettering giving the name of the pipe content in full or abbreviated form, and showing the direction of flow by arrows. All lettering and arrows shall be of the plastic snap-on type, Seton nameplate "setmarks", or equal, or they shall be formed by stenciling in an approved manner using white or black as directed and shall have an overall height in inches in accordance with the following table:

Diameter of Pipe or Pipe Covering	Height of Lettering
3/4 to 1-1/4 inches	1/2-inches
1-1/2 to 2-inches	3/4-inches
2-1/2 to 6-inches	1-1/4-inches
8 to 10-inches	2-1/2-inches
Over 10-inches	3-1/2-inches

B. Identification lettering and arrows shall be placed as directed by the Design/Builder, but shall generally be located each fifteen (15) feet in pipe length, and shall be properly inclined to the pipe axis to facilitate easy reading.

- END OF SECTION –

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SECTION 15095

VALVES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.

B. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated.

C. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.

1.02 SUBMITTALS

A. Shop Drawings conforming to the requirements of Section 01300 - Submittals are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn using a ladder-type format in accordance with JIC standards. Shop Drawings for pneumatically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.

C. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

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PART 2 -- PRODUCTS

2.01 STRAINERS

A. PVC and CPVC y-strainers shall be provided in PVC and CPVC piping and as shown on the Drawings. Strainer shall be provided with PVC or CPVC body and end cap, EPDM or Viton seal as required for the chemical service, and 20 mesh screen. Temperature rating

shall be 30°F to 140°F, and pressure rating shall be 150 psi @ 70°F, non-shock. PVC and CPVC y-strainers shall be as manufactured by Asahi/America, Hayward, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Except where noted otherwise herein, all valves shall be installed and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes, and shall bear no stresses due to loads from the adjacent pipe.

B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated and cylinder operated valves shall be tested for control operation as directed by the Design/Builder.

C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.

D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Design/Builder. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.

- END OF SECTION -

SECTION 15100

VALVE OPERATORS AND ELECTRIC VALVE ACTUATORS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions.

B. Reference Section 15390 – Schedules for additional information on valves and operators/actuators.

C. The electric valve actuators shall meet the signal requirements described in Section 17920 – Control System Input/Output Schedule and Section 17950 – Functional Control Descriptions.

D. Valve operators and electric valve actuators shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valves will be subjected.

E. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Design/Builder. There shall be no mounting restrictions on the electric valve actuator.

F. The valve operators and electric actuators shall be the full and undivided responsibility of the valve manufacturer in order to ensure complete coordination of the components and to provide unit responsibility.

1.02 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals and Section 11000, Equipment General Provisions:

1. Certification that the force required to operate all valves is as specified herein.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Electric actuators shall be provided where specified in the Valve Schedule in Section 15390 – Schedules.

B. Manual operators shall be provided on all valves which do not receive electric actuators. Manual operator type shall be as specified herein and as shown on the Drawings.

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2.02 ELECTRIC OPERATORS FOR PVC/CPVC VALVES

A. Automatic electric operators shall be provided for PVC/CPVC valves where specified and/or as shown on the Drawings. Operators shall operate on 120 volt AC, single phase, 60 hertz power and be equipped with solid state electronic internal controls. Motors shall be brushless, capacitor-run, reversing type, suitable for high duty cycle applications and shall be specifically designed for open/close service. Motors shall be provided with integral thermal overload protection with auto-reset. Operator gears and shafts shall be constructed of heat treated high-alloy steel. Operator output shaft shall be electro-less nickel plated. Operator gear trains shall be permanently lubricated. The gear train shall withstand operator stall torque. Operator enclosures shall be NEMA 4. Operators shall be provided with internally wired, thermostatically controlled enclosure heaters to maintain an enclosure temperature of at least 40 degrees F. Operators shall be provided with positive visual position indication markings permanently affixed to the operator body and final output shaft. Operator drive output shall be provided with a declutchable manual override. A manual lever shall be provided for manual valve positioning. Operators shall be failsafe, utilizing a mechanical spring with a clutch mechanism to uncouple the motor during spring return operation, allowing the spring to relax and either open or close the valve. Selection of either fail-opened or fail-closed shall be made by selection of field wiring terminals.

B. Independently adjustable cam-operated position limit switches shall be provided with dry contacts for remote fully opened and fully closed valve position indication. Operators shall respond to external dry contact open/close controls. The actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact open or close signal unless a stop signal is received. The all actuator control circuitry, including latching circuitry, shall be internal to the valve actuator. Valve control circuits and components mounted in a separate enclosure external to the valve actuator assembly will not be permitted. Connections for external remote controls shall be powered from an internal 24VDC or 120VAC power supply. Limit switches shall be rated for 15 amps at 120 VAC. Valve remote status shall also be provided as specified in Section 17950. Coordinate operator controls with the functional requirements specified in Section 17950 – Functional Control Descriptions.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for electric actuators:

Service	**Number of Trips**	**Number of Days/Trip**
Installation and Testing	1	1
Startup and Training	1	1

- END OF SECTION -

SECTION 15114

MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

PART 2 -- PRODUCTS

2.01 SOLENOID VALVES

A. Three-way two-position solenoid valves shall be of the two coil type. Both coils shall be normally closed and each shall open independently when energized. The valve shall be of forged brass-body and bonnet with a Buna "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi and shall be as manufactured by ASCO Valves, Automatic Switch Co., or equal, for 120V, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight.

B. Two-way solenoid valves shall be normally closed and shall open when the solenoid is energized, unless otherwise noted. The valve shall be of forged brass-body and bonnet with a BUNA "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi, and shall be as manufactured by ASCO Valves, Automatic Switch Co., or equal, for 120 volt, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight.

C. Four-way two-position solenoid valves shall be of the single coil type and shall be normally closed and shall open when the solenoid is energized (i.e. fail closed). The remainder of the four-way two-position solenoid valves shall be of the two coil type. Both coils shall be normally closed and each shall open independently when energized. The valve shall be of forged brass-body and bonnet with a Buna "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi and shall be as manufactured by ASCO Valves, Automatic Switch Co. or equal, for 120V, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight. The solenoid valve shall be provided with a manual override.

2.02 PRESSURE RELIEF, REDUCING AND REGULATING VALVES

A. Pressure relief valves 1 inch and under shall have bronze bodies and above 1 inch shall have cast iron bodies, bronze fitted with grey iron diaphragm base and straight chamber and phosphorus bronze diaphragm. The ratio of the diaphragm area to the seat area shall be adequate to overcome sticking. The seat disc shall be of non-corrodible, non-sticking material capable of withstanding extreme temperatures. Valves shall permit dismantling

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for repairs and cleaning without being removed from the line. Valves shall conform to the ASME Boiler Construction Code as approved by both the Underwriters Lab., and the National Board of Boiler Pressure Vessel Inspectors. All valves shall be designed for a minimum working pressure at least equal to the working pressure of the corresponding pipeline and shall have adjustment over a range of at least 20 percent above or below the required setting pressure of the installation.

B. Pressure relief valves (non-potable water service) shall be diaphragm activated, single seat, pilot operated and shall maintain a constant upstream pressure by relieving excess pressure. The valve shall be normally closed and shall open to maintain the required back pressure when the valve inlet pressure reaches the pilot control set point. The initial pilot control setting shall be 78 psi. The stem shall be stainless steel and shall be guided through the center for 100% of the stem travel. The main valve throttling plug shall be provided with V-port sections to insure precise control at low flow rates. All internal metal parts shall be bronze or stainless steel. The control pilot shall be direct acting, spring loaded, and adjustable with bronze body and stainless steel trim. The diaphragm and seat disc shall be BUNA-N. The valve shall be of the angle or globe pattern as shown on the Drawings and shall be fully repairable in the line. The pressure relief valve shall be the Model 428CP as manufactured by Bailey, Fresno, California, or equal.

C. Pressure reducing and regulating valves (water service) 1/2-inch and under shall be bronze and above 1/2-inch shall have cast iron bodies bronze fitted. Valves shall be constructed with full openings and capable of supplying a full flow of water at reduced pressure. Valves shall be so constructed that repairs can be made without removing the valves from the line. The valves shall be equipped with a sedimentation chamber and stainless steel or bronze strainer. Pressure reducing and regulating valves shall be the back pressure sustaining type and shall operate over a range at differential pressures from 5 to 120 psi. Reducing and regulating valves shall meet or exceed the requirements of ASSE 1003 (ANSI A112.26.2) and shall be Model 616R, as manufactured by Fisher Controls, WATTS Series 25 AUB, GA, or equal.

2.03 HOSE VALVES

A. Hose valves shall be 300 lbs. non-shock cold water angle or globe valves, Fig. 112/113 as manufactured by Jenkins Valve Co., or equal. Valves shall be bronze bodied with Buna-N or neoprene disc and bronze bonnet and packing nut. Valve stem, gland, and lock nut shall be brass. Valve shall be provided with 3 inch diameter malleable iron handwheel, cap and chain, and 3/4-inch or 1-inch (or 2 inch near flushing connections) hose connection outlet.

- END OF SECTION -

SECTION 15115

PVC/CPVC VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

A. Valves provided for chemical service shall be constructed of materials suitable for the intended service. PVC valves shall be provided in PVC piping and CPVC valves shall be provided in CPVC piping.

B. Valve bodies shall be constructed of Class 12454-B PVC or Class 23447-B CPVC.

C. Acceptable elastomer materials for each chemical service shall be as follows:

Chemical	**Acceptable Elastomers**
Drain	EPDM, Viton, Teflon, Buna N, Hypalon, Neoprene
Sodium Hypochlorite	Viton, Teflon
Water (NPW, PW)	EPDM, Viton, Teflon, Buna N, Hypalon, Neoprene

2.02 PVC/CPVC BALL VALVES

A. Ball valves shall have 125 psi minimum non-shock cold water pressure rating. Valves shall have integral unions with screwed ends or solvent weld ends as required and shall have removable handles. Valves shall be manufactured by Chemtrol Products Division of NIBCO, Inc., IPEX Industrial Thermoplastics, Hayward Industrial Products, or equal.

B. Ball valves for sodium hypochlorite service shall be single-seal type valves. The ball shall be drilled by the valve manufacturer at the factory and installed with vent hole facing upstream. The pressure rating shall be a minimum of 125 psi at 70°F.

2.03 PVC/CPVC BALL CHECK VALVES

A. Ball check valves shall have 150 psi minimum non-shock cold water pressure rating and integral union with screwed ends or solvent weld ends. Valves shall be as manufactured by Chemtrol Products Division of NIBCO, Inc., Hayward Industrial Products, or equal.

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2.04 PVC/CPVC DIAPHRAGM VALVES

A. Diaphragm valves shall have flanged ends and shall have a position indicator and adjustable travel stop. Diaphragm valves shall be similar to Type G, as manufactured by ASAHI/AMERICA, Hayward Industrial Products, or equal.

2.05 PVC/CPVC BUTTERFLY CHECK VALVES

A. Butterfly check valves shall have flanged ends or be wafer-style, as shown on the Drawings. Body and internal materials shall be PVC or CPVC, and elastomer materials shall be completely resistant to corrosion by the chemical being conveyed. Valves shall be elastomer hinged check valves with unrestricted full-port seatless design, tight shutoff, and the ability to be mounted in any position. Valves shall be Techno Multi-Purpose Check Valves by Cameron, or equal.

- END OF SECTION -

SECTION 15390

SCHEDULES

PART 1 -- GENERAL

1.01 PIPING SYSTEM SCHEDULES

A. Piping requirements for this Section are outlined on the Drawings, and in the Piping System Schedule. In the absence of a specified test pressure, pipe shall be tested at a pressure 50 percent greater than the normal operating pressure as determined by the Engineer or 10 psig, whichever is greater unless the Schedule indicates that no test is required.

B. If the pipe material is not shown on the Piping System Schedule or otherwise specified, the following materials shall be used:

Pipe Size	Material	Type of Joint	Class/Design	Test Pressure
4-in and larger	DIP	Flanged (Exposed)	Class 53	(1)
		Restrained (Buried)	Pressure Class 350	
Less than 4-in	PVC	Socket	Sch 80	(1)
(1) Test at 150 percent of normal operating pressure or 10 psi, whichever is greater.				

C. Non-critical gravity lines such as drains, floor drains, roof drains, etc., do not typically require a pressure test

1.02 VALVE SCHEDULES

A. All valves shall be tagged by the manufacturer according to the control valve designations listed in the Schedule.

B. Valves not listed in the valve schedule(s) shall be manually operated, unless otherwise shown on the Drawings.

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PIPING SYSTEM SCHEDULE					
PIPE IDENTIFICATION	MATERIAL	TYPE OF JOINT	CLASS/DESIGN	RESTRAINT SYSTEM DESIGN PRESSURE[1]	TEST PRESSURE
D[2]	< 4" PVC	SOLVENT WELDED	SCH 80	N/A	N/A
NPW, PW	< 4" PVC	SOLVENT WELDED	SCH 80	150 PSI	100 PSI
SH	PVC (BURIED, INTERIOR) CPVC (EXPOSED)	SOLVENT WELDED/FLANGED	SCH 80	150 PSI	100 PSI

1. DESIGN PRESSURE SHALL BE USED TO DETERMINE THE SIZE, NUMBER, MATERIAL AND DIMENSIONS OF TABS AND THREADED-RODS FOR PIPING SPECIFIED OR SHOWN TO HAVE THREADED-RODS FOR THRUST RESTRAINT.
2. DRAIN PIPING SHALL BE PLUGGED AT OPEN END AND FILLED COMPLETELY TO TEST FOR LEAKS.

PIPING SYSTEM SCHEDULE DESIGNATIONS

D	DRAIN	PW	POTABLE WATER
NPW	NON-POTABLE WATER	SH	SODIUM HYPOCHLORITE

ELECTRICALLY OPERATED VALVE SCHEDULE								
CONTROL VALVE DESIGNATION	TYPE VALVE	TYPE OPERATOR	SIZE (INCHES)	FLOW (GPM)	MAXIMUM DIFF. PRESSURE (PSI)	CLASS	SERVICE	LOCATION
RECIRC/ TRANSFER VALVE 1	3-WAY BALL	OPEN TO LINE OR BRANCH	2-1/2”	100	20	150	HYPOCHLORITE RECIRC/ TRANSFER VALVE NO. 1	CHEMICAL BUILDING 2
RECIRC/ TRANSFER VALVE 2	3-WAY BALL	OPEN TO LINE OR BRANCH	2-1/2”	100	20	150	HYPOCHLORITE RECIRC/ TRANSFER VALVE NO. 2	CHEMICAL BUILDING 2
BULK TANK CONNECTOR VALVE	BALL	OPEN/CLOSE	3”	100	20	150	HYPOCHLORITE BULK TANK CONNECTION ISOLATION VALVE	CHEMICAL BUILDING 2

- END OF SECTION -

SECTION 16000

BASIC ELECTRICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental, to the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Design/Builder shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.

B. THE DESIGN/BUILDER SHALL REFERENCE THE FUNCTIONAL DESCRIPTIONS AND OTHER REQUIREMENTS FOUND IN DIVISION 17, CONTROL AND INFORMATION SYSTEMS, FOR ADDITIONAL REQUIREMENTS PERTAINING TO WORK UNDER THIS CONTRACT. THE FUNCTIONAL DESCRIPTIONS REFERENCED HEREIN SHALL BE CONSIDERED AS PART OF THE WORK REQUIRED UNDER THIS CONTRACT.

C. THE DESIGN/BUILDER SHALL BE RESPONSIBLE FOR ALL INTERCONNECTING DEVICES, CONDUIT, WIRE, AND APPURTENANCES NOT FURNISHED BY OTHERS BUT REQUIRED FOR THE OPERATION OF EQUIPMENT AS DESCRIBED IN THE FUNCTIONAL DESCRIPTIONS WHETHER SPECIFICALLY SHOWN ON THE DRAWINGS OR NOT.

D. The scope of work for this project primarily includes, but is not limited to, the following:

1. Modifications to existing motor control equipment.

2. Modifications to existing electrical distribution system.

3. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, and other pertinent components.

4. Furnish and install all low voltage and cable resulting in a complete and operable electrical system.

5. Furnish and install new wiring devices.

6. Other electrical work as specified herein and indicated on the Drawings.

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E. Maintaining the operation of these facilities during the duration of the construction period is essential and required. The Design/Builder shall furnish and install temporary equipment as required to maintain facility operation.

F. All electrical equipment shall conform to the applicable NEMA specifications. All electrical equipment shall be properly identified in accordance with these Specifications and Contract Drawings. All panelboards, starters, control panels, cabinet enclosures, junction boxes, pull boxes, and equipment switches shall be identified per the requirements of Section 16195 – Electrical Identification.

G. All materials, equipment, sizes and capacities of electrical equipment incorporated in the project shall conform to the latest requirements of the current National Electric Code, the National Electrical Manufacturer's Association, the State and local electrical codes, and to applicable rules and regulations of the local electrical utility serving the project.

H. All material and equipment must be the product of an established, reputable, and approved manufacturer; must be new and of first class construction; must be designed and guaranteed to perform the service required; and must bear the label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.

I. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.

J. Where the Design/Builder's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Design/Builder shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Design/Builder's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.

K. Furnish and install controls for each piece of equipment requiring controls under this Contract. The controls shall be the size and type recommended by the manufacturer for the application and as otherwise specified or indicated on the Drawings. Refer to Divisions 1 and 17 of the Specifications for control, connection and coordination descriptions and requirements.

L. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.

M. All electrical components and systems, including electrical equipment foundations, shall be designed to resist operational forces as well as lateral sway and axial motion from seismic and thermal forces.

1.02 DRAWINGS

A. The Design/Builder shall furnish, install, and place in satisfactory condition ready for operation, all conduits, cables, and all other material needed for the complete lighting, power, control and other electrical systems shown or indicated in the Contract Drawings. Additional conduits and the required wiring shall be installed by the Design/Builder wherever needed to complete the installation of the specific equipment furnished.

1.03 EQUIPMENT LOCATION

A. The Drawings show the general location of feeders, transformers, outlets, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Design/Builder shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly; furnishing such fittings, junction boxes, and accessories as may be required to meet such conditions. The Design/Builder shall refer to the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Design/Builder shall verify all equipment dimensions to ensure that proposed equipment will fit properly in spaces indicated.

1.04 LOCAL CONDITIONS

A. The Design/Builder shall examine the site and become familiar with conditions affecting the work. The Design/Builder shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction. All costs, both temporary and permanent to connect all utilities, shall be included in the Bid. The Design/Builder shall be responsible for scheduling and coordinating with the local utility for temporary and permanent services.

B. In addition, the Design/Builder shall relocate all duct banks, lighting fixtures, receptacles, switches, boxes, and other electrical equipment as necessary to facilitate the Work included in this project. Costs for such work shall be included in the Bid.

1.05 SUBMITTALS

A. The Design/Builder shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

4. Special Tools List

5. Proposed Testing Methods and Reports of Certified Shop Tests.

6. Reports of Certified Field Tests.

7. Manufacturer’s Representative’s Certification.

B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements.

C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Design/Builder has provided no information.

D. Some individual Division 16 specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Design/Builder AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

1.06 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the Insurance Rating Organization having jurisdiction, the serving electrical utility company, the latest edition of the National Electrical Code (NEC), the National Electric Manufacturers Association (NEMA), the Institute of Electrical and Electronic Engineers (IEEE), the Insulated Cable Engineers Association (ICEA), the American Society of Testing Materials (ASTM), the American National Standards Institute (ANSI), the requirements of the Occupational Safety Hazards Act (OSHA), and all other applicable Federal, State and local laws and/or ordinances.

2. All material and equipment shall bear the inspection labels of Underwriters Laboratories, Inc., if the material and equipment is of the class inspected by said laboratories.

3. All work shall be in accordance with local codes.

B. Nonconformance

1. Any paragraph of requirements in these Specifications, or Drawings, deviating from the rules, requirements and Specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Design/Builder shall be held responsible for adherence to all rules, requirements and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or Specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Design/Builder from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

1. Upon completion of the work, the Design/Builder shall obtain certificate(s) of inspection and approval from the National Board of Fire Underwriters or similar inspection organization having jurisdiction and shall deliver same to the Engineer and the Owner.

1.07 TESTS

A. Upon completion of the installation, the Design/Builder shall perform tests for operation, load (Phase) balance, overloads, and short circuits. Tests shall be made with and to the satisfaction of the Owner and Engineer.

B. The Design/Builder shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Design/Builder at no cost to the Owner. The Design/Builder shall show by demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.

C. The grounding system shall be tested to assure continuity and compliance with the contract requirements.

D. Insulation resistance testing of all incoming and outgoing cables for switchgear, motor control centers, lighting and power distribution panelboards, and similar equipment shall be done after the cables are in place and just prior to final terminations. All data shall be recorded, as per Exhibit "A", attached to the end of this Section. See Section 16123 for detailed requirements.

E. Feeder circuits shall be tested with the feeder conductors disconnected from the supplied equipment. Each individual power circuit shall be tested at the panel or motor control center with the power equipment connected for proper operation.

F. The equipment to be tested shall include, but not be limited to, the following:

- Motor Control Equipment
- Conduit System
- Cable and Wire
- Grounding System

G. Refer to each specific specification section for detailed field tests.

H. The Design/Builder shall complete the installation and testing of the electrical installation at least two (2) days prior to the start-up and testing of all other equipment. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Design/Builder shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.

I. Before each test commences, the Design/Builder shall submit a detailed test procedure, and also provide test engineer resume, manpower and scheduling information for the approval by the Engineer. In addition, the Design/Builder shall furnish detailed test procedures for any of his equipment required as part of the field tests of other systems.

J. Just prior to the final acceptance of a piece of equipment, the Design/Builder shall perform an infrared inspection to locate and correct all heating problems associated with that electrical equipment. The infrared inspection shall include both digital and IR pictures which shall be submitted to the Owner for record purposes.

The infrared inspection shall apply to all new equipment and existing equipment that is in any way modified under this Contract. All heating problems detected with new equipment furnished and installed under the Scope of this Contract shall be corrected by the Design/Builder. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Design/Builder.

Any problems detected with portions of existing equipment that were not modified under this Contract are not the responsibility of the Design/Builder. Despite the Design/Builder not being held responsible for these problems, the Design/Builder shall report them to the Owner and Engineer immediately for resolution.

1.08 DOCUMENTATION

A. The work requirements of this Section is in addition to and does not supersede testing and adjusting specified in other portions of the Contract Documents. The Design/Builder shall submit to the Engineer test records and reports for all testing.

1.09 PROTECTIVE DEVICE SETTING AND TESTING

A. The Design/Builder shall provide the services of a field services organization to adjust, set, calibrate and test all protective devices in the electrical system. The organization shall be a subsidiary of or have a franchise service agreement with the electrical equipment manufacturer. The qualifications of the organization and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted.

B. All protective devices in the electrical equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.

C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.

D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers recommended test devices and procedures.

E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.

F. When completed, the Design/Builder shall provide a comprehensive report for all equipment tested indicating condition, readings, faults and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.

G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

1.10 SCHEDULES AND FACILITY OPERATIONS

A. Since the testing required in Article 1.07 above shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules must be submitted to the Engineer for review and approval one (1) month prior to any work beginning. When testing has been scheduled, the Engineer must be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of facility equipment must be coordinated with the Owner/Engineer so as not to affect proper facility operations.

B. At the end of the workday, all equipment shall be back in place and ready for immediate use should a facility emergency arise. In addition, should an emergency condition occur during testing, at the request of the Owner, the equipment shall be placed back in service immediately and turned over to Owner personnel.

C. In the event of accidental shutdown of Owner equipment, the Design/Builder shall notify Owner personnel immediately to allow for an orderly restart of affected equipment.

1.11 MATERIALS HANDLING

A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material shall be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of equipment, they shall be temporarily connected to a power source during storage.

(EXHIBIT A)
TEST DATA - MEGOHMS
TEST NO. ____

Date:			Company:				
Time:			Location:				
Circuit:	Circuit Length:	Aerial:	Duct:	Buried:	No. of Conduc-tors	Size:	AMG MCM Shld:
Insulation Material:			Insulation Thickness:		Voltage Rating:		Age:
Type: _____Pothead _____Terminal					Location: Indoors_____ Outdoors_____		
Number and Type of Joints:							
Recent Operating History:							
Manufacturer:							
State if Potheads or Terminals were grounded during test:							
List associated equipment included in test:							
Miscellaneous Information:							

(EXHIBIT A)
TEST DATA - MEGOHMS
TEST NO. ____

Part Tested:Test Made:_____
Hours/Days:_____
After Shutdown:_____

Grounding Time:Dry Bulb Temperature:_____
Wet Bulb Temperature:_____

Test Voltage:	Equipment Temperature: _____ How Obtained: _____ Relative Humidity: _____ Absolute Humidity: _____ Dew Point: _____

Megohmmeter: Serial Number: _____ Range: _____
Voltage: _____ Calibration Date_____

Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground	Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground
3 Minute				5 Minutes			
2 Minute				6 Minutes			
3/4 Minute				7 Minutes			
1 Minute				8 Minutes			
2 Minutes				9 Minutes			
3 Minutes				10 Minutes			
4 Minutes				10/1 Minutes			
				Ratio			

Remarks:

PART 2 -- PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.

C. All equipment and materials shall be new, unless indicated or specified otherwise.

D. The Design/Builder shall submit proof if requested by the Engineer that the materials, appliances, equipment, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc., in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming with this requirement.

2.02 SUBSTITUTIONS

A. Unless specifically noted otherwise a, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition. The Design/Builder, in such cases may, at his option use any article, device, product, material, fixture, or item of equipment which in the judgment of the Engineer, expressed in writing, is equal to that specified.

2.03 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each piece of electrical equipment that is installed indoors. Rubber mats shall not be installed outdoors. The mat shall be long enough to cover the full length of the equipment. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes, or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

B. Mats shall be provided for the following equipment:

- PLC/RTU Enclosures
- Motor Control Centers

2.05 CABINETS AND ENCLOSURES

A. Ratings

1. Unless specified otherwise in these Specifications or shown on the Drawings, cabinets and enclosures shall be:

a. NEMA 1A (gasketed) when located in environmentally controlled spaces such as control rooms, electric rooms, and similar locations.

b. NEMA 12 when located in dry, indoor process areas.

c. NEMA 4X stainless steel when located in damp/wet, indoor, or corrosive process areas.

d. NEMA 4X stainless steel for all outdoor locations.

e. Suitable for the specific Class, Division, and Group when located in hazardous locations.

B. Construction - Steel

1. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

2. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be stainless steel. Door latches for NEMA 4X cabinets and enclosures shall be all stainless steel, fast operating clamp assemblies that do not require bolts or screws to secure. A hasp and staple shall be provided for padlocking. Interior panels shall be provided. Each enclosure shall have a print pocket.

3. NEMA 1A and 12 enclosure finish shall be white enamel interior, light grey enamel, ANSI 61 exterior, over phosphatized surfaces. Interior panels shall be white enamel. Special finishes and colors shall be furnished as required.

4. NEMA 4X enclosures and enclosures suitable for hazardous locations shall be unpainted.

PART 3 -- EXECUTION

3.01 CUTTING AND PATCHING

A. Coordination

1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.

B. Damage

1. The Design/Builder shall perform all chasing, channeling, drilling and patching necessary to the proper execution of his Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Design/Builder's expense. If, in the Engineer's judgment, the repair of damaged equipment would not be satisfactory, then the Design/Builder shall replace damaged equipment at his own expense.

C. Existing Equipment

1. Provide a suitable cover or plug for openings created in existing equipment as the result of work under this Contract. For example, provide round plugs in equipment enclosures where the removal of a conduit creates a hole and the enclosure. Covers and plugs shall maintain the NEMA rating of the equipment enclosure. Covers and plugs shall be watertight when installed in equipment located outdoors.

3.02 CORROSION PROTECTION

A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Design/Builder shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

- END OF SECTION -

SECTION 16111

CONDUIT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Under this Section, the Design/Builder shall furnish and install all conduits and conduit fittings to complete the installation of all electrically operated equipment as specified herein and as required.

B. The Design/Builder shall install both exposed and concealed conduits in such a manner to avoid all interferences.

C. Reference Section 16000 – Basic Electrical Requirements and Section 16195 – Electrical Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

2.02 CONDUITS

A. Unless specified otherwise herein, or indicated on the Drawings, all conduits shall be rigid, Schedule 80 PVC.

All components of the conduit system shall be of the same material of construction. Conduit systems shall include fittings, couplings, connectors, and other components compatible with and approved for such systems.

B. Liquid-Tight Flexible Non-Metallic Conduit

1. Liquid-tight flexible non-metallic conduit (LFNC) shall be constructed of PVC. LFNC shall be UL listed. LFNC shall have an extruded moisture and oil-proof PVC jacket. LFNC shall be Ultratite Type NM as manufactured by Southwire, Type NM as manufactured by Electri-Flex, Anaconda Type NMUA by Anamet Electrical, Inc., or equal.

2. Watertight connectors shall be used with liquid-tight flexible non-metallic conduit on both ends. LFNC shall be used to connect all vibrating equipment installed in sodium hypochlorite storage and transfer areas as specified herein, and other applications as directed by the Engineer or as indicated on the drawings.

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C. Rigid Nonmetallic Conduit

1. Rigid nonmetallic conduit shall be Schedule 80 polyvinyl chloride (PVC), 90°C, UL listed and shall conform to NEMA TC-2. Fittings and conduit bodies shall conform to NEMA TC3.

2. Rigid non-metallic conduit shall be as manufactured by Carlon, Triangle Conduit and Cable, Cantex, Inc., or equal.

D. Conduit Fittings

1. Fittings for all conduit types shall conform to UL 467 and UL 514 as applicable.

2. Fittings for conduit installed in wet locations and underground shall provide a watertight joint.

3. Fittings or bushings shall be installed in easily accessible locations.

4. Where exposed conduits pass across structural expansion joints, approved weatherproof telescopic type expansion fittings shall be used. Fittings shall be OZ/GEDNEY Type AX, Crouse-Hinds Type XJG, or equal, watertight, and permit movement up to 4 inches. Each fitting shall be equipped with approved bonding jumpers around or through each fitting.

   Where embedded conduits pass through expansion joints, approved watertight, concrete-tight deflection/expansion fittings shall be used. Fittings shall compensate for movement of ¾-inch from the normal in all directions. Fittings shall be OZ/GEDNEY Type DX, Crouse-Hinds Type XD, or equal.

5. Conduit fittings ("condulets") shall be used on exposed conduit work for changes in direction of conduit runs and breaking around beams. "Condulets" shall be cast Schedule 80 PVC, as manufactured by Crouse-Hinds, OZ/Gedney, Appleton Company, or equal. Coated fittings and boxes shall be used with coated conduit in all chemically aggressive areas or where called for on the Drawings. Covers shall be of a design suitable for the purpose intended. In damp areas, the outside condulets shall be made watertight. Install all condulets with the covers accessible. Use proper tools to assemble conduit system to prevent injury to the plastic covering. No damage to the covering shall be permitted.

PART 3 -- EXECUTION

3.01 CONDUIT AND FITTINGS

A. Unless otherwise specified herein or indicated on the Drawings, the minimum size conduit shall be 3/4 inch for exposed work and 1 inch for conduit encased in concrete or mortar.

B. Conduit shall be installed concealed unless otherwise indicated or specified. Conduit may be run exposed on walls only where concealing is not practical, or at the direction of the Engineer.

C. Where exposed, maintain a minimum distance of 6 inches from parallel runs of flues or water pipes. Conduit runs shall be installed in such locations as to avoid steam or hot water pipes. A minimum separation of 12 inches shall be maintained where conduit crosses or parallels hot water or steam pipes.

D. A non-metallic raceway containing instrumentation cable (if specifically allowed herein) where installed exposed shall be installed to provide the following clearances:

1. Raceway installed parallel to raceway conductors energized at 480 through 208 volts shall be 18 inches and 208/120 volts shall be 12 inches.

2. Raceway installed at right angles to conductors energized at 480 volts or 120/208 volts shall be 6 inches.

E. For floor mounted equipment, conduit may be installed overhead and dropped down, where underfloor installation is not practical. Groups of conduits shall be uniformly spaced, where straight and at turns. Conduit shall be cut with a hacksaw or an approved conduit-cutting machine and reamed after threading to remove all burrs. Securely fasten conduit to outlets, junction and pull boxes to effect firm electrical contact. Join conduit with approved couplings. Conduits shall be freed from all obstructions.

F. Empty conduit systems shall be furnished and installed as indicated on the Drawings and shall have pull ropes installed. The polyethylene pull ropes shall be ¼" diameter, minimum. Not less than 12 inches of slack shall be left at each end of the pull rope.

G. Each piece of conduit installed shall be free from blisters or other defects. Each piece installed shall be cut square. Conduit connections shall be made with standard coupling and the ends of the conduit shall butt tightly into the couplings.

H. All bends shall be made with standard factory conduit elbows or field bent elbows. Field bending of conduit shall be done using tools approved for the purpose. Heating of conduit to facilitate bending is prohibited. Field bends shall be not less than the same radius than a standard factory conduit elbow. Bends with kinks shall not be acceptable.

The equivalent number of 90° bends in a single conduit run are limited to the following:

1. Runs in excess of 300 feet: 0

2. Runs of 300 feet to 201 feet: 1

3. Runs of 200 feet to 101 feet: 2

4. Runs of 100 feet and less: 3

I. Conduit shall be supported in accordance with the NEC and shall be installed parallel with or perpendicular to walls, structural members, or intersections of vertical planes and ceilings with right angle turns consisting of fittings or symmetrical bends. Conduits shall be supported within 1 foot of all changes in direction. Supports shall be approved pipe straps, wall brackets, hangers or ceiling trapeze. J. In no case shall conduit be supported or fastened to another pipe or installed to prevent the removal of other pipe for repairs. Fastenings shall be by expansion bolts on concrete; by machine screws, welded threaded

studs, or spring-tension clamps on steel work. Powder actuated fasteners may only be used to make connections where the use of this equipment complies with safety regulations and for structures in Seismic Design Categories A or B, unless the fasteners are approved for seismic use. Wooden plugs inserted in masonry and the use of nails as fastening media are prohibited. Threaded C-clamps shall not be used. Conduits or pipe straps shall not be welded to steel.

J. The load applied to fasteners shall not exceed 1/4 of the proof test load. Fasteners attached to concrete ceilings shall be vibration and shock resistant. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joints shall not cut the main reinforcing bars. Holes not used shall be filled. Spring steel fasteners shall not be used. Conduits shall be fastened to all sheet metal boxes and cabinets with two (2) locknuts where required by the National Electrical Code to ensure adequate bonding for grounding. Where insulated bushings are used, or where bushings cannot be secured firmly to the box or enclosure, a bonding jumper shall be installed to maintain suitable grounding continuity. Locknuts shall be the type with sharp edges for digging into the wall of metal enclosures. Bushings shall be installed on the ends of all conduits and shall be of the insulating type where required by the National Electrical Code.

K. Conduit installed in concrete floor slabs or walls shall be located so as not to affect the designed structural strength of the slabs. Conduit shall be installed within the middle one-third of the concrete slab except where necessary to not disturb the reinforcement. The outside diameter of conduit shall not exceed one-third of the slab thickness, and conduits shall be spaced no closer than three (3) diameters except at cabinet locations. Curved portions of bends shall not be visible above the finish slab. Where embedded conduits cross expansion joints, suitable expansion/deflection fittings and bonding jumpers shall be provided. Conduit larger than 1-inch trade size shall be parallel with or at right angles to the main reinforcement. When at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Conduits shall not be stacked more than two (2) diameters high in floor slabs. Embedded conduits shall be placed in accordance with the latest edition of ACI-318.

L. All conduit extending through the floor behind panels or similar equipment shall be PVC Schedule 80 and shall extend a minimum of 6 inches above the floor elevations, where practicable, with no couplings at floor elevations.

M. Joints in conduit shall be staggered so as not to occur side by side.

N. No more than three (3) 90 degree bends will be allowed in any one conduit run. Where more bends are necessary, a condulet or pull box shall be installed. All bends in conduit shall be machine bends. All conduit ends at switch and outlet boxes shall be fitted with an approved locknut and bushing forming an approved tight bond with box when screwed up tightly in place.

O. Conduits stubbed up through concrete floors for connections to freestanding equipment and for future equipment shall be provided with an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Screwdriver operated threaded flush plugs shall be installed in conduits from which no equipment connections are made.

P. Where outlets are shown near identified equipment furnished by this or other Design/Builders, it is the intent of the Specifications and Drawings that the outlet be located at the equipment to be served. The Design/Builder shall coordinate the location of these

outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings. Changes in outlet locations required to serve the equipment furnished by other Design/Builders on the Project shall be brought to the attention of the Engineer.

Q. Conduit shall be protected immediately after installation by installing flat non-corrosive metallic discs and steel bushings, designed for this purpose, at each end. Discs shall not be removed until it is necessary to clean the conduit and install the conductors. Before the conductors are installed, insulated bushings shall be installed at each end of the conduit.

R. Connections from rigid conduit to motors and other vibrating equipment, limit switches, solenoid valves, level controls, and similar equipment, shall be made with short lengths of liquid-tight flexible non-metallic conduit. These conduits shall be installed in accordance with the NEC. Flexible conduit length shall be three (3) feet, maximum.

S. Flexible conduit shall have a green insulated grounding conductor running through the flexible conduit. This conductor shall be terminated to the nearest pull box, motor terminal box, or any other apparatus ground terminal. Flexible metal conduit and liquid-tight flexible metal conduit shall be grounded and bonded per NEC Articles 348 and 350, respectively.

T. Conduits installed within or underneath floor slabs, underground direct-buried or concrete encased conduits, and all conduits installed in areas subject to liquid inadvertently entering the conduit system shall be sealed or plugged at both ends in accordance with NEC Article 300-5(g). This requirement applies to both conduits containing conductors and "spare" conduits.

Conduit passing through the walls and floors of buildings below grade shall be installed with appropriate watertight fittings to prevent the entrance of ground water around the periphery of the conduits. For vertical conduit penetrations through openings in concrete floors, the fittings shall be Type FSK Floor Seals as manufactured by OZ/Gedney. For conduit penetrations through openings in concrete walls, the fittings shall be Type WSK Thruwall seals as manufactured by OZ Gedney. Conduits shall be sloped away from the buildings toward splice boxes, handholes and/or manholes to provide drainage away from the building wall.

Conduits passing through sleeves in interior walls and floors shall be tightly caulked.

U. Weatherproof, insulated throat "Meyers" hubs shall be used on all conduit entries to boxes and devices without integral hubs in process areas to maintain NEMA 4X integrity.

V. The use of two (2) locknuts, one on each side of the enclosure, and a grounding bushing shall be required at all conduit terminations where hub type fittings are not required; such as electrical rooms, control rooms, and office areas.

W. Install non-metallic conduits in accordance with manufacturer's instructions where specified herein or indicated on the Drawings.

X. Join non-metallic conduit using cement as recommended by the manufacturer. Clean and wipe non-metallic conduit dry before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for twenty (20) minutes (minimum).

Y. Conduits shall not penetrate the floors or walls inside liquid containment areas unless specifically accepted by the Engineer.

Z. All conduits that are buried or encased in concrete that transition from the ground to any stationary structure or equipment shall be equipped with a longitudinal expansion coupling capable of at least four inches of expansion.

3.02 CONDUIT IDENTIFICATION

A. The identification system for the conduits furnished and installed under this Contract shall match the existing identification system used at the facility.

3.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.

b. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swab followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling tape.

- END OF SECTION -

SECTION 16123

BUILDING WIRE AND CABLE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, install, connect, test, and place in satisfactory operating condition, ready for service, all cables and wires indicated on the Drawings and as specified herein or required for proper operation of the installation, with the exception of internal wiring provided by electrical equipment manufacturers. The work of connecting cables to equipment, machinery, and devices shall be considered a part of this Section. All hardware, junction boxes, bolts, clamps, insulators, and fittings required for the installation of cable and wire systems shall be furnished and installed by the Design/Builder.

B. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years.

C. Reference Section 16000, Basic Electrical Requirements.

1.02 SUBMITTALS

A. The Design/Builder shall obtain from the wire and cable manufacturer and submit the following:

1. Shop Drawings

2. Reports of Field Tests

3. Wiring Identification Methods

B. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.

B. Partial, incomplete, or illegible Submittals will be returned to the Design/Builder without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Wiring identification methods and materials.

1.04 IDENTIFICATION

A. Each cable shall be identified as specified in Part 3, Execution, of this Specification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The wire and cable covered by this Specification is intended to be standard equipment of proven performance. Wire and cable shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

B. The wire and cable manufacturer shall be ISO 9000 registered.

2.02 600 VOLT POWER WIRE AND CABLE

A. 600 volt power cable and wire installed between the output terminals of a VFD and the respective motor shall consist of stranded copper conductor with insulation type XHHW/XHHW-2, rated 90°C.

B. 600 volt power cable and wire for all other loads shall consist of stranded, copper conductor with insulation type THHN, 90°C for dry locations and THWN, 75°C for wet locations.

C. Conductors shall be stranded copper per ASTM-B8 and B-33, and Class B or C stranding contingent on the size unless otherwise specified. Minimum size wire shall be No. 12 AWG.

D. 600 volt individual power wire and cable shall be Okoseal-N as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent with SIMPull jacket, or equal. Multi-conductor power cables shall be Okoseal-N Type TC Cable as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent, or equal.

2.03 600 VOLT CONTROL CABLE

A. 600 volt control cable shall consist of stranded, copper conductor with insulation type THHN, 90°C for dry locations and THWN, 75°C for wet locations. The individual conductors of the multiple conductor cable shall be color coded for proper identification. Color coding shall be equal to ICEA S-68-514, Method 1, E2. Cables shall meet requirements of IEEE-383.

B. Conductors shall be stranded copper per ASTM B-8 and B-33, and Class B or C stranding contingent on the size unless otherwise specified. Minimum wire size shall be No. 14 AWG.

C. 600 volt individual conductor control wire shall be Okoseal-N as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent with SIMPull jacket, or equal. Multi-conductor control cable shall be Okoseal-N Type TC Cable as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent, or equal.

2.04 LIGHTING AND RECEPTACLE WIRE AND CABLE

A. The lighting and receptacle branch circuit wire shall consist of solid, copper conductors with insulation type THHN, 90°C for dry locations and THWN, 75°C for wet locations.

B. Conductors shall be solid copper per ASTM- B-33. Minimum size wire shall be No. 12 AWG.

C. Lighting and receptacle cables and wire shall be Okoseal-N as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent with SIMPull jacket, or equal.

2.05 INSTRUMENTATION CABLE

A. The instrumentation cable for analog signals shall be shielded, twisted pairs or triads with 600 volt insulation and shall have a 90°C insulation rating.

B. Conductors shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM-B8, Class B stranding unless otherwise specified. Minimum size wire shall be No. 16 AWG.

C. The instrumentation cable shall be Okoseal-N Type P-OS for single pair or triad applications and Okoseal-N Type SP-OS for multiple pair or triad applications as manufactured by the Okonite Company, Cerro Wire and Cable equivalent, Southwire Company equivalent, or equal.

2.06 CABLE PULLING LUBRICANTS

A. Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Yellow #77 Plus by Ideal, Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

PART 3 -- EXECUTION

3.01 600V POWER, CONTROL, AND LIGHTING/RECEPTACLE WIRE AND CABLE INSTALLATION

A. The cable and wires shall be installed as specified herein and indicated on the Drawings.

B. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.

C. To minimize oxidation and corrosion, wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for "copper-to-copper" connections. The compound shall be Penetrox E as manufactured by Burndy Electrical, or equal.

D. Splices shall not be allowed in the underground manhole and handhole systems. If splices are required, the Design/Builder shall obtain approval in writing from the Engineer prior to splicing. Splicing materials shall be barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. No splicing of instrumentation cable is allowed. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits. Reference Section 16130 for additional requirements regarding control wiring.

E. Wire and Cable Sizes

1. The sizes of wire and cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be increased so that the voltage drop measured at the load does not exceed 2-1/2%.

2. Minimum wire size within control panels, motor control centers, switchboards and similar equipment shall be No. 12 AWG for power and No. 14 AWG for control.

F. Number of Wires

1. The number of wires indicated on the Drawings for the various control, indication, and metering circuits were determined for general schemes of control and for particular indication and metering systems.

2. The actual number of wires installed for each circuit shall, in no case, be less than the number required; however, the Design/Builder shall add as many wires as may be required for control and indication of the actual equipment selected for installation at no additional cost to the Owner. The addition of conductors shall be coordinated with and approved by the Engineer to avoid violations of the NEC regarding conduit fill.

3. All spare conductors shall be terminated on the terminal blocks mounted within the equipment.

G. Wiring Identification

1. In addition to color coding, all wiring shall be identified at <u>each</u> point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. The Design/Builder shall meet with the Owner and Engineer to come to an agreement regarding a wire identification system prior to installation of any wiring. Wire numbers shall not be duplicated.

2. Wire identification shall be by means of a heat shrinkable sleeve. Sleeves shall have a white background with black text. Wire sizes #14 AWG through #10 AWG shall have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.

3. Sleeves shall be suitable for the size of wire on which they are installed. When installation is complete, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Design/Builder shall take special care to ensure that the wiring insulation is not damaged during the heating process.

4. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.

5. Sleeves shall be white polyolefin as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal.

6. Where sleeves are not available in the size required for the wire, the Design/Builder shall use an adhesive label with a white background and black text. Text size shall be in accordance with the requirements listed above.

7. Adhesive labels, for the case when sleeves are not suitable for the wire size, shall be white permanent vinyl as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal.

H. Cable Installation

1. All interior cable not protected by a compartment enclosure shall be installed in conduit.

I. Wiring Supplies

1. Only electrical wiring supplies manufactured under high standards of production and meeting the approval of the Engineer shall be used.

2. Rubber insulating tape shall be in accordance with ASTM Des. D119. Friction tape shall be in accordance with ASTM Des. D69.

J. Connections at Control Panels, Limit Switches, and Similar Devices

1. Where stranded wires are terminated at panels, and/or devices, connections shall be made by solderless lug, crimp type ferrule, or solder dipped.

2. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make 7-strand, No. 12 AWG, wire terminations impractical, the Design/Builder shall terminate external circuits in an adjacent junction box of proper size complete with terminal strips and shall install No. 14 AWG stranded wires from the device to the junction box in a conduit. The #12 AWG field wiring shall also be terminated in the same junction box to complete the circuit.

K. Pulling Temperature

1. Cable shall not be flexed or pulled when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the work day for which the cable is removed from the protected storage. Any remaining cable reels shall be returned to storage at the completion of the workday.

L. Color Coding

1. Conductor insulation shall be color coded as follows:

   a. 480/277V AC Power

      Phase A - BROWN
      Phase B - ORANGE
      Phase C - YELLOW
      Neutral - GREY

   b. 120/208V or 120/240V AC Power

      Phase A - BLACK
      Phase B - RED
      Phase C - BLUE
      Neutral - WHITE

   c. DC Power

      Positive Lead - RED
      Negative Lead - BLACK

   d. DC Control

      All wiring - BLUE

   e. 120VAC Control

      Single conductor 120 VAC control wire shall be RED except for a wire entering a motor control center compartment or control panel which is an interlock. This conductor shall be color coded YELLOW.

   f. 24VAC Control

      All wiring - ORANGE

   g. Equipment Grounding Conductor

      All wiring - GREEN

2. Conductors No. 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape in accordance with the requirements listed above.

3. Low voltage feeder and branch circuit conductors shall be identified in accordance with the NEC. The method utilized for conductor identification for each nominal voltage system shall be permanently posted at each feeder or branch circuit distribution equipment assembly. Reference Articles 200, 210, and 215 of the NEC.

3.02 INSTRUMENTATION CABLE INSTALLATION

A. The Design/Builder shall install all cable or conductors used for instrumentation wiring (4-20 mA DC, etc.) in rigid galvanized steel or PVC coated rigid galvanized steel conduit. The use of asbestos cement or PVC conduit shall not be permitted. Analog signal wires shall exclusively occupy these conduits. No other wiring for AC or discrete DC circuits shall be installed in these conduits.

B. All shielding shall be continuous and shall be grounded at one point only, or in accordance with the instrumentation equipment manufacturer's recommendations.

C. Where instrumentation cables are installed in panels, manholes, handholes, and other locations, the Design/Builder shall arrange wiring to provide maximum clearance between these cables and other conductors. Instrumentation cables shall not be installed in same bundle with conductors of other circuits.

D. Additional pullboxes shall be furnished and installed for ease of cable pulling and the cable manufacturer's recommended conduit fill factor shall be followed. Where required or specifically directed by the Engineer, the Design/Builder shall moisture seal the cables at all connections with OZ Gedney Type "CSB", or equal, sealing bushings.

E. Special instrument cable shall be as specified or recommended by the manufacturer of the equipment or instruments requiring such wiring. Installation, storage, terminations, etc., shall be per manufacturer's recommendations.

F. All cable insulation and jackets shall have adequate strength for it to be pulled through the conduit systems. All conductors shall be color coded and all wires shall be suitably tagged with permanent markers as specified herein.

3.03 TESTING

A. The following tests are required:

1. Shop Test

a. Cable and wiring shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer’s standards.

2. Field Tests

a. After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be “test light” or “buzzer” style.

b. After installation, all wires and cables shall be tested for insulation levels. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:

(1) For 600V power and control cable, apply 1,000 VDC from a Megaohmeter for one (1) minute for <u>all</u> 600V wires and cables

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installed in lighting, control, power, indication, alarm and motor feeder circuits. Resistance shall be no less than 100 Megaohms.

(2) 600V instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter, or approved equal. The resistance value shall be 200 Megaohms or greater.

B. Low voltage wires and cables shall be tested before being connected to motors, devices or terminal blocks.

C. If tests reveal defects or deficiencies, the Design/Builder shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner.

D. All tests shall be made by and at the expense of the Design/Builder who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

- END OF SECTION -

SECTION 16130

BOXES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all pull, junction and outlet boxes for power, lighting and control as required for a complete electrical installation as shown on the Drawings and specified herein.

B. Coordination

1. The Design/Builder shall review installation procedures under other Divisions and coordinate them with the Work specified herein.

2. The Design/Builder shall notify others in advance of the installation of the Work included herein to provide them with sufficient time for the installation and coordination of interrelated items that are included in the Contract and that must be installed in conjunction with the Work included in this Division.

C. Boxes shall conform to all applicable Federal, UL and NEMA standards. Materials and components shall be new and conform to grades, qualities and standards as specified herein and shown on the Drawings.

D. Reference Section 16000, Basic Electrical Requirements.

1.02 SUBMITTALS

A. The Design/Builder shall obtain from the equipment manufacturer(s) and submit the following:

1. Shop Drawings

B. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible Submittals will be returned to the Design/Builder without review for resubmittal.

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C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings for each box with clearly marked dimensions.

1.04 IDENTIFICATION

A. Each junction and pullbox shall be identified with the box name as indicated on the Contract Drawings or as directed by the Engineer. A nameplate shall be securely affixed in a conspicuous place on each box. Nameplates shall be as specified in Section 16195, Electrical – Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 PULL, JUNCTION, AND OUTLET BOXES

A. Exposed Indoor Wet Process and Outdoor Areas

1. Exposed outlet boxes for outdoor and indoor wet process areas used for lighting fixtures, switches, and receptacles shall be of cast, rust-resisting metal provided with integral conduit hubs and rubber or neoprene gasketed covers of similar metal.

2. Junction and pull boxes shall be of NEMA 4X 304 stainless steel construction and of ample size to house the required devices. Junction and pull boxes shall be gasketed and have hinged covers. Door latches shall be all stainless steel, fast operating clamp assemblies that do not require bolts or screws to secure.

B. Concealed

1. Outlet boxes for concealed work shall be a minimum of 4 inches square and 2 inches deep consisting of zinc coated pressed steel provided with knockouts for the conduit required. Boxes shall be provided with approved covers or plaster rings where necessary. Boxes with eccentric or concentric knockouts shall not be used.

2. Boxes for housing receptacles, switches and similar devices shall be of the deep type.

C. Exposed Indoor Dry Locations

1. Pull and junction boxes for indoor exposed use in dry locations shall be galvanized sheet steel with neoprene gasketed screwed-on covers and of all welded construction. Boxes with eccentric or concentric knockouts shall not be used.

D. Exposed Chemical Storage and Transfer Areas

1. Outlet, junction, and pull boxes for exposed work in chemical storage and transfer areas shall be Schedule 80 PVC where Schedule 80 PVC is specified in Section 16111 and/or on the Drawings for the conduit in that area.

2. Outlet, junction, and pull boxes for exposed work in all other chemical storage and transfer areas shall be the same as required herein for wet process area.

E. Miscellaneous

1. The Design/Builder shall furnish and install enclosures for housing interfacing and transition equipment, or other equipment requiring an enclosure. The Design/Builder shall be responsible for mounting the enclosure. The enclosures shall be a low profile type, weatherproof, and lockable. The enclosures shall be furnished and installed in complete compliance with the NEC and with all state and local codes. The single door enclosure shall be finished with light gray epoxy paint and shall be manufactured by Hoffman, Rittal, The Austin Company, or equal.

2. All boxes shall be UL listed and labeled.

3. For boxes shown or required in hazardous locations, boxes shall be furnished and installed in accordance with the Class, Division, and Group suitable for the application.

F. Galvanizing

1. The inside and outside surface of the boxes and covers shall be hot dipped or electro-galvanized after fabrication.

G. Box Sizes

1. The minimum size of boxes shall be in accordance with the NEC. No box shall be filled to more than 40% of capacity.

H. Barriers

1. Galvanized steel or aluminum barriers shall be provided in junction or pull boxes to isolate conductors of different voltages and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:

a. Power (480 and 120 volts)

b. Control wiring

c. Instrumentation wiring (twisted, shielded pairs or triads)

2. Barriers shall be provided in multi-gang outlet boxes when the voltage between switches exceeds 300 VAC.

I. Where control wires must be interconnected in a junction box, terminal strips, consisting of an adequate number of screw type terminals shall be installed. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected. Approximately 20 percent of the total amount of terminals provided shall consist of spare terminals. Terminals shall be lettered and/or numbered to conform with the wiring labeling scheme diagrams.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Outlet Boxes

1. All outlet boxes required for supporting lighting fixtures shall be provided with fixture studs of sizes suitable for supporting the weight of the fixtures connected thereto. Fixture studs shall not be less than 3/8 inches in diameter and shall be either integral with the box or of the type which is inserted and supported from the back of the box. In no case shall the support of a fixture be dependent upon bolts holding the stud to the box.

2. Outlet boxes for concealed work shall be arranged and located so that tile, where required, may be cut in straight lines to fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.

B. Junction and Pull Boxes

1. All junction boxes and pull boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Wooden plugs are not permitted for securing boxes to concrete. Sidewalk-type boxes shall be cast into concrete structures and shall be flush with concrete surfaces after installation.

- END OF SECTION -

SECTION 16141

WIRING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish and install all switches and receptacles for lighting and miscellaneous power applications of the type and at the locations as specified herein and as shown on the Drawings.

B. All switches and receptacles shall be furnished and installed in outlet boxes as specified in Section 16130, Boxes.

C. Reference Section 16000, Basic Electrical Requirements.

1.02 SUBMITTALS

A. The Design/Builder shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Design/Builder without review for resubmittal.

C. Shop drawings shall include, but not be limited to:

1. Product data sheets.

1.04 SUPPLIES AND SPARE PARTS

A. The Design/Builder shall furnish 10% (minimum of 1) spare of each receptacle, switch, and plug furnished and installed for this project.

B. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same parts number.

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1.05 IDENTIFICATION

A. Each switch and receptacle shall be identified with the equipment item number, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The Design/Builder shall use the products of a single manufacturer for each type of wiring device.

C. The Design/Builder shall use the products of a single manufacturer for all device plates. Plate variations are allowed for the following devices:

1. Where the selected plate manufacturer does not manufacture a suitable finish plate.

2. For heavy-duty receptacles rated at more than 30A.

3. Where non-standard plates are required, specified, or shown.

D. The Design/Builder shall furnish and install all wiring devices and device plates. Wiring devices as listed herein are intended to indicate type, function, and quality of the products.

E. The receptacles, switches, device plates, and other appurtenances shall comply with the requirements of these Specifications. Receptacles installed in toilet, locker, and bathrooms shall be of ground fault interrupter type to meet the minimum NEC requirements. Ground fault circuit interrupter receptacles shall also be furnished and installed as specified herein, indicated on the Drawings, and required by the NEC.

F. Wiring devices shall be approved for use with stranded conductors, if stranded conductors are to be used with the device. Reference Section 16123, Building Wire and Cable.

G. The Design/Builder shall provide specification grade devices which shall be as manufactured by Appleton, Crouse-Hinds, Leviton, Harvey Hubbell Co., Bryant Electric Company, Pass & Seymour, or equal.

2.02 WIRING DEVICES

A. Wiring devices shall be in accordance with the following for nonhazardous areas:

1. Wall Switches, Single Pole, 20 A, 120-277V equivalent to Hubbell No. 1221, Pass & Seymour No. 20AC1, Leviton equivalent, or equal. Switches rated 30 A, 120-277V shall be Leviton 3031, Hubbell equivalent, Pass & Seymour equivalent, or equal.

2. Wall Switches, Double Pole, 20 A, 120-277V equivalent to Hubbell No. 1222, Pass & Seymour No. 20AC2, Leviton equivalent, or equal. Switches rated 30 A, 120-277V shall be Leviton 3032, Hubbell equivalent, Pass & Seymour equivalent, or equal.

3. Wall Switches, Three-Way, 20 A, 120-277V equivalent to Hubbell No. 1223, Pass & Seymour No. 20AC3, Leviton equivalent, or equal. Switches rated 30 A, 120-277V shall be Leviton 3033, Hubbell equivalent, Pass & Seymour equivalent, or equal.

4. Wall Switches, Four-Way, 20 A, 120-277V equivalent to Hubbell No. 1224, Pass & Seymour No. 20AC4, Leviton equivalent, or equal.

5. Convenience Receptacles 20 A, 125V, duplex polarized with grounding connection equivalent to Hubbell No. 5362, Pass & Seymour equivalent, Leviton equivalent, or equal.

6. Hubbell Cat. No. GF-5362, Pass & Seymour equivalent, Leviton equivalent, or equal, for 20A, 120V, duplex, ground fault circuit interrupting type.

B. Special Purpose Receptacles shall be rated to carry, at least where required the full load amperes and voltage of the unit connected thereto. These receptacles shall be provided with grounding poles and shall be equivalent to the following:

1. Hubbell Cat. No. HBL-5661, Pass & Seymour No. 5871, Leviton equivalent, or equal, for 20A, 250VAC, 1-phase service.

2. Hubbell Cat. No. HBL-9330, Pass & Seymour No.3801, Leviton equivalent, or equal, for 30A, 250VAC, 1-phase service.

3. Hubbell Cat. No. 9430, Pass & Seymour No. 5740, Leviton equivalent, or equal, for 30A, 208/120V, 3-phase service.

4. Hubbell Cat. No. 9450, Pass & Seymour No. 5750, Leviton equivalent, or equal, for 50A, 208/120V, 3-phase service.

5. Hubbell Cat. No. 9460, Pass & Seymour No. 5760, Leviton equivalent, or equal, for 60A, 208/120V, 3-phase service.

6. Hubbell Cat. No. 9330, Pass & Seymour No. 5930, Leviton equivalent, or equal, for 30A, 208V, single-phase service.

7. Hubbell Cat. No. 9315, Pass & Seymour equivalent, Leviton equivalent, or equal, for 30A, 277V, single-phase service.

8. Hubbell Cat. No. 23CM10, Pass & Seymour equivalent, Leviton equivalent, or equal, for 20A, single, 125V, polarized with grounding connection, twist lock type. Matching plug shall be Hubbell Cat. No. 23CM11, Pass & Seymour equivalent, Leviton equivalent, or equal.

9. Crouse-Hinds "Arktite" Series, Appleton equivalent, Killark equivalent, or equal, 30A, 3P, 600 Volt, twist lock, weatherproof, power receptacle and box with matching plug.

C. For hazardous areas the following shall be provided:

1. Wall Switches, single pole, 20 A, 120 V equivalent to Crouse Hinds Cat. No. EFD3591 or EFDC3591 (as required); Appleton No. EDS175F1 or EDSC175F1, Killark equivalent, or equal.

2. Convenience Receptacles 20 A, 120-250 VAC, 2 wire, 3 pole equivalent to Crouse Hinds Cat. No. CPS152-201, Appleton No. CPE1-2375, Killark equivalent, or equal.

D. Plugs for hazardous and non-hazardous receptacles shall be provided:

1. Plugs and respective cable shall be provided for equipment furnished under other Divisions (steam cleaners, welders, etc.) as necessary.

2.03 DEVICE PLATES

A. Wall plates with gaskets for flush-mounted receptacles and switches shall be made of Type 304 stainless steel, not less than 0.032 of an inch thick, with beveled edges and milled on the rear so as to lie flat against the wall. Wall plates shall be equivalent to Hubbell Series 9600, Pass & Seymour series 93000, Leviton equivalent, or equal.

B. Device plates for outdoor installations and indoor wet process area installations shall be Appleton Type FSK, Crouse-Hinds #DS185, or equal for wall switches. Device plates for receptacles shall be “in-use” style. “In-use” weatherproof covers shall be rugged, minimum 3 ¼” depth, die-cast aluminum as manufactured by Thomas & Betts "Red Dot," Intermatic International, Inc., or equal.

C. Device plates for indoor dry process areas with surface mounted boxes shall be Crouse-Hinds DS32, or equal for switches, and Crouse-Hinds DS23 or equal for receptacles.

2.04 PLUGS

A. The Design/Builder shall furnish suitable plugs with equipment furnished under the respective Contract. Plugs shall be black rubber or plastic. For waterproof receptacles, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided with clamping nuts and stuffing gland cable outlets.

2.05 PROCESS INSTRUMENTS

A. The Design/Builder shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument etc.,) to disconnect the 120VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch without overload protection as manufactured by Crouse-Hinds, Appleton equivalent, or equal. For hazardous locations, the device shall be a front operated general use snap switch mounted in an EFS enclosure as manufactured by Crouse-Hinds, Appleton equivalent, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Switch boxes shall be of unit construction and of sizes as required to adequately house the number of switches required. No sectional type switch boxes shall be permitted.

B. Where more than one (1) switch occurs at one (1) point, gang plates shall be used.

C. All device plates shall be set true and plumb, and shall fit tightly against the finished wall surfaces and outlet boxes.

D. All devices shall be flush-mounted in finished areas, unless otherwise noted. The Design/Builder shall determine the proper position of every outlet, and relocate any outlet without additional cost to the Owner if same is incorrectly or improperly located. The Engineer reserves the right to change the location of any outlet or connecting equipment up to the time of roughing in without additional cost to the Owner, provided conduit runs are not increased by more than ten (10) feet.

E. In all areas where thermal or acoustic insulation is applied to the ceiling or walls, outlet boxes shall be set to finish flush with the finished surface of the insulation.

F. When indicated height would place any of the equipment at an unsuitable location such as at a molding or break in wall finish, the Design/Builder shall bring it to the attention of the Engineer for a decision.

G. For the below-named items, mounting heights from finish floor, or finish grade to top is applicable. Mounting heights shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):

1. Single-pole light switches, 48 inches.

2. Duplex receptacles in dry areas, 16 inches

3. Duplex receptacles in pump rooms, 48 inches

H. The Design/Builder shall furnish and install switches as indicated on the Drawings. Switches shall be single pole, double pole, 3-way, or 4-way as indicated on the Drawings and as required. Switches located outdoors or in wet indoor locations shall be installed in cast boxes complete with yellow, fiberglass weatherproof covers. Reference Section 16141, Wiring Devices.

I. All receptacles shall have a self-adhesive label installed on the top at the respective device plate that indicates which panel and which circuit number the receptacle is supplied from. Labels shall have a white background and black lettering in 14 point font.

3.02 CIRCUITING

A. Convenience receptacles shall be grouped on circuits separate from the lighting circuits. A maximum of eight (8) convenience receptacles are permitted per 20A, 120V circuit.

- END OF SECTION -

SECTION 16190

SUPPORTING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish and install structural supports for mounting and installing all electrical, lighting, alarm systems, instrumentation, and communications equipment furnished under this Contract.

B. Equipment shall be installed strictly in accordance with recommendations of the manufacturer and best practices of the trade resulting in a complete, operable, and safe installation. The Design/Builder shall obtain written installation manuals from the equipment manufacturer prior to installation.

C. Reference Section 16000, Basic Electrical Requirements.

1.02 SUBMITTALS

A. The Design/Builder shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Design/Builder without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

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2.02 MATERIALS

A. Materials used in accordance with this Section shall be as specified herein.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Concrete or Masonry Inserts

1. The Design/Builder shall be responsible for the furnishing and installation of all conduit sleeves, anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.

2. If a time delay for the arrival of any special inserts or equipment drawings, etc. occurs, the Design/Builder may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and, upon subsequent installation, the Design/Builder shall be responsible for filling in such recesses and openings.

3. The Design/Builder shall furnish leveling steel channels for all switchgear, switchboards, motor control centers, and similar floor mounted equipment. The leveling steel channels shall be provided for installation in the equipment housekeeping pads. Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain coverage of the reinforcement bars while not exceeding the maximum mounting heights requirements of the NEC.

B. Support Fastening and Locations

1. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel. Where supports or hangers are required for heavy electrical equipment units exceeding fifty pounds, a proposed support detail shall be submitted to the Engineer for review and approval. Where required, additional sections shall be provided for a safe installation. Supports and hangers shall be aluminum or stainless steel as required to suit the application and shall be compatible with the balance of the installation.

2. All holes made in reflected ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling grid bars where possible, to facilitate removal of ceiling panels.

3. For interior dry areas, a bracket and channel type support of zinc chromated galvanized steel construction shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.

4. For outdoor service or in indoor damp/wet process areas, the support system shall be made of Type 304 stainless steel. The materials of construction shall be coordinated with the process/chemical area in which the support system will be installed. All equipment, devices, and raceways that are installed on the dry side of a water bearing wall shall not be installed directly onto the wall. Nominal 1-5/8" x 3/4" (minimum) channel shall be used to allow ventilation air to pass behind the equipment, devices, or raceway.

5. For sodium hypochlorite storage and transfer area, the support system shall be made of reinforced fiberglass.

6. All hardware (bolts, nuts, washers, etc.), regardless of installation location, shall be Type 304 stainless steel.

7. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework. Wherever this occurs, a provision shall be made for ready access to the wiring for connections to the equipment by means of boxes with screw covers.

8. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.

9. Actual designs for supporting framework should take the nature of a picture frame of channels and bracket with a plate for mounting the components. The Design/Builder is responsible for the design of supporting structure; he shall submit design details to the Engineer for acceptance before proceeding with the fabrication.

10. Wherever dissimilar metals come into contact, the Design/Builder shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

- END OF SECTION -

SECTION 16195

ELECTRICAL - IDENTIFICATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All switchgear, switchboards, motor control centers, variable frequency drives, lighting and distribution panelboards, combination starters, control panels, pull/junction boxes, enclosures, disconnect switches, control stations, and similar equipment shall be identified in the manner described, or in an equally approved manner.

B. The types of electrical identification specified in this section include, but are not limited to, the following:

1. Operational instructions and warnings.

2. Danger signs.

3. Equipment/system identification signs.

4. Nameplates.

1.02 SIGNS

A. "DANGER-HIGH-VOLTAGE" signs shall be securely mounted on the entry doors of all electrical rooms.

1.03 LETTERING AND GRAPHICS

A. The Design/Builder shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Design/Builder without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The material covered by these Specifications is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

2.02 NAMEPLATES

A. Nameplates shall be engraved, high pressure plastic laminate, white with black lettering.

B. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or equal.

2.03 HIGH VOLTAGE SIGNS

A. Standard "DANGER" signs shall be of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where a larger size is needed for adequate identification.

2.04 CONDUIT IDENTIFICATION

A. Conduit identification shall be as specified in Section 16111, Conduit.

2.05 WIRE AND CABLE IDENTIFICATION

A. Field installed wire and cable identification shall be as specified in Section 16123, Building Wire and Cable.

B. Wiring identification for factory installed wiring in equipment enclosures shall be as specified in the respective section.

2.06 BOX IDENTIFICATION

A. Pull, junction and device box identification shall be as specified in Section 16130 – Boxes.

PART 3 -- EXECUTION

3.01 NAMEPLATES

A. Nameplates shall be attached to the equipment enclosures with (2) two stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

- END OF SECTION -

SECTION 16440

DISCONNECT SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish and install separately mounted, individual disconnect switches as specified herein and indicated on the Drawings.

B. Reference Section 16000, Basic Electrical Requirements.

1.02 SUBMITTALS

A. The Design/Builder shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

B. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Design/Builder without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.

3. Assembled weight of each unit.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Design/Builder intends to provide are acceptable and shall be submitted.

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1.04 TOOLS, SUPPLIES, AND SPARE PARTS

A. The equipment shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment, and with all spare parts as recommended by the equipment manufacturer.

B. One (1) complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.

C. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

D. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.05 IDENTIFICATION

A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the circuit number and equipment name with which it is associated. Equipment identification shall be in accordance with Section 16195, Electrical - Identification.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Switches shall be manufactured by the Square D Company, Cutler-Hammer, the General Electric Company, or Siemens Energy and Automation, Inc.

2.02 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Drawings and as required by the NEC. Handles shall be lockable.

B. Switches shall be NEMA Type HD, single-throw, externally operated, fused or non-fused as required. Switches of the poles, voltage, and ampere ratings shown shall be furnished in NEMA 1A (gasketed) enclosures in indoor dry areas, and in NEMA 4X Type 304 stainless steel enclosures for damp/wet indoor process areas. Enclosures for outdoor applications shall be NEMA 4X Type 304 stainless steel. Switches located in hazardous areas shall be suitable for the Class, Division, and Group to suit the application. Enclosures for switches located in sodium hypochlorite storage and transfer areas shall be NEMA 4X non-metallic.

C. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.

D. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.

E. Disconnect switches shall be furnished with a factory installed internal barrier kit that helps prevent accidental contact with live parts and provides “finger-safe” protection when the door of the enclosed switch is open.

F. Disconnect switches for process instruments shall be as specified in Section 16141 – Wiring Devices.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All disconnect switches shall be mounted five (5) feet above the floor, at the equipment height where appropriate, or where shown otherwise.

B. The Design/Builder shall furnish and install fuses of various types as required with the continuous ampere ratings as required or shown on the Drawings.

3.02 TESTING

A. The following tests are required:

1. Witnessed Shop Tests

    a. None required.

2. Field Tests

    a. Field testing shall be done in accordance with the NETA Acceptance Testing Specifications, latest edition.

- END OF SECTION -

SECTION 16902

ELECTRIC CONTROLS AND RELAYS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.

B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.

C. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings.

D. Reference Section 16000, Basic Electrical Requirements and Section 16195, Electrical Identification.

E. The Design/Builder shall furnish and install, as specified herein and indicated on the Drawings, all motor control components and wiring for all motor-operated equipment furnished under this Section and all other Sections as indicated. The Design/Builder shall review the entire Contract Documents to be totally familiar with his responsibilities.

F. The Design/Builder shall furnish and install all external power and control wiring to control panels of prewired packaged equipment, unless indicated otherwise.

G. Control wiring requirements are indicated in electrical schematics and descriptions on the Drawings, in functional control descriptions which appear in Section 17950 of these Specifications, and in equipment manufacturer's equipment data. The Design/Builder shall furnish and install all control wiring in accordance with these Contract Documents. The Design/Builder shall provide all control circuits and wiring for a particular item of equipment in accordance with requirements as set forth by the manufacturer of the particular item of equipment.

H. As specified herein and indicated on the Drawings, furnish and install instrumentation wiring and connections to instrumentation equipment furnished under all Contracts of this Specification. Unless indicated otherwise, motor control switches, pilot lights, relays, and other control equipment for mounting in instrumentation panels shall be furnished, installed, and wired by the Design/Builder.

I. Where pumps provided by others are furnished with solenoid valves or other devices for control, the Design/Builder shall wire these valves or devices.

J. Unless otherwise specified herein or indicated on the Drawings, motor controllers shall be wired to drop out and remain dropped out on loss of power to the line side of the controller.

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Operator action shall be required to restart the motor unless the motor is intended to automatically restart.

K. Motor control components and control wiring shall conform to NEMA Specifications ICS-1970 (Revised, 1975), Industrial Controls and Systems.

L. Where devices are installed on the doors of NEMA 4, 4X, or 3R enclosures, devices shall be selected and installed to maintain the NEMA rating of the enclosure.

M. Wiring in all starters, panels, junction boxes, and similar equipment shall be brought out to numbered terminal strips for interconnection. The Design/Builder shall be responsible for documenting terminal numbers for all starters, controls, panels, and similar equipment provided under the Contract. At the completion of the project, the Design/Builder shall submit a complete set of record drawings showing and/or listing all terminals in boxes, panels, starters, and similar equipment in a single, complete bound package for the equipment and control supplied under the Contract.

N. The Design/Builder is responsible for coordinating the electrical work under the Contract with all equipment starters, controls, and instruments provided by others. The Design/Builder shall verify and coordinate with process equipment power supply and voltage, process equipment control power supply and voltage, and details of installation and interconnection.

O. Electrical control schematic diagrams drawn using a ladder-type format in accordance with JIC standards shall be submitted for all electrical equipment which is being provided under the Contract.

P. Record drawings shall be provided. One complete set of record wiring diagrams encased in plastic or plexiglass envelopes shall be provided for each starter, panel, and similar equipment. The diagrams shall include wire color codes showing connections from numbered terminal blocks to external equipment.

Q. Where space or strip heaters are provided within the enclosures for electrical equipment, the Design/Builder shall make connections to these heaters from an appropriate power source and operate the heaters with temperature control as necessary until the equipment is installed and operated according to its intended use.

R. Control stations shall be furnished and installed at each motor and at all other controlled devices (e.g. solenoid valves) as specified herein and indicated on the Drawings.

1.02 SUBMITTALS

A. The Design/Builder shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Operation and Maintenance Manuals.

B. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Shop drawings shall include but not be limited to:

1. Product data sheets.

C. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Design/Builder intends to provide are acceptable and shall be submitted.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. The electrical control and relay systems and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Design/Builder.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Design/Builder shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same part number.

PART 2 -- PRODUCTS

2.01 CONTROL COMPONENTS

A. Pilot Devices

1. Pushbuttons (PB) and selector switches (SS) shall be Type E34 as manufactured by Eaton Corporation, Type 3SBO as manufactured by Siemens Energy and Automation Inc., General Electric Company Type CR104P, The Square D Company equivalent, or Allen-Bradley equivalent. Pushbuttons and selector switches shall be 30.5 mm, heavy-duty, oil tight NEMA 4X corrosion resistant with legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering.

Pushbuttons and selector switches shall be non-illuminated. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release.

2. Pushbuttons and selector switches for all electrical equipment shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

3. Pushbuttons, selector switches, and other pilot devices for pump control panels shall be as specified herein and in the functional control descriptions which appear in Section 17950, and as shown on the Drawings.

4. Engraved nameplates shall be securely fastened to the front of each pushbutton station, disconnect switch, and motor starter remotely located from the motor control center. If adequate space is not available, the nameplate shall be mounted below the push button station. Nameplates shall be as specified in Section 16195, Electrical Identification. Identify all switches, control stations, and motor controllers as to their respective equipment.

5. Pilot lights shall be Type E34 as manufactured by Cutler- Hammer, Type 3SBO as manufactured by Siemens Energy and Automation Inc., General Electric Company Type CR104P, The Square D Company equivalent, or Allen-Bradley equivalent. Pilot lights shall be of the proper control voltage, LED type, push to test, heavy-duty, corrosion-resistant NEMA 4X with legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Pilot light lens colors shall be as follows:

   Red - "Run", "On", “Open”
   Green - "Off", “Closed”
   Amber - "Alarm", "Fail"
   White - “Control Power On”

6. Pilot lights for all electrical panels shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

7. Pilot lights for pump control panels shall be round with custom engraved legend plates for each pilot light.

B. Control and Timing Relays

1. Control Relays (CR) shall be Type DP3 as manufactured by Eaton Corporation, Type CR420 as manufactured by General Electric Company, Potter-Brumfield equivalent, The Square D Company equivalent, Siemens Energy and Automation Inc. equivalent, or Allen-Bradley equivalent. Relays shall be general purpose plug-in type with coil voltage as shown on the Drawings and sealed 10 ampere contacts. All relays shall have three SPDT contacts rated 120/240 VAC and 28 VDC minimum. Machine tool relays shall be provided when the contact burden exceeds 10 amperes. The relays shall be furnished with an internal pilot light for positive indication of coil energization. The relays shall be furnished with a manual operator to manually switch the contacts to simulate normal operation. Miniature type or "ice cube" relays are not acceptable.

2. Timing Relays (TR) shall be the general purpose plug-in type, Type TR as manufactured by Eaton Corporation, Type TUC as manufactured by Diversified Electronics The Square D Company equivalent, Siemens Energy and Automation Inc. equivalent, or Allen-Bradley equivalent. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with two SPDT timed output contacts. Contact ratings shall be the same as for control relays as specified above.

C. Control Stations

1. Control Stations (CS) shall be as manufactured by Eaton Corporation, General Electric Company, The Square D Company equivalent, Siemens Energy and Automation Inc., or Allen-Bradley equivalent. Control stations shall be furnished and installed complete with pushbuttons, selector switches, and other pilot devices as specified herein or indicated on the Drawings. Stop pushbuttons shall be furnished with a lock-out device as specified herein and indicated on the Drawings.

2. Control station enclosures shall be cast aluminum with gasketed cover for all indoor dry areas. Control station enclosures shall be NEMA 4X stainless steel with gasketed cover for all indoor damp/wet process areas. Control station enclosures shall be NEMA 4X stainless steel with gasketed cover for all outdoor applications.

3. Control stations located in hazardous locations shall be suitable for the Class, Division, and Group to suit the application. The pilot devices shall be the factory sealed type mounted in enclosures as specified above.

D. Motor Starters

1. Open type motor starters shall be rated 480 VAC, 3-pole, sized for the intended load unless otherwise indicated. In no case shall a starter smaller than a NEMA Size 1 be used. Each starter shall be able to withstand 20 million operations. Each starter shall be furnished with a minimum of two spare auxiliary contacts in addition to the hold-in contact. Starters shall be provided with coils for 120 VAC operation, unless otherwise indicated on the Drawings.

2. The motor starters shall conform to NEMA Standard IC1 and shall be for across-the-line starting, unless otherwise indicated. IEC rated equipment is not acceptable and shall be used as a basis for rejection of the equipment.

3. Each starter shall be supplied with a manual reset overload relay. Manual reset shall be accomplished by a door mounted overload reset pushbutton. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Design/Builder shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy or bi-metallic type overload relays shall not be used.

4. Open type magnetic motor starters shall be Eaton Corporation Type AN16 or AN56 using NEMA rated Freedom Series contactors, General Electric Company equivalents, The Square D Company equivalents, Siemens Energy and Automation Inc. equivalents, or Allen-Bradley equivalent.

E. Miscellaneous

1. Selected motors are indicated as requiring elapsed time indicators. Provide Eagle Signal Type HK210A6, General Time Catalog #ED27NR, Allen-Bradley equivalent, or equal, elapsed time indicators for 120 VAC volt operation mounted flush in the respective motor starter compartment door. Where clearance is not obtainable for compartment door closing, mount timers in a separately mounted enclosure, with each timer identified. Wire elapsed time indicator to operate when the respective motor operates.

2 Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or cabinet subpanel. Terminals shall be tubular screw type with pressure plate for wire size #22 - #8 AWG.

3. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30A. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20A. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. There shall be a sufficient quantity of terminals for the termination of all spare field conductors.

4. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system may be acceptable.

   The terminal blocks shall be as manufactured by Phoenix Contact, Inc., Wieland, Inc., or equal.

5. Alarm horns shall be as manufactured by Federal Signal Corporation, Edwards Signaling Company, EST (Edwards Systems Tech), or equal. Alarm horns shall be made for surface, flush, or semi-flush mounting on walls, panels, enclosures, or on square outlet boxes. Alarm horn sound output level shall be of 100 dB (nominal) at 10 feet.

PART 3 -- EXECUTION

3.01 CONFIGURATION OF CONTROLS AND EQUIPMENT

A. All controls including wiring, control switches, pushbuttons, indicating lights, control interlocks and similar devices, shall be provided at the control voltages specified herein or indicated on the Drawings. Each motor starter shall be provided with a control power transformer mounted in the starter unit. Primary wiring to the control power transformer shall be tapped to two (2) poles on the load side of the circuit breaker or fusible switch. Both primary wires shall be fused with 10- ampere, slow-blow fuses. The fuse on the ungrounded secondary side shall be capable of handling 100 percent to 125 percent of the rated control

transformer secondary current. Control power transformers shall be provided with volt-ampere (VA) ratings equal to a minimum of 125 percent of the volt-ampere (VA) load connected to the transformer.

B. All equipment, cabinets, and devices furnished under the Contract shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

C. All equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided.

D. All switches shall have double-pole, double-throw, contacts rated at a minimum of 600 VA, unless specifically noted otherwise.

E. Materials and equipment used shall bear a U.L. label wherever such labeling of equipment and materials are available.

F. Unless otherwise specified or indicated on the Drawings, all equipment shall be designed, furnished, and installed so that in the event of a power interruption, the equipment must be restarted manually after a power failure.

G. All power terminals shall be insulated and identified.

H. All instruments shall operate at 10 to 125 degrees F unless otherwise specified.

I. Internal wiring within all starters, panels, instruments, junction boxes and similar equipment, shall be brought out to numbered terminal strips for interconnection and field wiring.

J. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices. All internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the Drawings, Specifications, and supplier's data. Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors or on the side walls of panel/cabinet interiors unless otherwise indicated in the Contract Documents.

K. The functional control descriptions which appear in Section 17950 indicate interconnections between panels, instruments, and similar equipment. Unless otherwise noted, the Design/Builder shall provide all interconnecting wiring and conduit for complete control systems. The Design/Builder shall make all connections to equipment devices, instruments, and all components requiring electrical connection.

L. The shield on each instrumentation cable shall be continuous from source to destination and shall be grounded as directed by the manufacturer of the instrumentation equipment. In no case shall more than one ground point be employed for each shield. The ground point shall be as specified in Division 17. All analog control functions shall utilize 4-20 mADC control signals, unless otherwise specified. All analog transmission shall take place within shielded twisted cables which are not susceptible to interference or noise.

M. Lightning/surge protection shall be provided to protect the instrumentation and control system from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and shall be maintenance free and self-restoring. Equipment shall be housed in a suitable metallic case, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and, where practical, each ground wire run individually and insulated from each other. These protectors shall be mounted within the enclosure or in a separate NEMA 4 junction box coupled to the enclosure.

N. Reference Division 17 - Control and Information Systems for additional information regarding lightning/surge protection requirements.

3.02 FIELD TESTS

A. The Design/Builder shall conduct field tests prior to operation of the equipment. The Engineer shall witness all field testing. Field testing shall be conducted at a time approved by the Engineer. Field tests shall be conducted for all hardware components and shall include a functional check of all items. Field tests shall include a functional check of all instruments and control equipment. All equipment shall be connected and fully operational for field testing. Field tests shall demonstrate that the controls perform according to the Contract requirements and that all equipment, valves, switches, controls, alarms, interlocks, indicating lights, and similar equipment function properly. Based on the results of field tests, the Design/Builder shall make any required corrections to equipment and controls and shall make any adjustments required to the control logic and control settings to achieve the specified operation or operation otherwise directed by the Engineer. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. The Design/Builder shall make modifications and adjustments to the controls as directed by the Engineer for optimizing operation of the overall system. All costs in connection with field tests of equipment provided under the Contract, shall be borne by the Design/Builder. The Design/Builder shall be fully responsible for the proper operation of all motor starters and controls during the tests.

- END OF SECTION -

SECTION 17125

OPERATOR INTERFACE UNITS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation all operator interface units, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17100 – Digital System Hardware Configuration

PART 2 -- PRODUCTS

2.01 OPERATOR INTERFACE UNIT

A. An Operator Interface Unit (OIU) shall be provided to view and enter delivered sodium hypochlorite solution information using a text-based user interface. The OIU shall provide the following features as a minimum.

1. Minimum of 6.5 inch diagonal display
2. 18-bit color TFT LCD display of 640 X 480 pixels
3. Resistive film touch screen interface
4. Minimum of 512 MB internal storage
5. Minimum of 512 MB RAM application memory
6. 1.0 GHz CPU
7. Windows CE Operating System
8. Battery-backed real-time clock
9. Communication Interfaces:1 SD, 2 USB-A, 1 Mini-USB-B, and 1 PCI
10. RJ-45 Ethernet communication interface, 10/100 Mb auto selecting
11. RS-232 serial port
12. Sound and buzzer output
13. Windows-based configuration software complete with download cable
14. Operating Voltage: 120 VAC or 24 VDC (internal or via independent power supply)
15. Enclosure Rating: NEMA 12/4X to match the associated PLC cabinet rating
16. Environment: 0-55°C, 5-95% relative humidity, non-condensing

B. The operator interface unit shall be Allen-Bradley PanelView Plus 6 700, or equal.

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PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. The OIU shall be configured such that the operator can enter the delivered sodium hypochlorite solution data and the calculated (performed by the associated PLC) dilution water requirements shall be displayed.

B. All necessary configuration and programming software shall be provided on optical media and turned over to the Owner.

C. Unless otherwise noted, each OIU shall be mounted between 48 and 60 inches above the floor or work platform.

- END OF SECTION -

SECTION 17500

ENCLOSURES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

B. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17100 – Control and Information System Hardware, General

B. Section 17520 – Field Panels

C. Section 17550 – Panel Instruments and Accessories

D. Section 17560 –Surge Protection Devices

E. Section 17600 – Unpowered Instruments, General

F. Section 17700 – Powered Instruments, General

G. Refer to Division 16 for additional requirements for cable, circuit breakers, disconnect switches, etc.

1.03 GENERAL INFORMATION AND DESCRIPTION

A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.

B. Either manufacturer-standard or custom cabinetry may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.

C. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Design/Builder shall examine plans and/or field inspect new and existing structures as required to determine installation requirements, and shall coordinate the installation of all enclosures with the Owner and all affected contractors. The Design/Builder shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

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1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Supplies and spare parts shall be provided as specified in the individual cabinet and panel specification sections (175XX).

PART 2 -- PRODUCTS

2.01 TERMINAL BLOCKS

A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Weidmuller, Wieland, Square D, or equal.

B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.

C. Discrete signal terminal blocks shall be 2-tier with a minimum rating of 600 volts, 20 amps. One terminal block shall be used for each signal. The hot wire shall be installed on the top terminal.

D. Analog signal terminal blocks shall be 3-tier with a minimum rating of 600 volts, 20 amps. One terminal block shall be used for each signal. The + wire shall be installed on the top terminal and the shield wire shall be installed on the bottom terminal.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top (NEMA 12 cabinets only).

2. Thermostatically controlled, low noise internal air blowers (initial setpoint 75°F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure interior temperature alarm shall be displayed on the HMI.

E. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.

F. Wiring within cabinets, panels, and consoles shall be installed neatly and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16 of the Specifications, except that the minimum wire size for discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

G. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.

H. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

I. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.

J. A copper ground bus shall be installed in each cabinet, and shall be connected to the building power ground.

K. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 16123 - Building Wire and Cable. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 16123. Where applicable, the wire number shall be the ID number listed in the input/output schedules.

L. Wires shall be color coded as follows:

Equipment Ground - GREEN

120 VAC Power - BLACK
120 VAC Power Neutral - WHITE

120 VAC Control (Internally Powered) - RED
120 VAC Control (Externally Powered) - YELLOW

24 VAC Control - ORANGE

DC Power (+) - RED
DC Power (-) - BLACK
DC Control - BLUE

Analog Signal – BLACK/WHITE or BLACK/RED

M. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

N. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

O. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power". Letters in the word "WARNING" shall be 0.75 inch high, white.

P. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

3.02 PAINTING/FINISHING

A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 9 for additional requirements.

B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.

C. Panels fabricated from stainless steel shall not be painted.

D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be painted.

- END OF SECTION -

SECTION 17520

FIELD PANELS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the field panels, with all spare parts, accessories, and appurtenances as specified or shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17500 – Enclosures, General

PART 2 -- PRODUCTS

2.01 FIELD PANELS

A. Field panels for outdoor service shall be suitable for wall or pipe mounting. Panels shall have the following features:

1. Nonmetallic NEMA 4X construction.

2. Hinged and foamed-in-place continuous gasketed door(s). Door material shall match enclosure and shall have piano hinge(s) and three-point latches.

3. Thermal insulation and thermostatically controlled space heaters where required to prevent condensation or maintain environmental conditions for installed components.

4. External sun shields or shades constructed of the same materials as the associated enclosure, unless otherwise specified. Sun shield or shade shall be fitted to enclosure supports and not to enclosure. Sunshield or shade shall have a slightly sloped top to shed water and shall extend past the front of the enclosure by at least 6 inches and extend down the side and back of enclosure.

B. All external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to the temperature of the lines. Heat tape shall be powered from a GFCI circuit from within panel, unless otherwise shown or specified.

C. Field panels shall be adequately sized to house instruments, power supplies, surge protection, and appurtenant equipment required for operation. Sufficient space shall be provided for servicing instruments without removal of equipment from the enclosure.

D. Field panels shall be as manufactured by Hoffman, Saginaw Control and Engineering (SCE), or equal.

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PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17550

PANEL INSTRUMENTS AND ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the panel instruments and accessories, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17100 – Control and Information System Hardware, General

B. Section 17500 – Enclosures, General

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. The following specific spare parts items shall be provided:

1. One of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract. A spare operator interface unit, specified in Section 17125, is not required.

2. Five of each type of interposing relay provided under this Contract.

PART 2 -- PRODUCTS

2.01 ELECTRONIC INDICATORS

A. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor service as required and shall have the same NEMA enclosure rating as the associated enclosure. Indicators shall be Red Lion Model IMP or APLCL, or equal.

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2.02 SIGNAL CONVERTERS

A. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.

B. General Requirements – Converters shall be of the miniature type, utilizing all solid state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.

C. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

D. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4-20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

E. Frequency to Current Transducers – Frequency to current transducers shall convert pulse-rate and pulse-duration signals to 4-20 mA, 24 VDC analog signals. Converters shall include field-adjustable input frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5100 as manufactured by AGM, or equivalent by Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

F. Current to Frequency Transducers – Current to frequency transducers shall convert 4-20 mA, 24 VDC analog signals to pulse-rate and pulse-duration signals. Converters shall include field-adjustable output frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5016 as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

G. Integrators – Integrators shall be provided as interchangeable plug-in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be ± 0.1% of input span. Integrators shall convert linear analog signals to pulse rate and provide a solid-state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

H. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4-20 mADC, and the set point shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be ±0.1% per degree F. The repeatability shall be ±0.1% of span. The units shall be furnished with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

I. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4-20 mADC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Design/Builder shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer's standard enclosure for installation in an existing indoor electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

J. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be small format type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall have a flag indicator to show relay status, a pushbutton to allow manual operation of the relay, and an internal pilot light to indicate power to the coil. Relays shall be as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

K. Timing Relays – Timing Relays (TR) shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.

L. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA-classified hazardous areas. Intrinsically safe relays and barriers shall be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

2.03 ACCESSORIES

A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.

B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type. Pilot lights shall be of the proper control voltage, LED type with light lens colors as specified below.

Color	Function
Green	Running (Open)
Red	Stopped or Off (Closed)
Amber	Fault
White	Other

C. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.

D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.

E. Alarm horns shall be general-purpose type, panel-mounted, and shall be suitable for indoor or weatherproof service, as required. Power supply shall be either 115 VAC or 24 VDC. Horns shall be capable of producing 100 dB at 10 feet, and shall have adjustable volume. Horns shall be Vibratone series as manufactured by Federal Signal Corporation, McMaster-Carr equivalent, Edwards Signaling Company equivalent, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17560

SURGE PROTECTION DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, install and place in satisfactory operation the surge protection devices (SPDs) as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17100 – Control and Information System Hardware, General

B. Section 17500 – Enclosures, General

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All surge protectors of each type provided under this Contract shall be furnished by a single manufacturer.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Five of each type of surge protection device provided under this Contract shall be provided as spare parts.

PART 2 -- PRODUCTS

2.01 SURGE PROTECTION, GENERAL

A. All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.

B. Manufacturer's Requirements: All surge protection devices shall be manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Phoenix Contact, Weidmuller, Transtector, or equal.

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C. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.

D. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.

E. Device Locations: As a minimum, provide surge protection devices at the following locations:

1. At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters.

2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.

3. At both ends of all copper-based communication cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.

4. On all external telephone communication lines.

2.02 AC POWER PROTECTION

A. Surge protection device assemblies for connections to AC power supply circuits shall:

1. Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.

2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.

3. Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.

4. Comply with all requirements of UL 1449, latest edition.

5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6. Have the following characteristics:

a. Maximum Continuous Operating Voltage: 150VAC
b. Maximum Operating Current: 20 amps
c. Ambient Temperature Range: -20 degrees C to +65 degrees C
d. Response Time: 5 nanoseconds

2.03 ANALOG SIGNAL CIRCUIT PROTECTION

A. Surge protection device assemblies for analog signal circuits shall:

1. Have four lead devices with DIN Rail mounting.

2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

3. Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.

4. Comply with all requirements of UL 497B.

5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6. Limit line-to-line voltage to 40 volts on 24VDC circuits.

7. Have the following characteristics:

   a. Maximum Continuous Operating Voltage: 28VDC
   b. Ambient Temperature Range: -20 degrees C to +65 degrees C
   c. Response Time (Line-to-Line): 5 ns

2.04 COMMUNICATION CIRCUIT PROTECTION

A. Surge protection devices for copper-based data communication circuits shall:

1. Be designed for the specific data communication media and protocol to be protected (i.e. telephone, serial, parallel, network, data highway, coax, twinaxial, twisted pair, RF, etc.).

2. Provide protection of equipment to within the equipment's surge withstand levels for applicable standard test wave forms of the following standards:

   a. IEC 60-1 / DIN VDE 0432 part 2
   b. CCITT K17 / DIN VDE 0845 part 2
   c. IEEE C62.31

3. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

4. Provide automatic recovery.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17600

UNPOWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, install, test and place in operation process instrumentation (flow elements, pressure switches, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process controls as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Design/Builder shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17500 – Enclosures, General

B. Section 17698 – Instrumentation and Control System Accessories

C. Section 17700 – Powered Instruments, General

D. Unpowered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

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1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Spare parts as specified in individual instrument specification sections.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Unless otherwise specified, instruments shall be provided with enclosures to suit specified environmental conditions. Field-mounted devices shall be rugged and mounted on walls or pipe stanchions.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Equipment shall be located so that it is accessible for operation and maintenance.

B. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

C. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

D. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

E. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

3.02 ADJUSTMENT AND CLEANING

A. The Design/Builder shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced at no cost to the Owner. The Design/Builder shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field instrument calibration requirements shall conform to the following:

1. The Design/Builder shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The Design/Builder shall provide a written calibration sheet to the Owner for each instrument, certifying that it has been calibrated to its published specified accuracy. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard.

5. Upon completion of calibration, devices shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

- END OF SECTION -

SECTION 17650

PRESSURE GAUGES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17600 – Unpowered Instruments, General

B. Section 17698 – Instrumentation Accessories

PART 2 -- PRODUCTS

2.01 PRESSURE GAUGES

A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".

B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed the approximately 75% of the full-scale range.

C. Features

1. Mounting: ½" NPT, lower stem mount type
2. Accuracy: 0.5% full scale
3. Case: Solid front, black phenolic material
4. Dial: White background and black letters
5. Glass: Shatterproof
6. Blow-out protection: Back
7. Pressure element: stainless steel bourdon tube
8. Movement: Stainless steel, Teflon coated pinion gear and segment
9. Gaskets: Buna-N

D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid shall be halocarbon.

E. Gauge size shall be 2" for line sizes up to 3" and 4½" for line sizes of 4" or greater.

F. Diaphragm seals shall be furnished in accordance with the requirements specified under Section 17698 - Instrumentation and Control System Accessories.

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G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A ½" isolation ball valve shall be provided for each gauge assembly.

H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3.

- END OF SECTION -

SECTION 17698

INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17600 – Unpowered Instruments, General

B. Section 17700 – Powered Instruments, General

C. Section 16902 – Electric Controls and Relays

PART 2 -- PRODUCTS

2.01 INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

A. General: Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This subarticle shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

B. Process Tubing: Process tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37 degrees stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.

C. Power, Control and Signal Cables: Power, control and signal wiring shall be provided under Division 16 of the Specifications.

D. Chemical Diaphragm Seals: Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, all components shall be non-reactive with the process fluid in all cases. Refer to the Instrument Schedules for specific materials requirements. Seal shall have fill connection, 1/4-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

E. Filling Medium: The filling medium between instruments and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10°F to +150°F. Filling medium shall be halocarbon.

F. Isolation Valves: Isolation valves shall be 1/2 - inch diameter ball valves with 316 stainless steel body, 316 stainless steel ball, except that materials of construction shall be suitable for the associated process fluid where applicable (i.e., chemical service).

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3 of the specifications.

- END OF SECTION -

SECTION 17700

POWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, install, test and place in operation powered process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process control system as shown on the Drawings and as specified. Powered instruments are those instruments that require power (120 VAC or 24 VDC loop power) to operate. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Design/Builder shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17500 – Enclosures, General

B. Section 17600 – Unpowered Instruments, General

C. Section 17698 – Instrumentation and Control System Accessories

D. Powered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures which are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 (B) herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper-free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where the Contract Documents do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square by 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The Design/Builder shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced at no cost to the Owner. The Design/Builder shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. The Design/Builder shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. If the manufacturer's recommendations require calibration, each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy’s as set forth by the National Institute for Standards and Technology (NIST).

3. The Design/Builder shall provide a written calibration sheet to the Owner for each instrument, certifying that it has been calibrated to its published specified accuracy. The Design/Builder shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the Design/Builder shall perform a loop check. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

SECTION 17701

MAGNETIC FLOW METERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17700 – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a 316 stainless steel or carbon steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, hard rubber, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes.

D. Grounding rings shall be provided for both ends of all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C. Meter and transmitter housings shall meet NEMA 4X/IP66 requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Where the flow tube is subject to submergence through installation in a

meter vault or similar location, the flow tube assembly shall be rated NEMA 6P/IP68 and electronics shall be factory sealed against moisture intrusion. The use of field kits for modifying NEMA 4/4X/IP66 flow tubes to submergence duty shall not be acceptable. The associated transmitter shall be located in an area not subject to submergence.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. The remote configuration device shall be as specified under Section 17700. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.25% of rate over the flow velocity range of 0.3 to 10.0 m/s (1.0 to 33 ft/sec). Repeatability shall be $\pm$ 0.1% of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°C. Power supply shall be 115 VAC, 60 Hz.

M. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

N. Magnetic flow meter systems shall be as manufactured by Rosemount, ABB/Fischer & Porter, Endress + Hauser, Foxboro, Krohne Siemens, Toshiba or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

B. Refer to Section 17700, Part 3, for further requirements.

- END OF SECTION -

SECTION 17740

ULTRASONIC LIQUID LEVEL MEASUREMENT SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the ultrasonic liquid level measurement systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17700 – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 ULTRASONIC LEVEL CONTROLLERS

A. Each ultrasonic level monitoring system shall include one ultrasonic level sensor and an "intelligent" transmitter (controller). The ultrasonic level monitoring system shall be required to monitor the level of process liquids or solids as shown on the Drawings and/or as specified herein. Location of the sensor and transmitters shall be as shown on the Drawings and/or as specified.

B. For outdoor installation, the use of approved watertight conduit hub/glands shall be required. Tank mounting applications shall include mounting flange adapter supplied by the manufacturer, which is compatible with the process media and the tank flange connection. Channel or wall mounting applications shall include mounting bracket supplied by the manufacturer and constructed of 316 stainless steel material. Sensor mounting thread shall be 1" NPT.

C. The level sensor shall be unaffected by moisture droplets on the transducer face and operate on the ultrasonic echo ranging principle. The sensor shall also be fully submersible and resistant to corrosive materials. Sensor accuracy shall be a minimum of 0.25 percent of level measurement range, and include integral temperature compensation with an accuracy of 0.09% of range. Resolution shall be at least 0.1 percent of full range or 0.08 inches, whichever is greater.

D. Display shall be LCD with backlighting, shall have the capability to display a minimum of 4 characters at one time, and shall be shielded from direct sunlight. The units shall have as a minimum, the required number of programmable set points to perform the functions specified. Each set point shall operate a set of contacts rated at 5 amps, 250 VAC, non-inductive.

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E. The transmitter shall compensate for changes in temperature and air density. The controller shall be capable of performing the following functions: level monitor, volumetric calculation, and remote alarm contacts. Output level signal shall be linear, isolated 4-20 mA DC. Power requirement for the transmitter shall be 120 VAC, 60 Hz. The units shall have a NEMA 4X stainless steel or nonmetallic enclosure.

F. Ultrasonic level measurement system shall be the LUT420/EchoMax Series Transducers by Siemens/Milltronics, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Where level transducers may become submerged, provide a manufacturer-supplied submergence hood.

B. Where level transducers are mounted on tanks, the Design/Builder shall coordinate the tank instrument mounting nozzle dimensions and geometry with the instrument manufacturer's installation requirements.

C. Refer to Section 17700, Part 3 of the specifications for additional requirements.

- END OF SECTION -

SECTION 17751

RF ADMITTANCE LEVEL SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation all RF Admittance level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17700 – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 RF ADMITTANCE SWITCHES

A. The RF Admittance level switch shall consist of a sensing element and dual electronics compartment. The sensing element shall be mounted in the vessel and provides a change in radio frequency (RF) admittance indicating the presence or absence of material in the vessel.

B. RF Admittance level switches shall have the following specifications:

1.	Temperature Limit:	-40 °C to 70 °C
2.	Pressure Limit:	50 PSI
3.	Switch Type / Quantity:	Two SPDT; the first set of switches shall be for alarm purposes, the second set of switches shall be user configurable (alarm or fault).
4.	Switch Rating:	5 A, 120 VAC
5.	Sensing Element Material:	PFA (material must be compatible with process fluid)
6.	Mounting:	¾" NPT, PFA or based on sensing material
7.	Remote Electronics:	Three (3) conductor coaxial cable up to 75 feet from sensing element.
8.	Diagnostics:	Continuous self checks electronics and sensing element for faults.
9.	Supply Voltage:	120 VAC
10.	Repeatability:	2 mm
11.	Response Time:	Less than 1 second
12.	Electronics:	Dual compartment, powder coated aluminum, IP66 NEMA 4X rated
13.	Enclosure Classification:	Class I, Div 1&2, Groups A, B, C, D Class II, Groups E, F, G

C. Manufacturer/Model: IntelliPoint RF Series by AMETEK Drexelbrook, equivalent by Siemens or approved equal.

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PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Where level switches are mounted on tanks, the Design/Builder shall coordinate the tank instrument mounting nozzle dimensions and geometry with the instrument manufacturer's installation requirements.

B. Refer to Section 17700, Part 3 of the specifications for additional requirements.

- END OF SECTION -

SECTION 17760

PRESSURE INDICATING TRANSMITTERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation the pressure indicating transmitter, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17700 – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 GAUGE PRESSURE INDICATING TRANSMITTERS

A. Gauge pressure transmitters shall be of the capacitance type with a process-isolated diaphragm with silicone oil fill, microprocessor-based "smart" electronics, and a field adjustable rangeability of 100:1 input range. Span and zero shall be continuously adjustable externally over the entire range. Span and zero adjustments shall be capable of being disabled internally. Transmitters shall be NEMA 4X weatherproof and corrosion resistant construction with low-copper aluminum body and 316 stainless steel process wetted parts. Accuracy, including nonlinearity, hysteresis and repeatability errors shall be plus or minus 0.075 percent of calibrated span, zero based. The maximum zero elevation and maximum zero suppression shall be adjustable to anywhere within sensor limits. Output shall be linear isolated 4-20 milliamperes 24 VDC. Power supply shall be 24 VDC, two-wire design. Each transmitter shall be furnished with a 4-digit LCD indicator capable of displaying engineering units and/or milliamps and mounting hardware as required. Overload capacity shall be rated at a minimum of 25 MPa. Environmental limits shall be -40 to 85 degrees Celsius at 0-100% relative humidity. Each transmitter shall have a stainless steel tag with calibration data attached to body.

B. The piezoresistive silicon pressure sensor shall be mechanically, electrically, and thermally isolated from the process and the environment, shall include an integral temperature compensation sensor, and shall provide a digital signal to the transmitter's electronics for further processing. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA

output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds. Total long term stability (frequency of calibration) shall be not less than 0.125% for five years.

C. Where scheduled, gauge pressure indicating transmitters shall be calibrated in feet of liquid for liquid level service.

D. Gauge pressure indicating transmitters shall be Model 3051T as manufactured by Rosemount, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17910

INSTRUMENT SCHEDULE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17920 - Control System Input / Output Schedule

B. Section 17950 - Functional Control Descriptions

PART 2 -- INSTRUMENT SCHEDULE

Pressure Gauges - Section 17650			
Tag Number	**Service Description**	**State/Span**	**Remarks**
PI 203	Dilution Water Pressure	0-100 psi	
PI 201	Hypochlorite Transfer Pump 1 Discharge Pressure	0-50 psi	Diaphragm Seal
PI 202	Hypochlorite Transfer Pump 2 Discharge Pressure	0-50 psi	Diaphragm Seal
PI 204	Carrying Water Pressure	0-100 psi	
Magnetic Flow Meters - Section 17701			
Tag Number	**Service Description**	**State/Span**	**Remarks**
FE/FIT 200	Sodium Hypochlorite Dilution Water Flow	0-150 gpm	Line size: 2"
Ultrasonic Liquid Level Measurement Systems - Section 17740			
Tag Number	**Service Description**	**State/Span**	**Remarks**

LE/LIT 201	Sodium Hypochlorite Bulk Storage Tank 1 Level	0-16 ft	
LE/LIT 202	Sodium Hypochlorite Bulk Storage Tank 1 Level	0-16 ft	
RF Admittance Level Switches - Section 17751			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LSH 101	Sodium Hypochlorite Day Tank 1 Level High	11 ft	See Note 1
LSH 102	Sodium Hypochlorite Day Tank 2 Level High	11 ft	See Note 1
Pressure Indicating Transmitters - Section 17760			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LIT 103	Sodium Hypochlorite Day Tank Level	0-11 ft w.c.	

Notes:

1. Initial setting relative to day tank invert.

- END OF SECTION -

SECTION 17920

CONTROL SYSTEM INPUT / OUTPUT SCHEDULE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation all control system inputs and outputs as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17910 - Instrument Schedule

B. Section 17950 - Functional Control Descriptions

2.01 INPUT/OUTPUT SCHEDULE

Service Description	State/Span	Type	PLC	Input/Output	TB	Notes
Sodium Hypochlorite Bulk Storage Tank 1 Level		AI	4A	I:6.0	116, 117	Existing spare
Sodium Hypochlorite Bulk Storage Tank 2 Level		AI	4A	I:6.1	132, 133	Existing spare
Sodium Hypochlorite Dilution Water Flow		AI	4A	I:6.2	134, 135	Existing spare
Sodium Hypochlorite Control Panel Temperature	High	DI	4A	I:3/2	40	Existing prewired spare
Sodium Hypochlorite Bulk Storage Tank 1 Max Fill Pilot Light	Activate	DO	4A	O:1/4	2241	Existing spare
Sodium Hypochlorite Bulk Storage Tank 2 Max Fill Pilot Light	Activate	DO	4A	O:1/5	2261	Existing spare
Sodium Hypochlorite Dilution Water Valve 1 Control	Open	DO	4A	O:9/0	90	New DO module
Sodium Hypochlorite Dilution Water Valve 2 Control	Open	DO	4A	O:9/1	91	New DO module
Sodium Hypochlorite Bulk Storage Tank XConnect Valve Status	Remote	DI	4A	I:3/3	4	Existing prewired spare
Sodium Hypochlorite Bulk Storage Tank XConnect Valve Position	Opened	DI	4A	I:3/4	42	Existing prewired spare
Sodium Hypochlorite Bulk Storage Tank XConnect Valve Position	Closed	DI	4A	I:3/5	43	Existing prewired spare
Sodium Hypochlorite Bulk Storage Tank XConnect Valve Control	Open	DO	4A	O:9/2	72	New DO module
Sodium Hypochlorite Transfer Valve 1 Position	Recirc	DI	4A	I:3/8	46	Existing prewired spare
Sodium Hypochlorite Transfer Valve 1 Position	Transfer	DI	4A	I:3/9	47	Existing spare

Service Description	State/Span	Type	PLC	Input/Output	TB	Notes
Sodium Hypochlorite Transfer Valve 1 Control	Transfer	DO	4A	O:9/3	73	New DO module
Sodium Hypochlorite Transfer Valve 2 Position	Recirc	DI	4A	I:3/10	48	Existing spare
Sodium Hypochlorite Transfer Valve 2 Position	Transfer	DI	4A	I:3/11	49	Existing spare
Sodium Hypochlorite Transfer Valve 2 Control	Transfer	DO	4A	O:9/4	74	New DO module
Sodium Hypochlorite Transfer Pump 1 Status	Run	DI	4A	I:3/12	50	Existing spare
Sodium Hypochlorite Transfer Pump 1 Status	Fail	DI	4A	I:3/13	51	Existing spare
Sodium Hypochlorite Transfer Pump 1 Control	Stop	DO	4A	O:9/5	75	New DO module
Sodium Hypochlorite Transfer Pump 2 Status	Run	DI	4A	I:3/14	52	Existing spare
Sodium Hypochlorite Transfer Pump 2 Status	Fail	DI	4A	I:3/15	53	Existing spare
Sodium Hypochlorite Transfer Pump 2 Control	Stop	DO	4A	O:9/6	76	New DO module
Sodium Hypochlorite Day Tank Level		AI	4	I:12.1	220, 221	Existing Chlorine Weight #1
Sodium Hypochlorite Day Tank 1 Level	High	DI	4	I:3/14	62	Existing Chlorinator 1 Low Vacuum Alarm
Sodium Hypochlorite Day Tank 2 Level	High	DI	4	I:3/15	63	Existing Chlorinator 2 Low Vacuum Alarm
Sodium Hypochlorite Metering Pump 1 Status	Run	DI	4	I:4/0	64	Existing Chlorinator 3 Low Vacuum Alarm
Sodium Hypochlorite Metering Pump 1 Status	Remote	DI	4	I:4/1	65	Existing Chlorinator 4 Low Vacuum Alarm
Sodium Hypochlorite Metering Pump 1 Status	Fail	DI	4	I:4/2	66	Existing Chlorinator 5 Low Vacuum Alarm
Sodium Hypochlorite Metering Pump 1 Control	Start/Stop	DO	4	O:28/0	154	New DO module; Note 2
Sodium Hypochlorite Metering Pump 1 Speed Feedback	0-100%	AI	4	I:18.0	295, 296	New AI module; Note 2
Sodium Hypochlorite Metering Pump 1 Speed Control	0-100%	AO	4	O:20.0	242, 243	Existing Chlorinator 1 Setpoint
Sodium Hypochlorite Metering Pump 2 Status	Run	DI	4	I:4/3	67	Existing Chlorinator 6 Low Vacuum Alarm
Sodium Hypochlorite Metering Pump 2 Status	Remote	DI	4	I:4/4	68	Existing Chlorinators High Vacuum Alarm
Sodium Hypochlorite Metering Pump 2 Status	Fail	DI	4	I:4/5	69	Existing Cl2 Cylinder Replaced
Sodium Hypochlorite Metering Pump 2 Control	Start/Stop	DO	4	O:28/1	155	New DO module; Note 2
Sodium Hypochlorite Metering Pump 2 Speed Feedback	0-100%	AI	4	I:18.1	297, 298	New AI module; Note 2
Sodium Hypochlorite Metering Pump 2 Speed Control	0-100%	AO	4	O:20.1	244, 245	Existing Chlorinator 2 Setpoint
Sodium Hypochlorite Metering Pump 3 Status	Run	DI	4	I:27/1	139	New DI module; Note 2
Sodium Hypochlorite Metering Pump 3 Status	Remote	DI	4	I:27/2	140	New DI module; Note 2
Sodium Hypochlorite Metering Pump 3 Status	Fail	DI	4	I:27/3	141	New DI module; Note 2
Sodium Hypochlorite Metering Pump 3 Control	Start/Stop	DO	4	O:28/2	156	New DO module; Note 2
Sodium Hypochlorite Metering Pump 3 Speed Feedback	0-100%	AI	4	I:18.2	299, 300	New AI module; Note 2
Sodium Hypochlorite Metering Pump 3 Speed Control	0-100%	AO	4	O:20.2	246, 247	Existing Chlorinator 3 Setpoint

Service Description	State/Span	Type	PLC	Input/Output	TB	Notes
Sodium Hypochlorite Metering Pump 4 Status	Run	DI	4	I:27/4	142	New DI module; Note 2
Sodium Hypochlorite Metering Pump 4 Status	Remote	DI	4	I:27/5	143	New DI module; Note 2
Sodium Hypochlorite Metering Pump 4 Status	Fail	DI	4	I:27/6	144	New DI module; Note 2
Sodium Hypochlorite Metering Pump 4 Control	Start/Stop	DO	4	O:28/3	157	New DO module; Note 2
Sodium Hypochlorite Metering Pump 4 Speed Feedback	0-100%	AI	4	I:18.3	301, 302	New AI module; Note 2
Sodium Hypochlorite Metering Pump 4 Speed Control	0-100%	AO	4	O:20.3	248, 249	Existing Chlorinator 4 Setpoint
Sodium Hypochlorite Metering Pump 5 Status	Run	DI	4	I:27/7	145	New DI module; Note 2
Sodium Hypochlorite Metering Pump 5 Status	Remote	DI	4	I:27/8	146	New DI module; Note 2
Sodium Hypochlorite Metering Pump 5 Status	Fail	DI	4	I:27/9	147	New DI module; Note 2
Sodium Hypochlorite Metering Pump 5 Control	Start/Stop	DO	4	O:28/4	158	New DO module; Note 2
Sodium Hypochlorite Metering Pump 5 Speed Feedback	0-100%	AI	4	I:19.0	303, 304	New AI module; Note 2
Sodium Hypochlorite Metering Pump 5 Speed Control	0-100%	AO	4	O:21.0	250, 251	Existing Chlorinator 5 Setpoint
Sodium Hypochlorite Metering Pump 6 Status	Run	DI	4	I:27/10	148	New DI module; Note 2
Sodium Hypochlorite Metering Pump 6 Status	Remote	DI	4	I:27/11	149	New DI module; Note 2
Sodium Hypochlorite Metering Pump 6 Status	Fail	DI	4	I:27/12	150	New DI module; Note 2
Sodium Hypochlorite Metering Pump 6 Control	Start/Stop	DO	4	O:28/5	159	New DO module; Note 2
Sodium Hypochlorite Metering Pump 6 Speed Feedback	0-100%	AI	4	I:19.1	305, 306	New AI module; Note 2
Sodium Hypochlorite Metering Pump 6 Speed Control	0-100%	AO	4	O:21.1	252, 253	Existing Chlorinator 6 Setpoint
Sodium Hypochlorite Metering Pump 7 Status	Run	DI	4	I:27/13	151	New DI module; Note 2
Sodium Hypochlorite Metering Pump 7 Status	Remote	DI	4	I:27/14	152	New DI module; Note 2
Sodium Hypochlorite Metering Pump 7 Status	Fail	DI	4	I:27/15	153	New DI module; Note 2
Sodium Hypochlorite Metering Pump 7 Control	Start/Stop	DO	4	O:28/6	160	New DO module; Note 2
Sodium Hypochlorite Metering Pump 7 Speed Feedback	0-100%	AI	4	I:19.2	307, 308	New AI module; Note 2
Sodium Hypochlorite Metering Pump 7 Speed Control	0-100%	AO	4	O:24.3	280, 281	Existing spare
Sodium Hypochlorite Feed Area Eyewash/Shower	In Use	DI	4	I:27/0	138	New DI module; Note 2
Sodium Hypochlorite Carrier Water Solenoid Valve	Open	DO	4	O:9/7	171	Existing spare
Sodium Hypochlorite Sump Level Switch	High	DI	4	I:8/1	356	Existing

Notes:

1. Input / Output types are as follows:

   DI - Discrete Input
   DO - Discrete Output

Service Description	State/Span	Type	PLC	Input/Output	TB	Notes

AI - Analog Input
AO - Analog Output

2. All signal terminal blocks associated with new I/O modules are installed in the new junction box mounted to the right side of the RTU-4 enclosure.

- END OF SECTION -

SECTION 17950

FUNCTIONAL CONTROL DESCRIPTIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Design/Builder shall furnish, test, install and place in satisfactory operation all equipment as herein specified and as shown on the Drawings. THE DESIGN/BUILDER SHALL BE RESPONSIBLE FOR FURNISHING COMPLETE FUNCTIONING SYSTEMS AS DESCRIBED HEREIN.

B. Together with the control system input/output schedule, the equipment specifications, and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.

C. THE FUNCTIONAL DESCRIPTIONS CONTAIN REQUIREMENTS FOR FURNISHING AND INSTALLING LABOR AND MATERIALS THAT MAY NOT APPEAR ELSEWHERE IN THE CONTRACT DOCUMENTS.

D. All equipment and services required in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Design/Builder through individual equipment suppliers.

E. Unless specifically stated otherwise, all interconnected wiring between all instruments, panels, controls, and other devices listed in the functional descriptions as required to provide all functions specified herein shall be furnished by the Design/Builder under Division 16. The Design/Builder shall provide all cable and conduit required to carry all signals listed in the process input/output schedules. Special cables that are required for interconnection between sensors or probes and transmitters or signal conditioners shall be furnished with the instrumentation devices by the equipment supplier.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17910 – Instrument Schedule

B. Section 17920 – Control System Input/Output Schedule

PART 2 -- FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL

2.01 DEFINITIONS

A. RUNNING status signals shall be from auxiliary contacts provided with the motor control equipment (i.e., starter, VFD, SCR, etc.).

B. AUTO status signals shall be defined as HAND-OFF-AUTO switch in the AUTO position or process control system in AUTO (versus MANUAL).

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C. FAIL status signals shall be defined as motor overload and/or any other shut down mode such as overtorque, overtemperature, low oil pressure, high vibration, etc.

D. READY status signal shall be defined as all conditions, including equipment control power, satisfied to permit remote control of the equipment.

E. HUMAN-MACHINE INTERFACE (HMI) shall be defined as any text-based or graphical user interface including but not limited to PC-based operator workstations and operator interface units (OIUs).

2.02 CONVENTIONS

A. Operator workstation graphic display symbols and indicator lights on all MCC's, control panels, starter enclosures, etc. shall conform to the following color convention:

Condition	Color
Running/On/Open	Green
Auto/Ready	White
Stopped/Off/Closed	Red
Fail/Alarm	Amber
Generic Status	Blue or White

2.03 PROCESS CONTROL

A. Where setpoints, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable and, based on actual operating conditions, the Design/Builder shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.

B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:

1. For alarms and control actions derived from analog input signals, use adjustable time delays and deadbands.

2. For alarms and control actions derived from discrete input signals, use adjustable time delays.

3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for deadbands shall be 5% of span (range 0-100%).

4. Equipment that is started or stopped manually by the operator shall start or stop immediately, with no time delay.

C. Unless otherwise specified, all equipment shall be capable of being manually controlled at the HMI. This manual mode of operation shall be provided in addition to any automatic mode of operation described herein. Manual or automatic mode, where applicable, shall be selectable at the HMI.

D. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero.

E. Equipment failure shall be generated through the PLC for any drive, motor, etc. for which a command has been issued, but for which the PLC is not receiving a confirming status signal (e.g., start command with no run feedback). The failure shall be logged.

F. Instrument failure shall be generated via the operator work stations for any instrument which is generating a signal which is less than 4 mA or greater than 20 mA.

G. A control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in AUTO. If equipment within an equipment chain is required to be running for program operation and it is running in HAND or MANUAL, then the program shall run and control the other equipment that is in AUTO.

H. All PLC wait states (internal time delays, etc.) after an operator action shall be displayed on the operator workstation.

PART 3 -- FUNCTIONAL CONTROL DESCRIPTIONS

3.01 SODIUM HYPOCHLORITE STORAGE

A. Process Overview

1. The Carvins Cove WTF currently uses a chlorine gas system to provide pre-oxidation and disinfection in its treatment process. The existing gas feeders and chlorine solution system shall be replaced with a sodium hypochlorite storage and feed system as specified and shown on the Drawings.

2. The sodium hypochlorite storage facilities shall include a Sodium Hypochlorite Control Panel; a water softener and magnetic flow meter for hypochlorite dilution water; two sodium hypochlorite bulk storage tanks, with a motor-operated valve provided in the piping connecting the two tanks; two recirculation/transfer pumps, each provided with a motor-operated valve on the discharge for directing flow to either bulk tank or day tanks; two day tanks (operating as a common tank); and an emergency shower/eyewash station in the day tank area.

B. Control Equipment

1. Existing motor starters, located in MCC-B, shall be used to start/stop each of the two new sodium hypochlorite transfer pumps.

2. One NEMA 4X nonmetallic Sodium Hypochlorite Control Panel shall be provided at the fill station to monitor and control product delivery and transfer operation. The panel rear subplate shall be sized to accommodate six 1-inch conduit entries through the back of the enclosure. Control and power conduits shall be separated by at least 12 inches. The control panel shall have a “dead front” and sunshade that is stood off from the panel to absorb heat. The control panel shall be provided with the following devices mounted on the interior door:

a. Panel-mounted Operator Interface Unit

b. Transfer Pump START/STOP pushbuttons (for both pumps)
c. Transfer Pump RUNNING indication light (for both pumps)
d. Transfer Pump FAIL indication light (for both pumps)
e. Cross Connect Valve LOCAL/REMOTE selector switch
f. Cross Connect Valve OPEN/CLOSE pushbuttons
g. Cross Connect Valve OPEN position indication light
h. Cross Connect Valve CLOSED position indication light
i. Transfer Valve RECIRC/TRANSFER pushbuttons (for both valves)
j. Transfer Valve RECIRCULATION position indication light (for both valves)
k. Transfer Valve TRANSFER position indication light (for both valves)
l. Tank 1 MAX FILL indication light
m. Tank 2 MAX FILL indication light

3. An ultrasonic level transmitter and associated transducer shall be provided for each of the two bulk storage tanks.

4. One pressure indicating transmitter shall be provided to measure level in the two day tanks.

5. The existing Milltronics AiRanger XPL ultrasonic level measurement system, located in Chemical Building 2, shall be modified as required to accommodate the new bulk storage tank configuration.

6. An RF admittance type level switch shall be provided for each of the two day tanks.

7. One magnetic flow meter shall be provided to measure dilution water flow.

8. Two two-way solenoid valves shall be provided for dilution water service.

C. Control Operations

1. Continuous level and liquid volume in the sodium hypochlorite storage tanks shall be displayed on the HMI. An alarm shall be generated at the HMI upon reaching low or high level conditions in any of the tanks.

2. The operator shall enter a desired sodium hypochlorite solution concentration at the HMI, initially set at 5%. The PLC shall then calculate the effective density of the sodium hypochlorite solution as follows:

Effective Density (lbs available Cl_2 per gal) = [Trade Concentration (%)] * 0.08345

3. Product Delivery

a. The operator shall manually transfer existing chemical from the bulk storage tanks to the day tanks from the Sodium Hypochlorite Control Panel prior to new product delivery.

b. The operator shall initiate product delivery by pressing a corresponding button at the operator interface unit (OIU) mounted on the Sodium Hypochlorite Control Panel. Bulk tank level equalization shall occur as follows if the valve on the line connecting the two tanks is in REMOTE mode.

Automatic tank level equalization shall be omitted if this valve is not in REMOTE mode.

i. The PLC shall automatically open the valve. The PLC shall also automatically position the valves on the recirculation/transfer pump discharge in the recirculation position.

ii. The PLC shall then automatically close the valve on the line connecting the two tanks when the levels in the two bulk storage tanks equalize, within +/- 1%.

iii. An alarm shall be generated at the HMI upon any of the following conditions:

- The valve on the line connecting the two tanks has not closed within 10 minutes after opening.

- New product is delivered while the valve on the line connecting the two tanks is in the open position. This shall be determined to be occurring if the sum of the two tank levels increases while the valve on the line connecting the two tanks is not in the fully closed position.

- Either recirculation/transfer pump discharge valve does not remain in the recirculation position throughout the product delivery operation.

c. The operator shall enter the concentration of the newly delivered sodium hypochlorite solution into the Sodium Hypochlorite Control Panel OIU. The PLC shall then calculate the effective density of the delivered sodium hypochlorite solution as described above.

d. After the existing product in the bulk storage tanks has been equalized (refer to paragraph b, above), the following filling process shall commence.

i. A single fill connection shall be used to fill both storage tanks.

ii. The PLC shall continuously calculate the volume of the newly delivered product and shall continuously calculate the volume of water required to dilute the product down to the desired concentration as follows:

Dilution Water Required (gal) = A * B / C – A, where:

A = Delivered product volume (gal)
B = Delivered product effective density (lbs available Cl2 per gal)
C = Diluted product effective density (lbs available Cl_2 per gal)

iii. When the sum of the measured product level and the calculated dilution water level in either bulk storage tank reaches 5% less than the invert of the respective tank's overflow pipe, the PLC shall activate the associated bulk storage tank MAX FILL indication light located on the Sodium Hypochlorite Control Panel.

iv. When a bulk storage tank's MAX FILL indication light illuminates, the operator shall manually close the respective fill valve at the fill station and continue to deliver new product to the other bulk storage tank.

v. When the product delivery process has finished, the operator shall press a corresponding button on the Sodium Hypochlorite Control Panel OIU.

e. The following shall occur after the operator confirms (via prompt) the calculated dilution water volume at the OIU:

i. The PLC shall open Dilution Water Flow Control (solenoid) Valve 1 until the calculated volume of dilution water has been delivered to Bulk Storage Tank 1.

ii. After Dilution Water Flow Control (solenoid) Valve 1 has closed, the PLC shall open Dilution Water Flow Control (solenoid) Valve 2 until the calculated volume of dilution water has been delivered to Bulk Storage Tank 2.

iii. After Dilution Water Flow Control (solenoid) Valve 2 has closed, a "Delivery Completed" message shall be displayed on the HMI for 30 seconds.

4. Transfer / Recirculation Pumps

a. The Transfer / Recirculation pumps shall be manually controlled at the Sodium Hypochlorite Control Panel to recirculate product within a bulk storage tank, to transfer product between bulk storage tanks, or to transfer product to the day tanks.

b. The PLC shall automatically stop the running Transfer / Recirculation pump(s) and modulate the associated Transfer Valve to the Recirculation position upon any of the following conditions. The operator shall enable/disable this functionality individually at the HMI:

i. Low level condition in the source bulk storage tank

ii. High level in either of the other (i.e., not the source) tanks

iii. After an adjustable time delay, initially set at 90 minutes (range: 0-120 minutes), elapses after the next pump start occurring after product delivery completion. Independent time delays shall be provided for each pump, but will share a common setpoint. This interlock is intended to automatically stop the Transfer / Recirculation Pumps when they are used to recirculate product within the associated bulk storage tanks immediately after product delivery.

3.02 SODIUM HYPOCHLORITE METERING PUMPS

A. Process Overview

1. The sodium hypochlorite feed facilities shall include seven peristaltic metering pumps, each provided with an integral controller. The metering pumps shall pump diluted sodium hypochlorite to the existing chlorine application points as follows:

- One 7-gph pump for feed to the 44 Top of Filter application point
- One 10-gph pump for feed to the 54 Top of Filter application point
- One 8-gph pump for feed to the 44/54 Flash Mix application point
- One 10-gph pump for feed to the 94 Top of Filter application point
- One 49-gph pump for feed to the 36” Post Filter application point
- One 49-gph pump for feed to the 42” Post Filter application point
- One 49-gph pump for feed to the 94 Flash Mix application point and to serve as an installed spare for all pumps

B. Control Equipment

1. The metering pumps shall be provided under Division 11 with an integral digital controller.

2. One two-way solenoid valve shall be provided for carrying water service.

C. Control Operations

1. When the digital controller is in the Remote mode, the metering pump shall be controlled by the operator via the PLC as described below.

2. The operator shall select the duty pump for each of the six sodium hypochlorite application points at the HMI.

3. Pumps shall be manually started and stopped at the HMI. Pump speed (0-100%) shall also be manually entered at the HMI.

4. Upon duty metering pump failure, the operator shall select a different pump for that service and shall manually open or close the appropriate isolation valves to properly configure the alternate flow path.

5. The operator shall be prompted to confirm that all isolation valves are correctly positioned prior to starting any pump.

6. The PLC shall close the solenoid valve on the carrying water line when the plant is taken out of service each night and shall open the valve when the plant is placed back in service each morning. The solenoid valve shall be opened when the calculated plant flow becomes greater than 3 mgd and shall be closed 300 seconds after plant flow becomes less than 3 mgd, similar to the other existing water solenoid valves.

- END OF SECTION -